THE SMART FRAME 2.0:

AN REDESIGN OF EXPOSITION SETUP FOR 3D-PRINTED FINEART REPLICAS

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THE SMART FRAME 2.0: AN REDESIGN FOR THE EXPOSITION SETUP FOR 3D-PRINTED REPLICA

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This was an unconventional redesign project in terms of its process, which called for extraordinary effort to go through. Without the wonderful people and their effort, I would not accomplish this unusual but fruitful journey. So, for me, I was just the tiny one who was standing on the shoulder of giants (as shown in figure A) and my families, friends, supervisors, and participants who involved were all giants who supported me until the destination.

First and foremost, I am very grateful for the exceptional supervisory team, Sylvia and Tessa. Your criticism and encouragement guided my direction and accelerated my pace. The words from you were always helpful and insightful from the very beginning to the very end. Thank you for being my giants whose shoulders were powerful and tender .

The project was supported by the Museumfutures Lab. It was my fortune to have all the fellow students in the lab as helpful and inspiring companions on this journey. You were all so great to be my giants.

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Last but not least, I give my sincere appreciation to my family and my girlfriend who provided me both practical and emotional support. You were the greatest giant not only in journey but also in my life.

Figure A Standing on the shoulder of giant

INTRODUCTION

The project is part of 3D fine art reproduction program in the faculty of industrial design engineering. The alliance of the 3D scanning and the data processing technology from TU Delft and the 3D printing technology from Océ has created the possibility to print a lifelike reproduction of a historical painting including its texture and structure. Characterized by its durability, high-fidelity and the compatibility with all environmental conditions, the 3D fine art replica is aiming to fostering better experience of exploring a certain oil painting for art museum visitors who can not only look at paintings but also touch them.

The Smart Frame, as the name of the exposition setup for 3D printed fine art reproductions, was designed to provide specific information regarding the content of the painting and the technique of the painter in an universal way. The project first generally analyzed the role of expositions and exhibitions and the opportunities that allow reproductions to be part of a museum within the context of the museum, then it analyzed the influence of light on the perception of paintings together with the features of 3d printed reproductions in terms of visual qualities and production technique. From these analysis, conclusions were transferred into the final design of the Smart Frame1.0 (as shown in figure B). This design was also validated and refined into the Smart Frame1.1(as shown in figure C) after certain simulation and testing.

However, in the former project, there was no clear proposition of the valuable outcome for a target user group in a certain context. Hence, this follow-up project will first gain insight from the current user experience of the Smart Frame 1.1(as shown in figure C), then define target group based on the various expectation of art museum visitors. In order to make the new design of the exposition setup more convincing and promising, this project will also illustrate the future vision of art museums. Followed by the proposition, an user-orientated design goal and interaction vision will be formulated. Finally, there will be a redesign of the Smart Frame (the Smart Frame 2.0) aiming at the fulfillment of the design brief. Therefore, the design assignment for this graduation is:
"To redesign the Smart Frame for optimizing its user experience after clarifying its proposition"
The assignment comes with a number of subquestions:

- *What experience will art museum provide in the future?*
- *What is the proper location for exhibiting 3D replica in an art museum?*
- *How do visitors' art knowledge and interest affect their expectation when viewing a painting?*
- *How can visitors experience 3D printed replica to fulfill their expectation?*
- *How can the Smart Frame support the experience?*

Figure B The Smart Frame 1.0

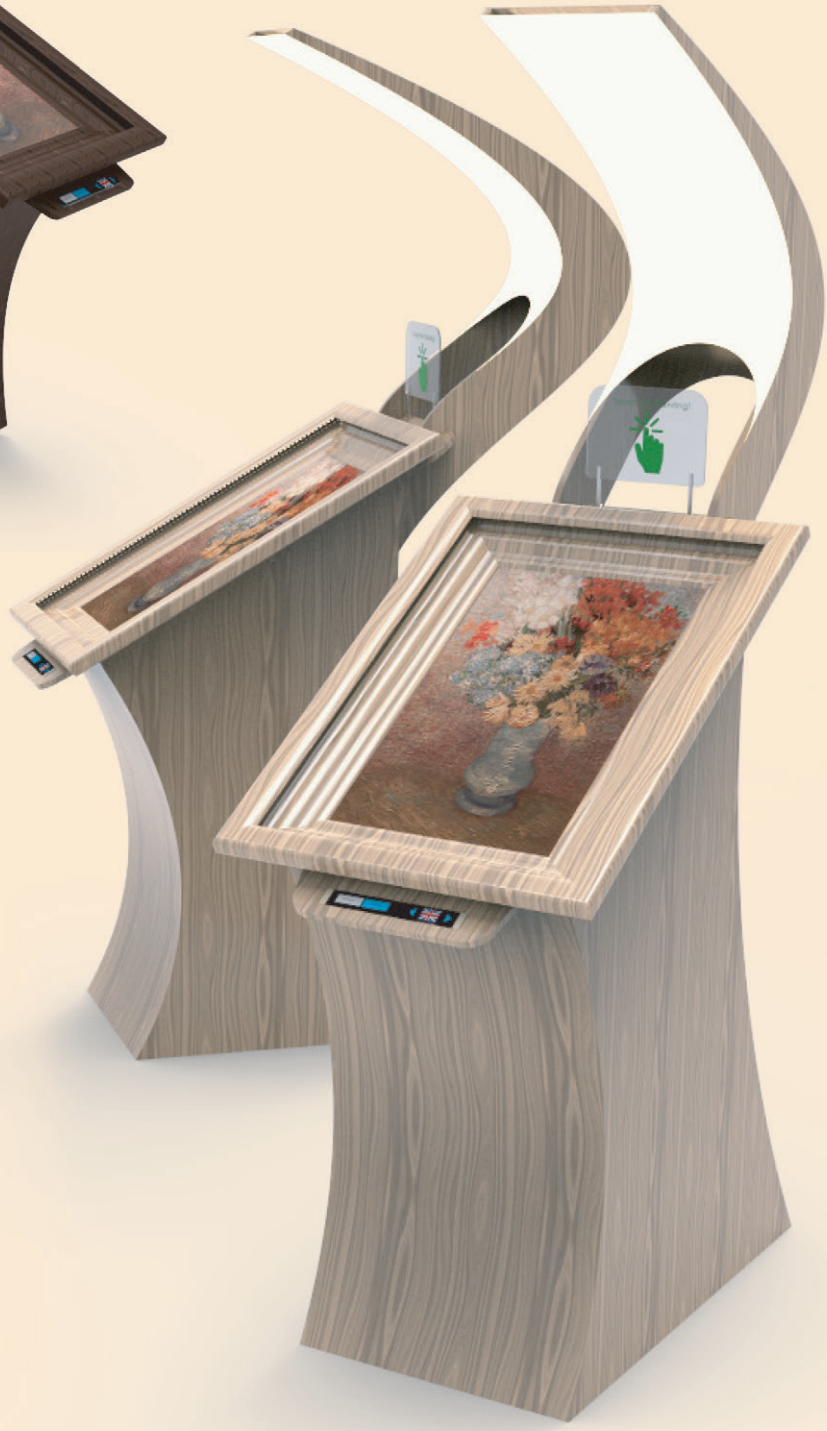


Figure C The Smart Frame 1.1

STRUCTURE OF THE REPORT

As the ultimate goal of this project is to improve the user experience of the smart frame, how to improve a target experience in a chosen context has been considered from a theoretical perspective at the beginning of the project. A Design for experience framework was chosen as a guideline for this project (See figure D).

The selected framework consists of 3 research and design stages including 14 ingredients of designing for user experience mentioned in the book "from floating wheelchairs to mobile car parks" by Desmet, P. M. and Schifferstein, R.[1]. The method derives from analysing 35 design cases which were considered as experience-driven design. Hence, it is a proper framework in guiding this design project.

All the content studied and discussed in this report is to comply with the some of the ingredients listed in the framework so that the user experience of the Smart Frame can be improved. As shown in figure E, chapter 2 to 7 are mainly to 'understand' the user experience of current design (chapter 2), user (chapter 3 to 6) as well as the usage situation (chapter 7). Those ingredients are decided from reviewing the former report (chapter 1). Then all the insights will be 'envisioned' as design goal, experience vision, interaction vision and interaction qualities, which will be concluded in chapter 8 as design brief. After that, ideas will be generated, visualized and tested by building experiential models. In the end, the concept will be evaluated (chapter 11) and refined (chapter12) to close up the stage of 'create'. Meanwhile, recommendations (chapter 12) for further studies will also be carried out.

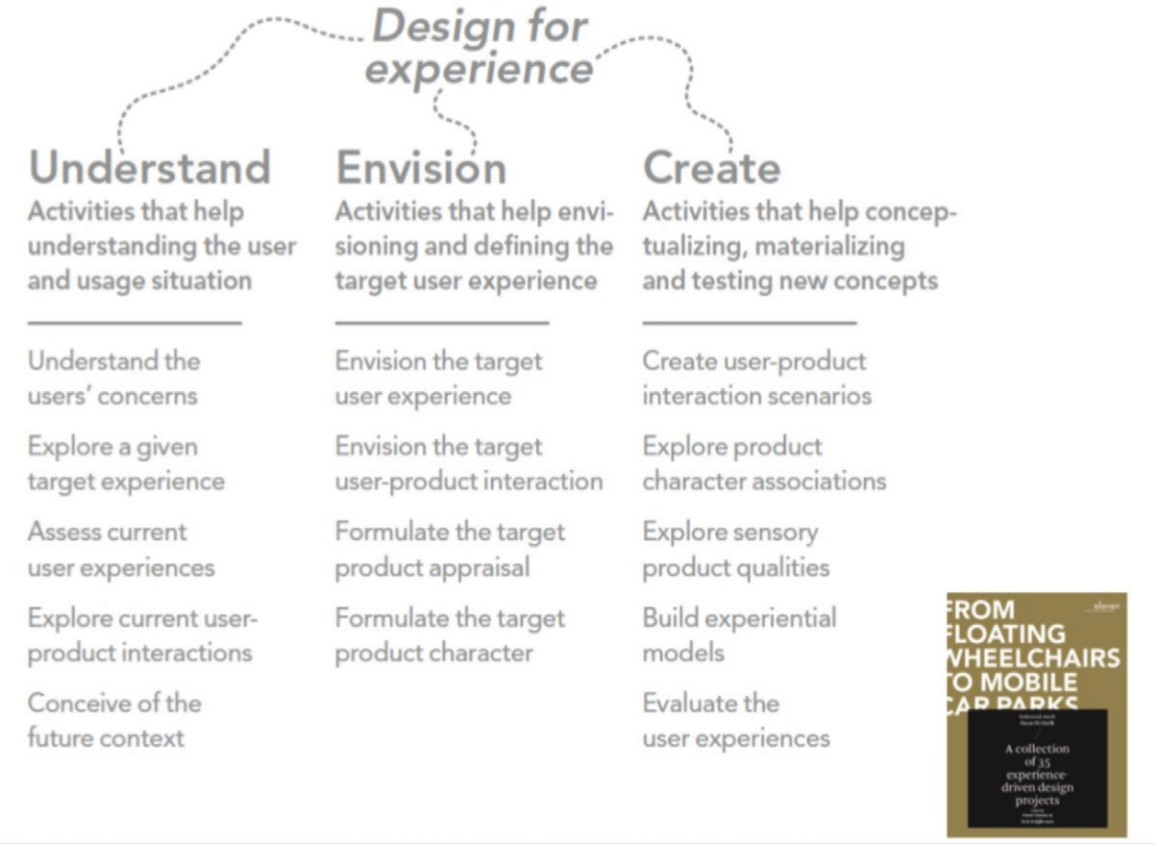


Figure D 14 ingredients of design for experience from the book 'From floating wheelchairs to mobile car parks'

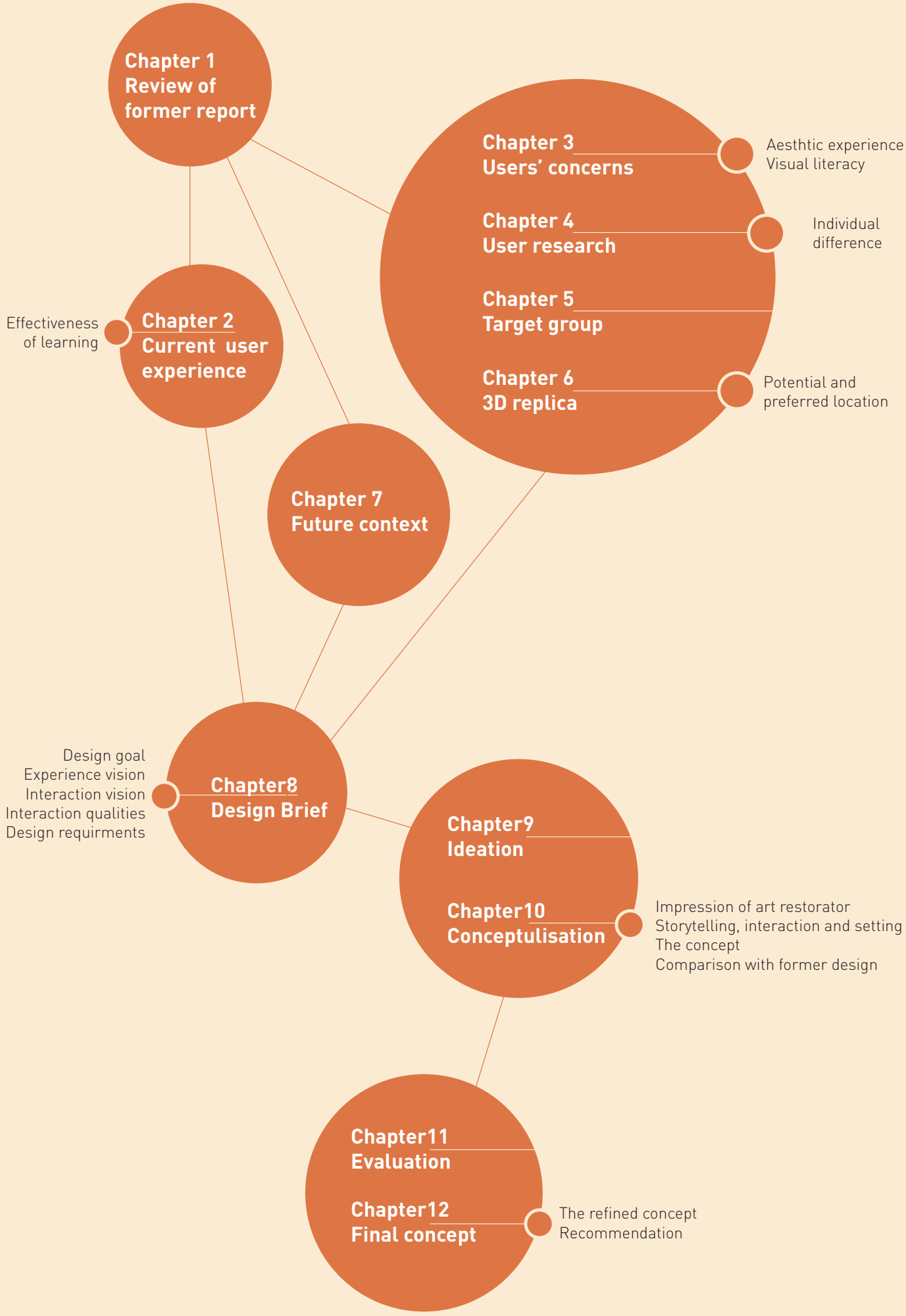


Figure E Structure of the report

CONTENTS

FORMER REPORT REVIEW

Considering this project was built upon a former graduation project, the first step was reviewing the previous report to understand the background knowledge, the technology, and the objective of the former design. Thus, the elements that lead to the design goal of former project were extracted and studied first. Such decomposition helped to set a base for research directions of this experience-driven project. According to the model of user experience driven design [2], following elements were selected to review: current using experience, context, user concern and target group.

Decomposition of the Smart Frame 1.1

• Current user experience of the Smart Frame 1.1

Evaluating the current user experience with the Smart Frame is need as the base for the improvement. At the end of the former project, there are a list of flaw that the final design was refined to solve, so a user test was called out to evaluate those refinement. In comparision to assess whether the final design fulfill the design goal or not, it is also insightful to record people's comments and expectation on the Smart Frame. The results will be combined as the starting points for improving the user experience.

• User concern

User concern is one of the direct and dynamic factor contribute to user interaction and user experience. As mentioned in former project, visitors sometimes bend their body to observe details of the painting while sometimes they don't. Their decision is potentially influenced by aesthetic appreciation, content of the painting, context and etc., but those factors are not taken into account in the final design [1]. However, as this follow-up project is going to put emphasis on the study of the interaction between visitors and replica, there is a need to delve into user behaviour as well as influencing factors mentioned above.

• Target group

The aim of defining the target group is to fulfill user needs more accurately, so the selection should be based on the difference between their behavior and expectation instead of solely on demographic information. By analysing trend and development of museum, the target group (the children in the age of category of 6-11 visit museums accompanied by school or parents and elderly people above the age of 50) was chosen in previous report [1]. However, it also mentioned that the majority of the museum visitors do not look at the painting in the same way, which can be differentiated by their interest and knowledge [1]. In order to categorize users based on their expectation from a painting and analyse their different way of interaction, it is more insightful to study on how different people with different level of art knowledge and interest appreciate the painting rather than putting too much emphasis on demographic information (gender, age, nationalities and etc.) [3].

• Context study

The visionary context and the specific placement of the Smart Frame in art museum required to study in order to find the space and direction for the improvement of user experience. In the report of former project, what has been described clearly is that the general purpose of art museum [1]. However, it is also necessary to illustrate the vision of art museum, so that the Smart Frame can be introduced to numerous art museums promisingly. While what hasn't described clearly is the exact location of placing the Smart Frame. Therefore, the research of future museum development and the reasonable location for placing the device will be conducted in this project.

Conclusion

From the perspective of experience driven design, the way of demonstrating 3D replica should prioritize user concerns rather than providing information. The key question for each aspect to answer is formulated as below:

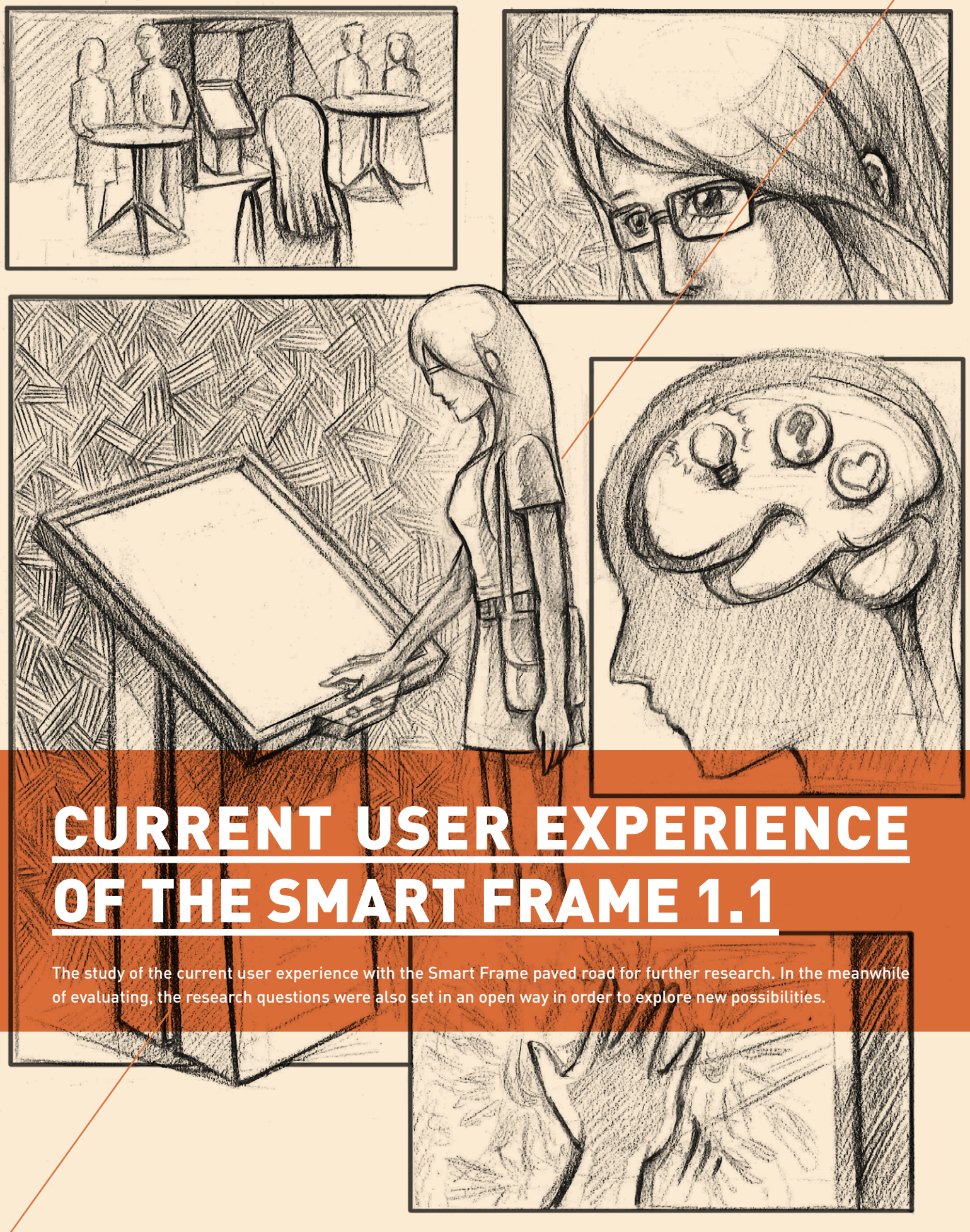
- *Current user experience: How well can people learn from the experience?*
- *User concern: Theoretically, what and how do people learn from viewing a painting ?*
- *User research: In practice, how can it be influenced by their individual difference?*
- *Context study: How does art museum look like in the future?*
- *Besides, 3D printed replica also deserves more study to understand how can it serve for the proposition and to find the reasonable location for exhibiting.*

Those aspects will be discussed further in corresponding chapters.

[1] Baay, M.P. (2016). Smartframe: Design of an exposition setup for 3d-printed fine-art replicas.

[2] Desmet, P. M. A., & Schifferstein, H. N. J. (2011). From floating wheelchairs to mobile car parks: A collection of 35 experience-driven design projects. The Hague, The Netherlands: Eleven Publishers.

[3] Kirchberg, V., & Tröndle, M. (2015). The museum experience: Mapping the experience of fine art. Curator: The Museum Journal, 58(2), 169-193.



CURRENT USER EXPERIENCE OF THE SMART FRAME 1.1

The study of the current user experience with the Smart Frame paved road for further research. In the meanwhile of evaluating, the research questions were also set in an open way in order to explore new possibilities.

Scenario of user test

Purpose

In order to evaluate the user experience of the Smart Frame, a user test is called out. There are two main purposes within the test: to evaluate whether user can learn from the experience and to discover extra information or value that participants would like to obtain. Those two purposes are derived from the design goal indicated in the former project - "To design a (standardized) exhibition setup for a reproduction that provides specific information regarding the content of the painting and technique of the painter" [1] - in which the reason of choosing painting content and painter's technique were insufficient, and the effectiveness of the information convey was also unmentioned.
Coupling with the list of design flaws that the Smart Frame 1.1 refined to solve [1]:

- It should be made clearer that it is possible to touch the painting.
- The light should be more diffuse.
- Too much light hit the frame next to the painting.

Since the audio tour is the main information input, the research questions of the test were formulated as below:

- *Is the Smart Frame inviting to use? Why or why not?*
- *Do visitors find the lighting system helpful for them to understand the painting? Why and why not?*
- *What information do participants get from the Smart Frame? What's more do they want to know?*
- *How do they experience the audio tour?*
- *What do they like and what do they dislike?*

Setup

A dark tent was built to let the lighting system have intended effect to participants. The tent was constructed by four black board. Outside the tent there was a notification panel to provide brief introduction to people. A camera was set on the top to record participants' interaction with the Smart Frame as well as their answer and comment.
The test was hold after the lighting symposium [2], thus participants were experts, Phd candicates and master students from fields relating to lighting design and multisensory design.

Process

For the sake of offering participants a fluid exploration process with the Smart Frame. Firstly, a brief introduction (see appendix I) was provided by me in case they ignored the information panel at the entrance of the tent, meanwhile, the permission of recording was also inquired. Then, participants were asked to think aloud while exploring the replica. During the process, following questions were asked:

- If without my instruction, would you touch it?
- What are you touching and what are you trying to find out?
- How do you experience it?
- How do you think of the Smart Frame?
- In the end, participants were asked to provide basic demographic information like age and occupation.

Figure 3.1. participant used bothe hand to interact

Figure 3.2. participant blocked part of the light

Figure 3.3. participants used gloves to feel the brushstroke

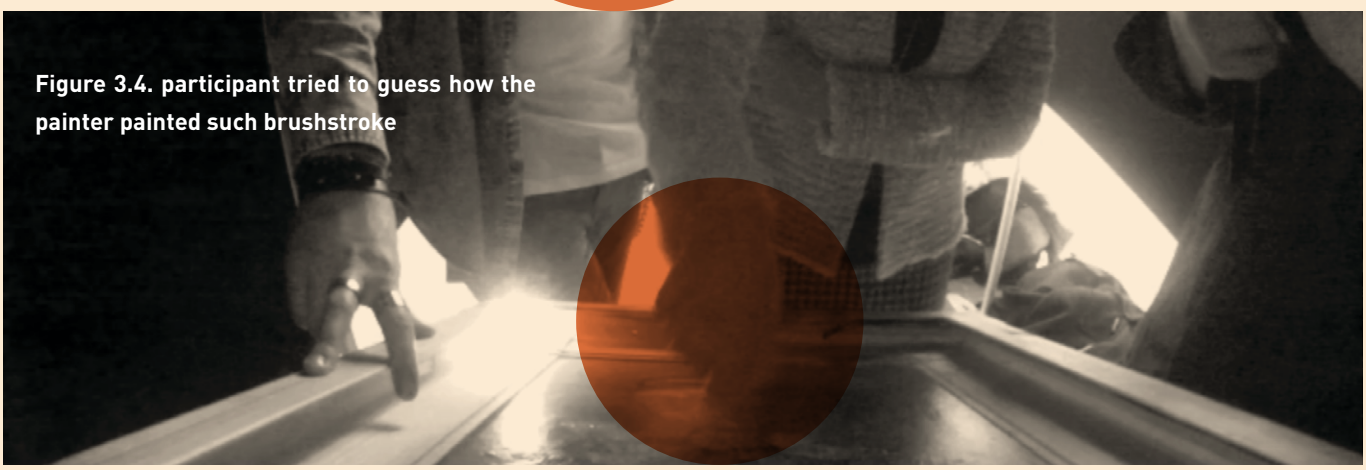


Figure 3.4. participant tried to guess how the painter painted such brushstroke

Result

Most participants (ten out of twelve) found it intuitive to touch the 3D replica while many of them (six out of twelve) mentioned that it was weird to touch. It was mainly because in their common sense, oil paintings are not allowed to touch even though there is sign asking them to touch. Two participants also found it interesting to touch although it was awkward at the beginning. After providing the participant who refused to touch the replica a glove, she found it easier for her to accept the truth that she can touch it (as shown in figure 3.3).

Nice participants out of twelve shared an idea that the lighting system added another dimension to the painting. There were mainly two merits brought by the lighting system: Firstly, it helped to present and compare the texture and brushstroke clearly; Secondly, it strengthened the contrast of the color. Two Participants who disapproved the added value of the lighting system and suspected that the light should guide people's hand instead of following behind. There was also one participant who preferred a simple and standstill light source, because she thought she already felt the brushstroke by touching.

Besides the information provided, **participants were triggered to know more about the painting in terms of the motivation of creating this painting, painter's information and different painting techniques in depth.** For instance, they tried to compare different techniques (as shown in figure 3.1) and they tried to imagine how the painter created such brushstroke (as shown in figure 3.4). While using the audio tour, all participants tended to stand still and listen instead of touching the corresponding part along with the introduction, even though they found it informative.

Three participants wanted the Smart Frame to be simpler, this was not only because the frame itself caught too much attention but also because the reflection on the margin was too bright to let them focus on painting (as shown in figure 3.2).

Conclusion

In a nutshell, most participants didn't find Smart Frame inviting to interact and they were unwilling to touch the replica even during the audio tour. In addition, they didn't learn so well from the whole experience although the lighting system is helpful them in examining the thickness of paint somehow. The answer to research questions are concluded as below together with corresponding insights.

- Is the Smart Frame inviting to use?
- No

There is a need to make the design and interaction more friendly and engaging. Most people feel reluctant to touch, so as an alternative, some chose to press the buttons at the bottom of the frame intuitively, even with an indicator telling people that they can touch the replica. Hereby, there are two possible ways for the Smart Frame to improve, one is to communicate enough values of touching 'painting' to users. Another way is to introduce a more natural interaction to user or change the design to make user friendly to interact.

- What information do participants get from the Smart Frame? What's more do they want to know? Do visitors find the lighting system helpful for them to understand the painting?
- The tracing light wss helpful but the conveyance of information was monotonous.

The information should be conveyed clearer and targeting more on the technique. Regarding the additional information that participants were curious to know, some were actually told in the audio guide (e.g. motivation of creation), but participants failed to catch them. So there should be a clearer hierarchy of information conveyance to satisfy their interest. Such interest can be seen in the painting techniques especially. Participants still wanted to know more about techniques, although the use of tracing light helped them to admire the beauty of the brushstroke somehow and the audio guide introduced the creation of different brushstroke.

- How do they experience the audio tour?
- Participant experienced the audio tour passively.

Before designing various educating strategy to visitors in different knowledge level, there are two objectives need to study. Firstly, the positive correlation of interest and knowledge needs be validated. Secondly, the interests of people who are in different knowledge level requires further study to know how their interest are varied.

- What do they like and what do they dislike?
- They disliked the complicated design of the frame.

The Smart Frame should be simpler as it is only the accessory for the replica and the margin around the replica should be shrunk or eliminated.

- Special working environment

The Smart Frame should step out of the black tent. As an exhibit which will appear in numerous art museums, it should not always work in a specially designed chamber as it causes so much additional cost for installation, so letting the Smart Frame step out of the black tent will be one of the priority for the improvement.

[1] Baay, M.P. (2016). Smartframe: Design of an exposition setup for 3d-printed fine-art replicas.

[2] Light in the eye of the beholder. (2017). Seeing, understanding and designing light. Retrieved March 31, 2017 from https://www.tudelft.nl/io/actueel/congressen-en-symposia/light-in-the-eye-of-the-beholder/

USER CONCERN

In order to design a clearer information hierarchy and find a proposition of target group. A theory foundation of how people view and learn from a painting is lied through literature research. Personal attributions (expertise, knowledge, interest and previous experience) are discussed by combining various theories in order to know how those attributions influence visitor's' interaction and expectations towards an art work.

A vsititor was adding arms to Venus in Lourvre museum

Chapter Overview

This chapter starts from a study goal based on the former report and the research from Kirchberg and Trondle about art museum experience. Leder's model about aesthetic appreciation and visual literacy of aesthetic development are used to explore the answer to the study goal. In the end, a conclusion can be drawn, which also leads to research questions for user research.

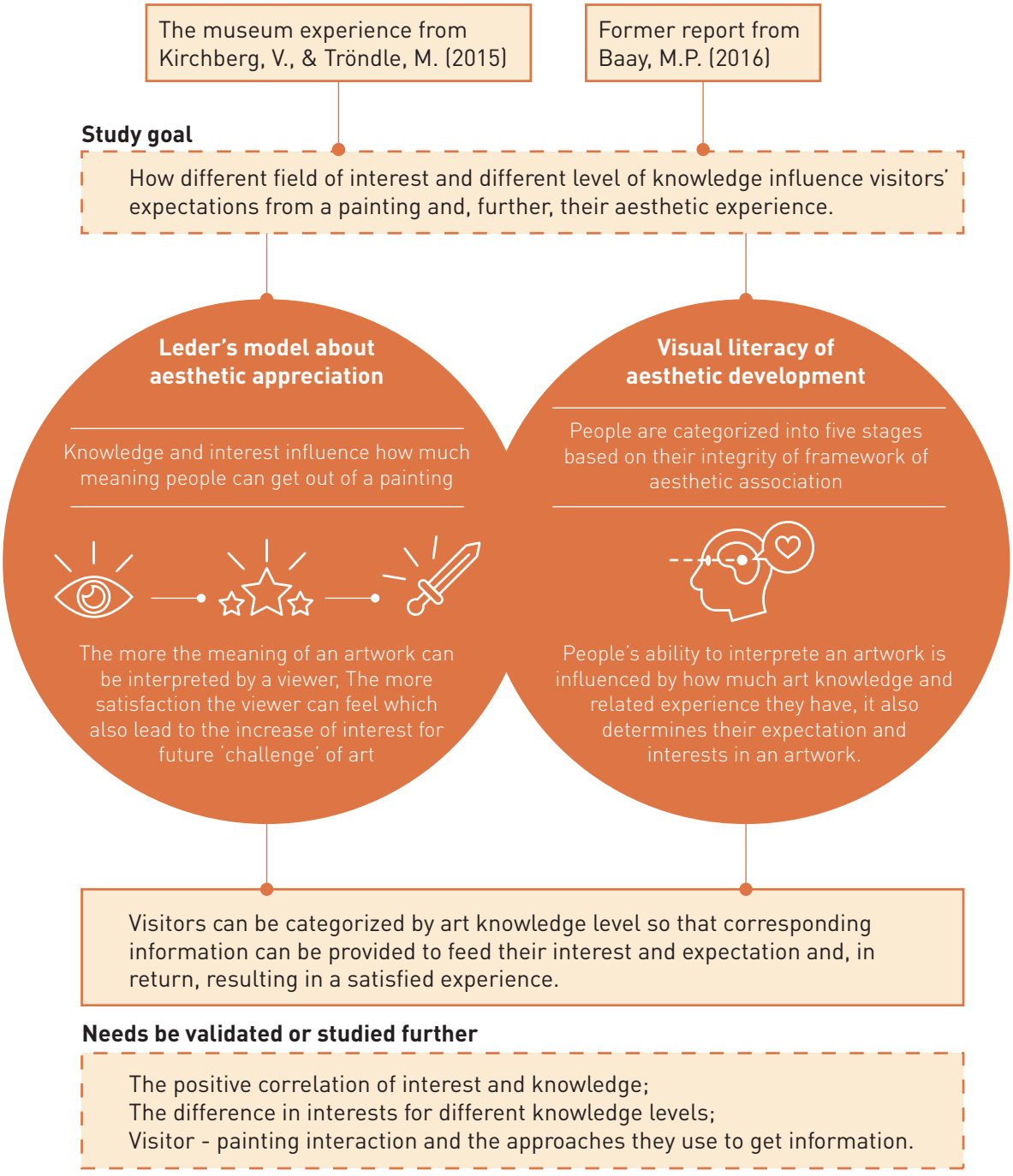


Figure 4.0 Overall of the literature study abuot user concern

Interest and knowledge

As mentioned in former project, there is a trend that two main groups of museum visitors visit the museum more often than before, which are elderly people in the age of 50+ and children in the age of 6 - 11 accompanied by school or parents. That is mainly because of the increase of free time and spendable income. And Amongst visitors, there are large differences in knowledge and interest in art, which influences the behavior in a museum dramatically [1]. Since the visiting experience of fine art museum doesn't have much relation to demographic information (like age and gender), according to the research done by Kirchberg and Trondle [5]. Therefore, it is necessary to categorize visitors from another perspective, like art knowledge and interest.

In order to improve the user experience of the Smart Frame, it is important to understand what they expect and feel interested to experience [2]. According to Kirchberg and Trondle 's research, as two main elements of art-personal relatedness, visitor's Interest and knowledge with art influence their experience in a way that they will focus on different aspect of the painting [5]. Since visitor's interest with art has various aspects including beauty, techniques, background story and etc.[6], **I propose that visitors with different field of interest and different level of knowledge influence visitors' expectations from a painting and, further, their aesthetic experience .**

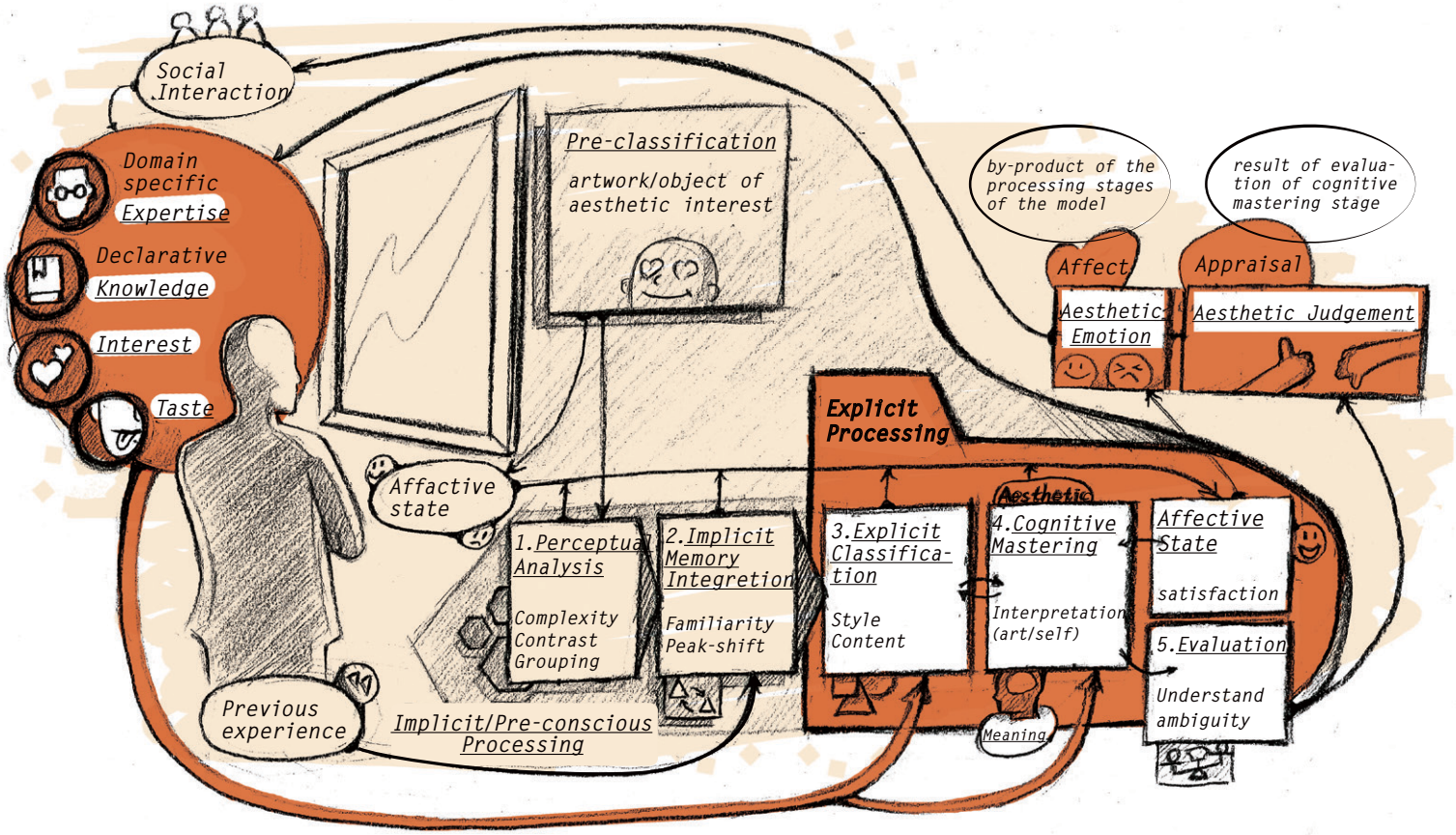


Figure 4.1 Leder model of aesthetic experience (adapted from Leder et al., 2004; Leder and Nadal, 2014).

Aesthetic experience and visual literacy

As aesthetic appreciation is one of the core factor that differentiate visitors' behavior, a model from Leder used to describe aesthetic experience is chosen to study further about the two key factors in the hypothesis - art interest and knowledge, because it is the most prominent model used in numerous fields outside art such as design [6]. The model describes both input and output of aesthetic experience (as shown in figure 4.1), the two outputs are independent, but, apart from the emotions that the artwork is aiming to arouse, aesthetic emotion can be described as pleasure when the information within the artwork is successfully processed and vice versa [6]. In other words, part of the satisfaction of aesthetic experience is derived from 'cognitive mastery' where meaning of an artwork is interpreted. In the stage of cognitive mastery, different level of knowledge results in different way of interpretation: lay persons may more likely draw on self-related interpretation while expert may rely more on art-specific style or concept. Same as 'explicit classification', it is also driven by personal characteristics such as knowledge and interest [7]. In Leder's model, there is an assumption saying that the successful mastery of an artwork will be the source of intrinsic motivation, which can result in the increase of interest for future 'challenge' of art [6], such reciprocal relationship between cognitive and affective experience implies a positive relationship between knowledge and interest. In the light of those insights, how different level of knowledge and interest influence 'cognitive mastery' requires and deserves further exploration.

Although it is clear that the more completely one can master a work, the more pleasurable outcome (flow-type experience) it will be [6], there is a need to examine how different people with different knowledge level process those information so that corresponding way of teaching can be provided, because educating was the core function of the Smart Frame [1].

Five stages in the model are described as below, occurring in sequence [5]:

(1) "perceptual analysis," where an object is initially subjected to analysis of low-level visual features (e.g., shape, contrast);

(2) "implicit memory integration," in which art is processed via previous experiences, expertise, and particular schema held by the viewer.

(3) "explicit classification," where one attunes to conceptual or formal/artistic factors, such as content and style

(4) "cognitive mastering," in which one creates and/or discovers meaning by making interpretations, associations, and links to existing knowledge.

(5) "evaluation," where processing outcomes combine, culminating in both aesthetic judgment and the potential for "aesthetic emotions."

Visual literacy

Stage I Accountive

In the first stage people are mostly storytellers. They sum up what they recognize in an artwork and build stories around these elements. Teaching effectively to this stage involves presenting the viewer with works that encourage a narrative reading, and relate to familiar contexts and activities.

Stage II Constructive

Viewers at stage II starts to develop interests in the artist's intentions and visual elements. When artworks are not realistic or show no immediate effort, they often want an explanation of that value, but, even more, they want to be able to make more informed, less subjective judgments on their own.

Stage III Classifying

Stage III viewers try to acquire and retain information about art and to classify it according to the systems of art historical scholarship Appropriate instruction exists to address the needs and interests of Stage III viewers: the teaching of art history and criticism as well as varied programs teaching studio practices.

Figure 4.2 Five stages of visual literacy

Since people's ability to interpret an image, in other word, visual literacy [8], is involved in the stages of 'explicit classification' and 'cognitive mastery' where people's experience and art knowledge start to influence [6]. Housen's model of visual literacy (see figure 4.2) is chosen to study such ability further as it is the most reliable source for aesthetic development [8].

In his model, people are categorized into five stages based on their integrity of framework of aesthetic association. Those of stage I and much of II are called pre-literate [8] and the model also proposed different effective ways of teaching for different stages. The information of familiar context and activities related to viewers' interpretation should be taught to them so that they can compare and share; The information associated with techniques, painting material and painter is proper to be taught to people in stage II; The appropriate instruction for people at stage III is to teach more about art history and criticism. Since effective teaching always feeds learner's expectations in an engaging way [4], people's expectation towards an artwork can be varied different stages according to visual literacy, which is determined by how much art knowledge they obtain. To be specific, people at stage I expect to learn a self-interpreted story from a painting, so they maybe interested in painting context which they can link to the experience of themselves and it is also the easiest way to understand painting [3]; In comparison, people at stage II want more objective interpretations about a painting so they maybe interested in painting content and techniques; While people at stage III expect to know the classification and appraisal of a painting, so they maybe interested in knowing the art movement and school that are associated.

As for the relationship between people's knowledge and interest, there are three factors contributing to the development of interest in education context: knowledge, positive emotion, and personal value according to Hidi and Renninger (2010) [4]. As individuals learn more about a topic, they become more skilled and knowledgeable. An increase in knowledge can bring about positive affect as individuals feel more competent and skilled through task engagement [8]. This, somehow, validates the assumption from Leder's model, which can lead to a conclusion that there is a positive correlation between knowledge and interest in general.

Conclusion

- **Art knowledge and interest differentiate people's expectation from a painting**

What and how do people learn from viewing a painting mainly depend on their ability to interpret painting (visual literacy), which is influenced by their art knowledge and interest. And whether visitor can have a satisfied experience in viewing an artwork depends on whether their expectation can be fulfilled [10]. From the study of the theories, we know that visitor's knowledge, expertise and interest influence their appraisal when viewing a painting. As people's interest and expertise in art can be accumulated and altered by art-related education. Visitors can be categorized by art knowledge level so that corresponding information can be provided to feed their expectation and, in return, resulting in a satisfied experience.

- **Educating as design direction**

Being one of the main functions of current art museums, education is already a potential direction to work on. Coupling with the insight that the more people master a painting the more pleasure they feel, imparting correct knowledge to different people can be a promising design direction, which can result in a delightful experience and such experience is what curators envisioned for future museum. Therefore, educating is decided as a design direction for the project.

- **Further study about the relationship between art knowledge and interest**

Before designing various educating strategy to visitors in different knowledge level, there are two objectives need to study in user research. Firstly, the positive correlation of interest and art knowledge implied in the aesthetic experience needs be validated in practice. Secondly, the interests of people at different art knowledge level requires exploration to know how their interest are varied.

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USER RESEARCH

For better understanding of user concern, several approaches of user research was conducted to validate and explore further of the theories from last chapter. There were three method used in the user research including observation, questionnaires, workshop and interview. Questionnaire was used along with interview and workshop. For every single research, a consent form for every participant to sign (see appendix II). All of them were aiming to find out certain patterns in terms of their concern, expectation or behavior based on the conclusion of literature research. Furthermore, the user research also sets a base to select target group with corresponding design goal.

Chapter Overview

The overview of this chapter can be seen in figure 5.0, the research questions (in orange solid circle) are formulated based on the questions concluded from literature study about user concern (circles with dashed border on the first line). One of the question was added after observing visitors' behavior in art museums. Then different research activities were conducted to explore the answers and insights.

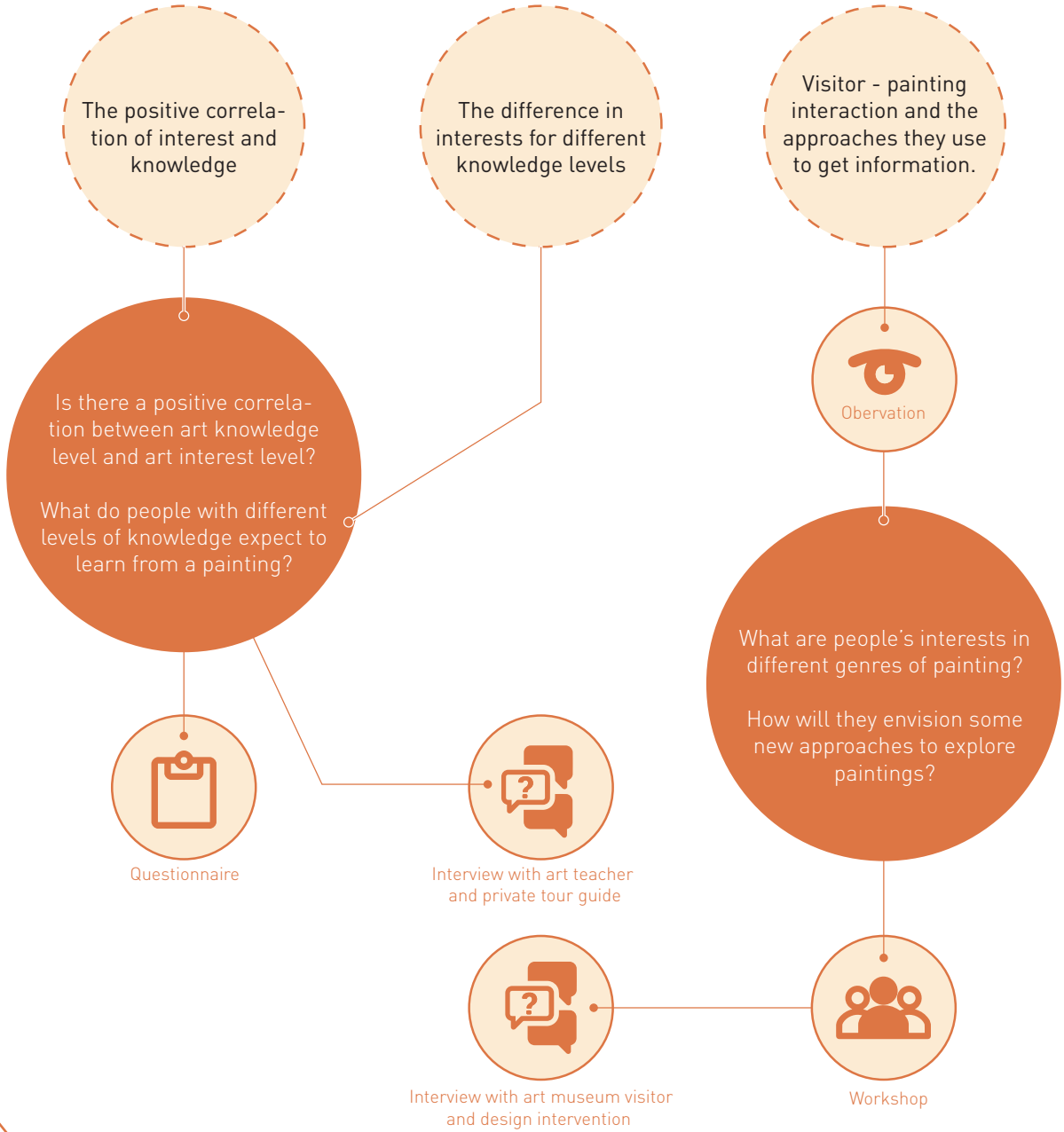


Figure 5.0 Chapter overview

Figure 5.1 visitors' interaction in front of van Gogh's painting in Rijksmuseum

Figure 5.2 visitors in front of van Gogh's paintings in Van gogh museum

Observation

In order to have an overall impression of individual difference in behavior, some observation were conducted in Rijksmuseum and van Gogh museum in the Netherlands. Unlike what it shows in the previous report, visitors' behavior is diverse and interesting according to my observation. As shown in figure 5.1, in front of the paintings from Vincent van Gogh who is one of the most famous Dutch painter, visitors perform different behavior and reveal the difference in interest - some visitors just ran towards those paintings and take a selfie then run away (on the left side of the figure); some visitors tended to check the details of the painting as close as possible even the safety guide came over to stop (on the right side of the figure). While in the van Gogh museum, it is often to see that more people gathering in front of genre paintings (where everyday life is depicted) than landscape paintings, although they were all from van Gogh in the same period (as shown in figure 5.2), so the genre of painting may also plays a role in differentiate people's interests.

Regarding the diversity of visitors' behavior discovered in the observation, it is worthwhile to not only examine how their art knowledge influence their interest but also look into visitors' interests in different genres of painting when visiting art museum

Research purpose

The purpose of user research is formulated from the conclusion from theory study. In order to categorize visitors according to their art knowledge level, it is necessary to first validate the hypothesis that different art knowledge level results in different art interest and expectation to a painting. Since visitors' interest maybe also varied by different type of painting, a detailed correlation between visitor's expectation and type of painting is also worthwhile to study. Besides, there should be a look into visitor-painting interaction and the way they get information.
Overall, research questions are formulated as below:

1. *What do people with different level of knowledge expect to learn from a painting?*
2. *Is there a positive correlation between art knowledge and art interest?*
3. *What are users' expectations for different type of painting?*
4. *How do they experience some new approaches to explore paintings?*

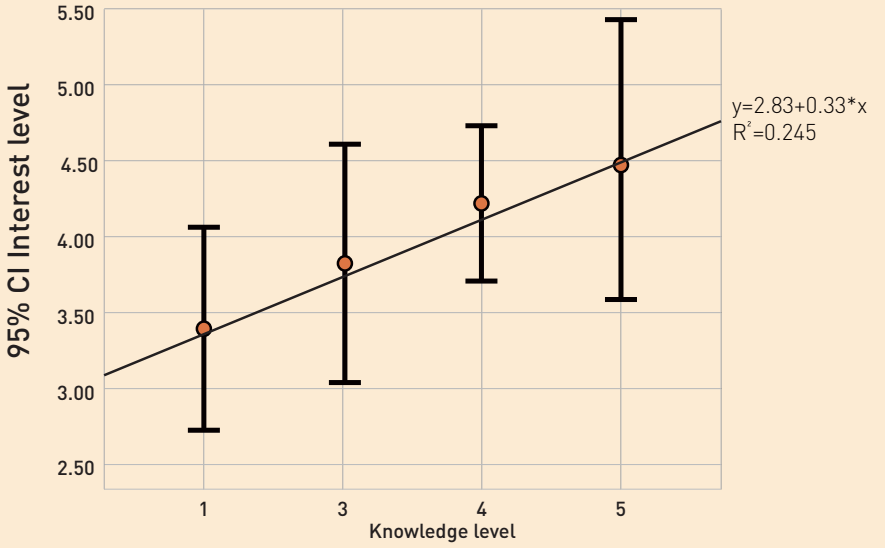
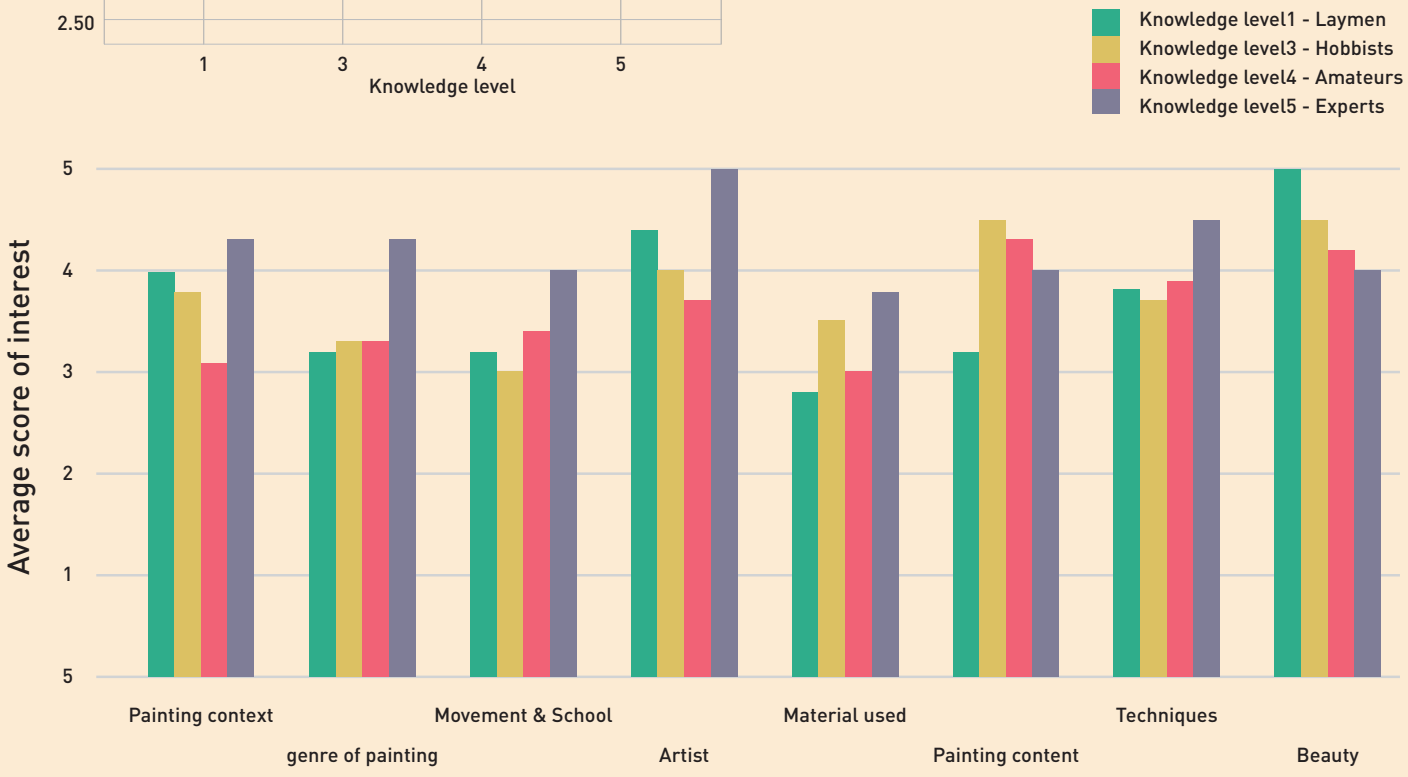
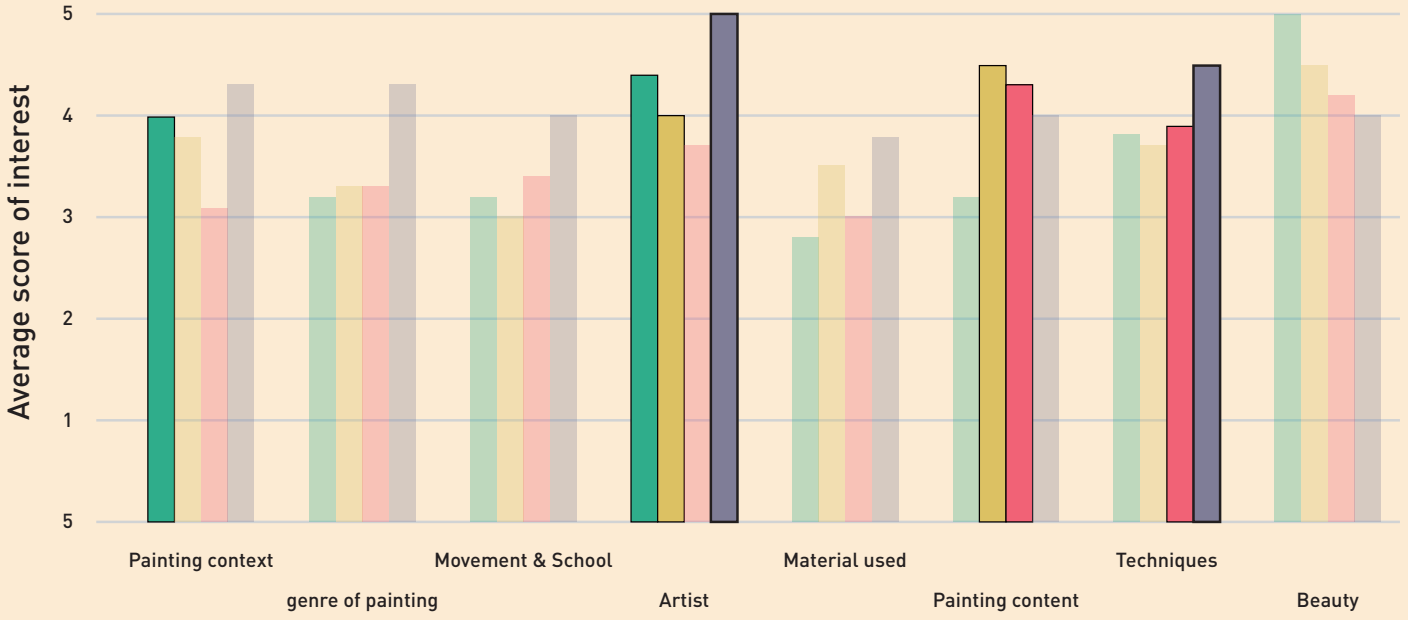


Figure 5.3 Error bar plot together with linear regression that shows the relationship between knowledge level and interest level

Figure 5.4 Bar chart of interest distribution
Figure 5.5 Top 2 fields of interest in different knowledge levels





Questionnaire

The questionnaire is composed by four parts which are background information, knowledge about art, interest about art and interaction with painting (see appendix VI). It is aiming to answer the first two research questions in research purpose.

- Background information: only occupation and art related education are asked as those two are proved to have impact on visiting experience. And the answer of those two question will determine participants' knowledge as well.
- Knowledge and interest: 5 point Likert scale is used for measuring both general art knowledge and interest. Expertise and specific interest are also covered in the questionnaire in which the painting context, type of painting, school or movement associated with paintings, artist, material used, content and subject matter and techniques are mentioned for participants to select from. Those aspects are selected based on the theory of art evaluation [2].
- Interaction: All the options are from observation. Traditional ways of getting information of a painting are also studied. This question is asked not only to compare how different participants with different level of art knowledge think of those information, but also to open up the discussion for new possibilities of interaction.

Result

The raw data can be seen in appendix VI. A Pearson product-moment correlations coefficient was computed to assess the relationship between art knowledge level and interest levels on the data for 29 answers. As shown in appendix V, a significant, strong, positive correlation was found between the two variables, r (25*)=+0.566, p< 0.002, two-tailed.

The increase of interest with the increase of art knowledge

In the figure 5.3, the error bar plot showed the means of the variable 'interest level' in four art knowledge levels together with the data dispersion. Comparing to those who had level 1 and three of art knowledge, the responses of people in level 4 were more centered, while the interest level of people in level 5 showed more variable distribution. In general, regarding the average interest level for each group, it climbed up with the increase of knowledge level. Moreover, people in the art knowledge of level 4 had same level of interest, while people in level 1 or 3 had higher interest level compared to their art knowledge level.

Although the interval was wide due to the sample size, it already revealed a trend that can be used to validate the hypothesis.

Different aspect of interest

In order to refer to people in different level of art knowledge more clearly, different names were given to each group: people who had level 1, 3, 4 and 5 art knowledge were named as laymen, hobbyists, amateurs and experts respectively [3] .

Figure 5.4 illustrates how laymen, hobbyists, amateurs and experts spreaded their interest in eight categories. Zooming into the interest in beauty, it is revealed a negative correlationship between interest level and art knowledge level. Apart from beauty, top two fields of interest for each group were highlighted in the figure 5.5, laymen were curious more about painting context and painter, hobbyists tended to interest more in content of painting and artist; amateurs had their emphasis of interest on painting content and painting techniques; while the interest of experts lied mostly in the information of artist and techniques.

Conclusion

Different distribution of interests

As proved from the research, there is a positive correlation between interest and knowledge, and people with different level of knowledge perform a different distribution of interest.

Laymen are interested in the background story of a painting; art amateurs and art hobbyists tend to interest in painting content, painter and techniques; experts have a wide range of interest but with one main focus lying in painter. Hereby, their art knowledge level can somehow be reflected by different focus of interests, which is matching with what has been proposed in the hypothesis from last chapter. However, there is still a need to check how those different levels of knowledge link to visual literacy through examining their main characteristics described in visual literacy.

Feeding more accurate and flexible information

The accuracy of information should be embodied in two aspects: content and length. The information offered should match with their interest, but at the same time as brief as possible. Or, there can be various options allowing them to choose freely. The way which visitor get information from should also not distracting them from viewing but to facilitate their understanding.

Discussion

The knowledge level was measured according to participant's own judgment, so it may deviate bit from the real situation.

People's interest are also determined by their motivation of visiting art museums, which is, potentially, responsible for the variation. For instance, people who just want to recharge themselves in the museum, they are more interested than average because of the emotional appeals; there are also some people who may spend some of their interest, which they have for artworks to their companions, this results in the deficiency to the average level [4].

People's profession could influence their interest as well (e.g. lighting designer is more interested in the painting context although he is in the level 3. As this project is mainly focus on the experience of aesthetic appreciation, in which people's interest and knowledge are given emphasis to discuss, the importance of other influence factors like emotion appeals, companionship and profession will not be measured in this project.

Session

A generative session was held in the MuseumFutures lab together with five students from the lab and one professor. At first, participants were asked to filling the questionnaire (the interaction part was left out). After the questionnaires were collected back, participants were asked to put their comments on two of the traditional approach for visitors to get painting information - audio tour and label. Then four paintings were shown to let participant speak out what information they want to know. At last, several gadgets were shown for participant to explore new interactions with the replica of Sunflow by van Gogh.
The session is trying to answer research question 3 and 4.

Selection of paintings

The criteria of painting selection can be seen in the Figure 5.8. Each selected painting was in different type ranging from portrait painting, genre painting, landscape painting to still live painting. Since moral message will be easily captured and understood if human is the main theme of the painting (portrait painting and genre painting), in comparison, the artist style and techniques are prior to be captured in landscape and still life painting [2]. I formulated a hypothesis that people tend to focus on the content of a portrait or a genre painting, while they will more focus on the techniques of a landscape or a still life painting. In order to make the differences more evident, Sunflower from Van gogh and Taos' mountain, Trail home from Cordelia Wilson were chosen for their intensive brushstroke, Girl with a pearl earring from Johannes Vermeer and Luncheon of the boating party from Pierre-Auguste Renoir were chosen for their dedicated brushstroke. Those paintings can be seen in figure 5.7 on next page.

Selection of gadget for exploration of new interactions

The gadgets used in the session were the products that people were familiar to interact with paintings (as shown in figure 5.6), since it was helpful to design a new interaction that was intuitive and inviting and an intuitive interaction always involves features people have encountered before [1]. Besides, those selected ones were also based on the stimulus to different senses. A mechanic watch was also added to the collection as time machine for people to replay painting context.

- Seeing: camera;
- Touching: gloves, mouse, brush (focus on handling);
- Hearing: earphone

Figure 5.6 Selection of gadgests based on familiar interaction with painting and stimulaus to differenct senses

[1] Girl with a Pearl Earring, c. 1665, Johannes Vermeer

[2] Luncheon of the Boating Party, 1880–1881, Pierre-Auguste Renoir

[3] Taos Mountain, Trail Home, ca. 1915-1920s, Cordelia Wilson

[4] Sunflower, 1889, Vincent van Gogh

Figure 5.7 selection of paintings

Result

Three of the participant had level 1 art knowledge, one of them was in level 3 while the rest of them were in level 4 (including the professor).

Regarding the traditional approaches to get information from the painting, all participant didn't have positive experience with them. participants all though that the text on the label was hard to read either because the size of text or the position of the label. Moreover, the information was always boring and far less than they needed. As for the audio tour, they found there was no dynamic connection to the painting and it created a personal bubble.

Participants' expectations for four different type of painting were listed as below:

- Girl with a pearl earring: participants were mainly interested in the story of the girl and even the relationship between she and the painter, beside participants wanted to know why it is so famous.
- Luncheon of th Boating party: participants cared more about the painting context (scene, relationship between people) and the meaning.
- Tao's mountain: participants were attracted more by the technique (what and why is that) comparing to the content. While the participant in level 4 could interpret the elements in the painting into a logical story, although it was bit abstract than former paintings.
- Sunflowers: Since participants already knew that the replica was 3D printed, their interests naturally shifted to the printing quality and it triggered their curiosity to feel the real one.

Painting / Theme / Fame	Still life or landscape painting with the technique of impasto	Genre or protrait painting without the technique of impasto
Famous	Vincent van gogh 1889 Sunflowers	Johannes Vermeer c. 1665 Girl with a Pearl Earring
Less famous	Cordelia Wilson ca. 1915-1920s, Taos Mountain, Trail Home	Pierre-Auguste Renoir 1880–1881 Luncheon of the Boating Party

Figure 5.8 Criteria of painting selection

New interaction

Participants were able to explore more possible interactions with the painting after the gadgets were provided, following new interactions were mentioned:

- Camera: was used as AR device to make the the painting "more 3D"
- Brush: was used to imitate Van Gogh's brush stroke ; acted as archaeologist to discover different brushstroke (first big one then small one)"
- Gloves: were used as eyedropper, and the gloves can change color according to where it touches;
  acted as curator to take care of the painting
- Watch plus mouse: were used as time machine with stop button
- Brush plus earphone: were used to hear different voice from different material when following the brush stroke

The raw result can be seen in appendix VII

Conclusion

As mentioned in the genre hierarchy [2], it is true that people may expect to get different information out of different type of painting. Participants were curious to know the meaning and the story behind the painting if human is the main focus of the painting (e.g. Portrait and genre painting) as there were moral message involved [2].
Furthermore, if the technique used in the landscape and still life painting was quite outstanding (e.g. Impasto), participant would shift their focus into techniques.

Interview

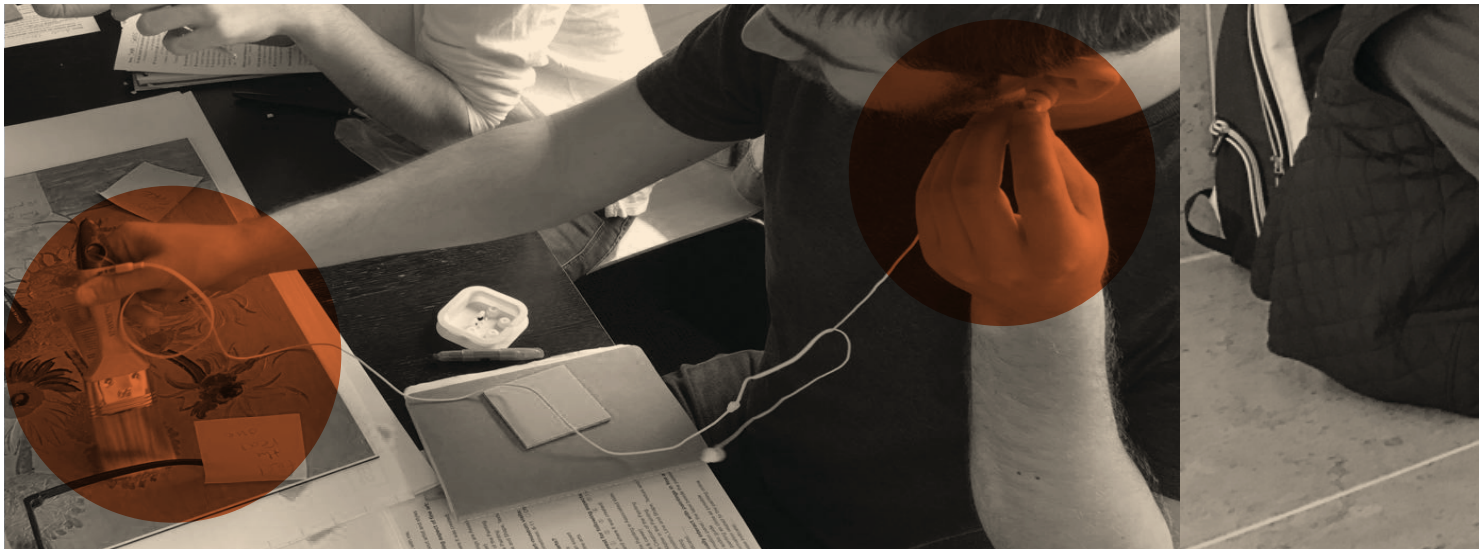
6 interviews were conducted in the Rijksmuseum. At first, the questionnaire was handed out, following questions were asked after they finished the questionnaire:

- How is your museum visiting?
- Did you enjoy it? Why and why not?
- How do you appreciate painting in the art museum? Text label? Audio guide?

As same as the process in the session, four paintings were shown for participants to speak out what they would like to know from the painting and then gadgets were shown for them to explore. The materials used in the interview is same as the ones used in the lab session.

In addition, two interviews also conducted with tour guides of private tour. The interview questions were listed as below:

- What do you do to make your private tour attractive?
- What is your way to explain an artwork to visitors?
- Do visitors always ask questions during the tour? What are those questions mainly about?
- What kind of people you always have in you tour? Will you adopt your story to different group of people?



Result

The interview conducted with participants who are with different level of art knowledge, but all of them were trying to understand the meaning of the painting in certain level. Their specific interest can be seen in appendix VIII. When exploring new interaction with the painting, the first choice was either using gloves or brush as shown in figure 5.9. All participants found it unnatural to touch an oil painting although some of them though it was a nice experience after trying. As mentioned in the interview with tour guides, it is the educational level that influences visitor's interest. Some of the quotes can be found in appendix IX.

Conclusion

Comparing to participants who have level 1 or 3 art knowledge, the biggest difference was that participants in level 4 or 5 were more curious about the year of the painting so that they can have a more subjective appreciation by relating the year of creation to certain movement or school in art history. There is pattern that pre-literate visitors (level 1, 3 and 4) could be easily influence by the theme of painting - they tend to focus on the subject in portrait painting; curious about the scene in genre painting, while if a intensive style is applied (e.g. impasto), they shift their focus to the painting technique when it comes to landscape and still life painting. Professionals only need to know the artist and year of creation since they habitually relied on their systematic framework, and they are more curious about some details or new interpretation beyond their knowledge.

From the exploration of new interaction with painting, it is clear that participants would like to have a connection to the painter and the painting. Besides, participants were welcome to new ways of interaction like using brush to imitate brushstroke, using mouse and camera to discover detail of painting.

Insight from the art teacher:
For portrait painting and genre painting it is porior to teach students about the subject or the context of the scene, the education should also include the painting style and the painter and historical timeframe he was living because without those knowledge, it is difficult to teach someone who has no idea about paintings to actually appreciate it.

Insight from the tour guide:
As shared by the strategy of storytelling from private tour guides, the story can be more engaging and impressive if the small story behind the art piece go first then connecting to the big story line.

Figure 5.9 participants were exploring interaction with the replica of 'Sunflowers'

"The more knowledge and experience you have, the more you can explain yourself" - Veronika

Conclusion

Putting the conclusions from interview and workshop side by side, lots of insights can be complemented and reiterated. People's expectation of a painting is mainly influenced by their knowledge level and theme of painting and they are open to new approaches to interact with paintings.

• Linking art knowledge level to visual literacy

Regarding the result of the questionnaire, art knowledge levels can link to visual literacy stages in a certain way as shown in figure 5.9: knowledge level 1, 3, 4 and 5 in the questionnaire can map to stage I, early stage II, later stage II and III in Housen's model respectively.

- Laymen (stage I) tend to make their own narrative based on their personal associations with who painted the painting at what time in what place
- Hobbyists (early stage II) tend to understand the painting by using their perception of painting content and knowledge of the natural world, besides, they are trying to have less subjective judgments by taking into account of painter's style and background.
- Amateurs (later stage II) already have their framework to appreciate paintings but they are still trying to enrich their database, so they are not only interest content but also in techniques used in painting to answer the questions within their own interpretations.
- Experts (stage III) are always familiar with historical scholarship, so they would like to know the provenance of a painting so that they can decode the painting by using their systematic framework to understand its meaning.

• Art knowledge level positively correlates with interest level and it determines people's fields of interest in a painting

The more art knowledge people obtain, the more interest they have, the more objective interpretation they want to have. So the knowledge level also determines the field of their interest towards paintings. Among the two pre-literate level, people in level 1 are more curious about painting context and artist, while people who have certain art knowledge (level 3 and 4) are more interested in the information about the content, artist and techniques. People who already obtain lots of art knowledge think themselves already know much about most paintings, their interest lie in the encounter of new perspective.

• The genre of painting influences the interests of "pre-literate" people

The use of intensive brushstroke on landscape and still life painting can capture the attention of "pre-literate" people. As for portrait and genre painting with tender brushstroke, the subject or the scene is more triggering for their curiosity.

• New possibilities of interaction with replica

Although touch a painting can result in a refreshing experience for visitors, it is still a challenge for most as them since the rule of 'No touching' is rooted in their common sense. However, some new interactions like backtracking and brushstroke imitation can also be helpful for people to connect to the painting and painter.

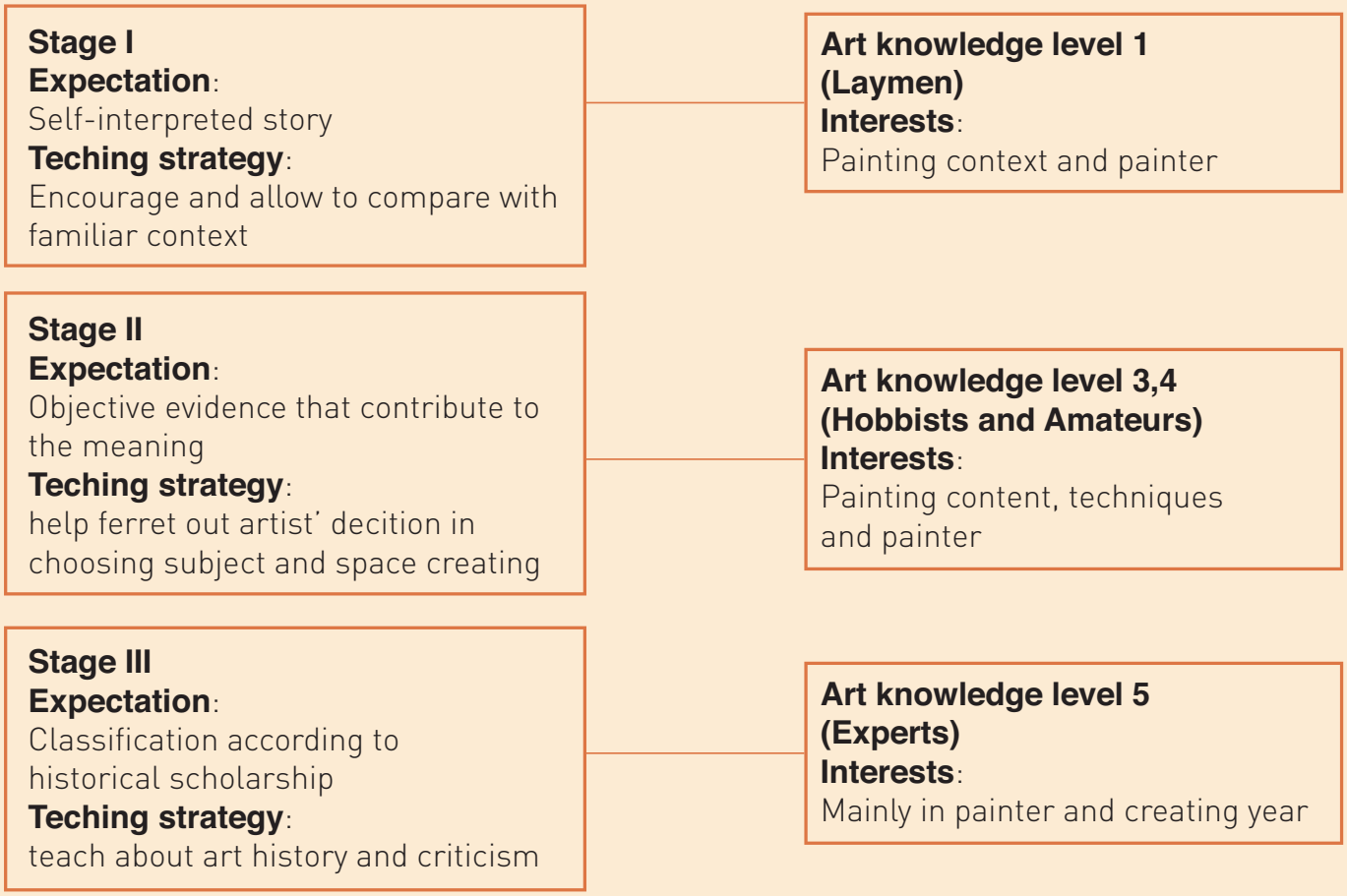


Figure 5.9 Linking of visual literacy and art knowledge level

[1]Blackler, A. L., & Hurtienne, J. (2007). Towards a unified view of intuitive interaction: definitions, models and tools across the world. MMI-interaktiv, 13(2007), 36-54.

[2] Collins, N (n.d.). Art Evaluation: How to Appreciate Art? Retrieved May 21, 2017 from http://www.visual-arts-cork.com/art-evaluation.htm.

[3] De Wal, A (n.d.). Hobbyist, Amateur, or Professional Artist – Which are You? Retrieved from http://emptyeasel.com/2011/02/01/hobbyist-amateur-or-professional-artist-which-are-you/

[4] Falk, J. (2009). Identity and the museum visitor experience, Walnut Creek, CA: Left Coast Press

TARGET GROUP

In the light of the conclusion of user research, three personas can be made based on the characteristics of people with different levels of art knowledge and interests. In the light of the personas, one of them was chosen as target group, who can benefit most from the design.

Personas

Paul *'the Professional'*
58 years old; Art college professor

Goal

Normally, I go to art museums after symposium, so I want to validate the new perspective of understanding that I have learnt. If I am with my colleagues, I like to share with them of my interpretation.

Concern

I only concern about the painting that fit my taste. Since I have sufficient knowledge about art history, I just need to know the year of creation and the painter.

As much as I personally would like to know this picture is what I can already see in the painting. It's a kind of style I do like because I studied art and it's a kind of my favorite style.

Elena *'the Amateur'*
28 years old; Design student

Goal

I would like to experience the feeling when I am in front of the real painting, drinking in abstract beauty and different impressions. So I want to see the real artworks meanwhile know more about them objectively.

Concern

Comparing to audio guide and label, It would be helpful if there are some intuitive and fun ways to tell me more about the painting content and painting techniques.

"It is excited and vibrant because of how he created it, they (artists) are doing it for reasons"

Louis *'the Experience seeker'*
38 years old; Software engineer

Goal

I just want to witness those famous paintings and share the experience of 'I have been there' on social media. Most times I just follow the route of must-sees. Blockbuster exhibitions are really attractive for me.

Concern

It is always helpful if the museum can provide my a brochure about the highlights of the exhibition. And I like those souvenirs of must-sees in the museum shop.

"I am here just to see the girl with a pearl earring, because it is so famous"

Selection of target group

The target group of the new Smart Frame will be people at stage II in visual literacy viz. art amateurs and hobbyist. It seems people in stage I have biggest opportunity to be taught since their interest level is far higher than their knowledge level (three versus one), however, it is stage II that is considered as the most educable stage among others according to visual literacy [1]. It is because stage I and stage II require different pedagogics. The effective way of teaching for stage I is to encourage them for narrative reading and let them think, compare then communicate with others about the familiar context, such way of teaching is aiming to ground their story with the evidence from the picture rather than their subjective imagination. While in stage II, people have learnt to distrust the judgement, so they expect to be informed about some value they cannot perceive as others do. Moreover, their knowledge base helps them to digest new knowledge more easily to formulate objective understanding of paintings. Although the overall interest of people in stage III is higher than those of stage II, the interest of people in stage III depends highly on personal expertise or specialization, thus, it is hard to comply with their diverse interest.

To conclude, for the sake of achieving best effect, art amateurs are selected to be the target group of this project, not only because they have more consistent interest compared to people who are more knowledgeable, but also because they can easily accept and grasp the meaning of a painting and such acquisition results in positive emotional response.

[1] Elkins, J. (Ed.). (2009). Visual literacy. Routledge.

3D PRINTED REPLICA

The most obvious benefit brought by the 3D printed replica is haptic experience, which was also the main concern for the design of the Smart Frame 1.1[1], but 3D printed replica provides numerous potential value more than that, for example, in outreach and education[6]. This chapter focuses on its potential on storytelling in education, which is the direction concluded from the chapter of user concern. Besides, the location of exhibiting 3D printed replica is also discussed with the regard of target group.

Possibilities exploration

Based on the advantages mentioned in former report [1], an individual brainstorming session was conducted to excavate the potential use of 3D printed replica, the mind map can be seen in Appendix X. All the ideas were clustered into three categories as shown in figure 7.1.

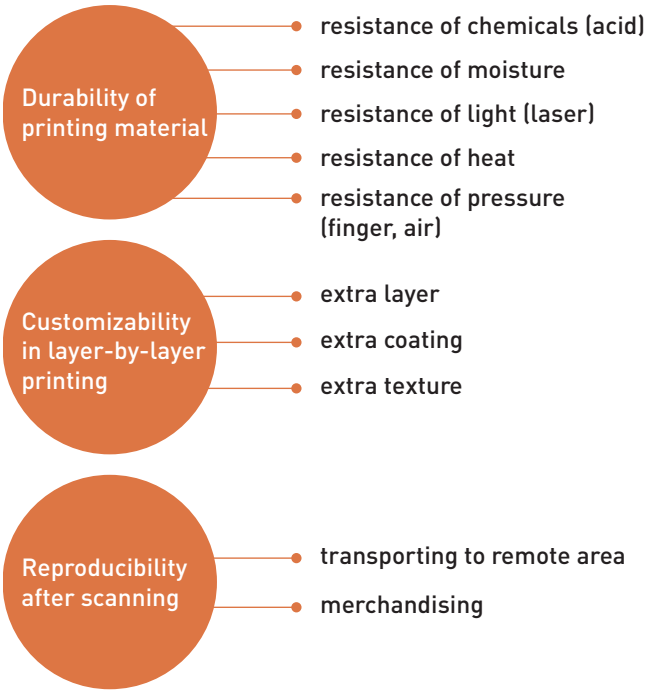


Figure 7.1 advantages and possiblites of 3D printed replica

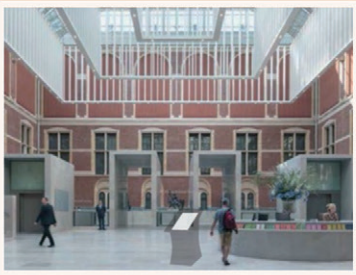
Multisensory storytelling

Thanks to its durability and customizability, 3D printed replica allows art enthusiasts have a more engaging experience, faithful to the artist's original intent and vision comparing to real oil painting [2]. It provides people more possibilities of interaction beyond just looking at it. Namely, people can immerse in haptic experience, augmented visual effect or even soundscape when corresponding technology is integrated. Thus, 3D replica is potential to be as a tool for multisensory storytelling.

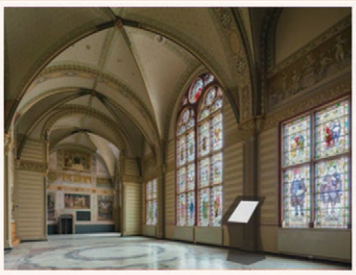
Referring to the book from Levent and Pascual-Leone, telling a story through the stimulus of multi senses can benefit museum experience through exerting potential impact on visitors [3]. Touching objects is not encouraged in most museums, since it puts objects at risk, but there is long been a desire for visitors to have this interaction and it also has been proven to have merit to social, cognitive and even therapeutic value [4]. As the sense of touch can connects visitors to the objects and its story [1], it benefits visitors from all ages to engage in the understanding of the object. Olfactory information is always powerful in retrieving emotions and old memories, but because it links closely to the diverse individual experience, olfactory stimuli cannot provide stable feedback among group of people [5]. Same story also happens in taste, and that's why taste and smell are ranked in the lowest two positions in intelligent senses [1]. In comparison, vision plays larger role in functional interaction in terms of linking to stored knowledge [5]. Moreover, as major role in communication, when audition goes along with congruent visual stimulus, it can result in better learning experience and aesthetic understanding, the effect of which can also be improved if physical action is involved [3].

In summary, multisensory (especially touching, viewing and hearing) storytelling has the potential to benefit both education and aesthetic experience, as long as the features of event is associated with certain multisensory encoding meaningfully [7].

A. Entrance of the show room



B. Auditorium



C. Hallway

D. Cafe

E. Along with other paintings

F. Beide the real one

G. Specially prepared room

H. Workshop room

Figure 7.2 Eight locations for people to choose

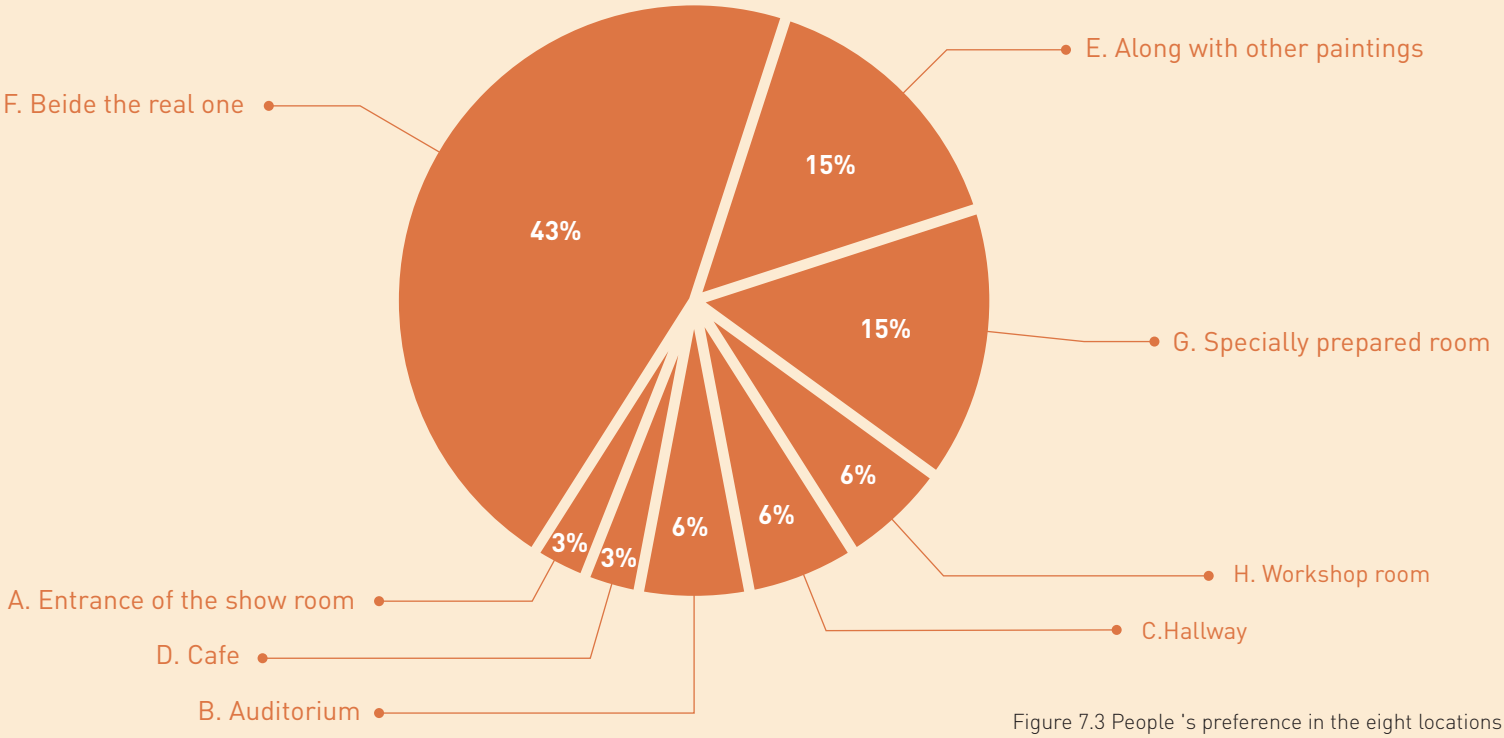


Figure 7.3 People 's preference in the eight locations

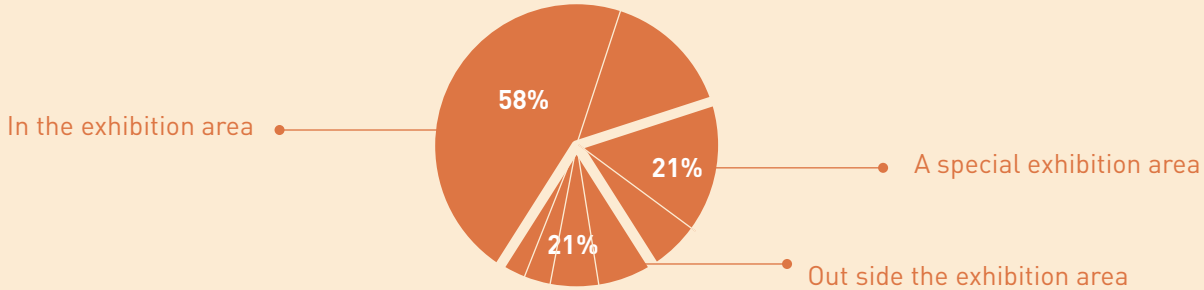


Figure 7.4 People 's preference in the three categories of locations

Exhibiting locations of 3D printed replica

In order to define the possible locations for exhibiting 3D reproduction, a questionnaire was issued online for participants to pick the one that is most attractive for them. Eight locations were selected (as shown in Figure 7.2) and the selection of the pictures were from Rijksmuseum which is one of the biggest art museum in the Netherlands.

Before choosing, people had to fill in their art knowledge level and art interest level to examine if they were from target group. After choosing, the reason behind their choice was also asked.

Result

33 out of 40 match the target group, the statistics of people's choice can be in Figure 7.3

Conclusion

Among those options there are mainly three types which are within the exhibition (beside the real one, along with other paintings), exclusive exhibition area (specially prepared room, workshop room) and outside the exhibition area (auditorium, hallway, cafe and entrance of the showroom) (as shown in the figure 7.4), it is clear that more than half of the participant choose to have it in the exhibition area, within which 'beside the real one for them is the top choice since they can compare the real one and the reproduced one, and it is also a clear indicate for them to interact. People who like to experience the 3D replica in the exclusive exhibition area think it can include more interactive information and create better atmosphere. For the area outside the exhibition, people would like to experience 3D replica for relaxation when they have a rest.

[1] Candlin, F. (2010). Art, Museums and Touch. Manchester: Manchester University Press

[2] Chatterjee, Helen J., ed. (2008). Touch in Museums: Policy and Practice in Object Handling. Oxford: BERG.

[3] Levent, N., & Pascual-Leone, A. (Eds.). (2014). The multisensory museum: Cross-disciplinary perspectives on touch, sound, smell, memory, and space. Rowman & Littlefield.

[4] Pye, Elizabeth, ed. (2008). The Power of Touch: Handling Objects in Museum and Heritage Context. Left Coast Press.

[5] Schifferstein, H. N., & Cleiren, M. P. (2005). Capturing product experiences: a split-modality approach. Acta psychologica, 118(3), 293-318.

[6] Scott, C (2016). Verus Art creates fully textured 3D printed reproductions of famous paintings. Retrieved from https://3dprint.com/154857/verus-art-3d-printed-paintings/

[7] Thelen, A., C. Cappe, et al. (2012). Electrical neuroimaging of memory discrimination based on single-trial multisensory learning. Neuroimage 62(3), 1478–88.

CONTEXT STUDY

The future context of the country (including its economy, age structure and policy) and the development of the world of museum (employment of new technologies and new ways of collaboration) influence the museum's marketing strategy and the direction of museum design. Inevitably, the museum sectors in the Netherlands, including fine art museums, will meet new challenges in the near future, and they need to change to adapt to the trend. Therefore, it is important to understand the roles of the museum in the current context as well as in the future context in order to formulate the guideline for the experience qualities of the Smart Frame.
In that case, the trend analysis of future context consists of:

- *What is the current role of museums in general and art museum in specific*
- *How curators see the development of museum in the near future and how they shape the museum experience in the future*
- *What technology will be used in museum and how can they related to the setup design to make the museum experience more integrate*

A vsititor was charging her phone while viewing a painting

Current roles of museums

According to the Dutch museum association, there are six main functions that museums are serving for in the society, which are (1) preserving art and history, (2) restoring heritage, (3) educating knowledge, (4) evoking visitor's awareness, (5) providing relaxing and social place and (6) profiling the country.

As for art museum specifically, they are conceived as an educative and pleasurable leisure place, where people feel at ease. Furthermore, art museums play a main role of entertainment and a supporting role of education in the visitor's' mind [8] (as shown in figure 8.1). Visitors who engaged in creative activities, especially the young, appear to invest slightly different values in these institutions. They seem to look for a more self-centered, more surrounding dimension into arts and imagine museums in a slightly less conventional way. This attitude is be fed by a growing need in the society for new experiences, self-expression, and immersion rather than the distance of the detached spectator [9]. For these visitors, a more developed experiential and entertaining dimension (with workshops, interactive art works, discussions with artists, etc.) might make a difference in the choice of art museums to visit [8]

Figure 8.1 Education in art musuems shot in Pompidou art musuem

Crystal Universe teamLab, 2015, Interactive Digital Installation

It is a real-time interactive, moving 3D artwork. Such installation shifts viewers' perspective by engaging (entering to cause changes) and immersing (bring changes by using smartphone) them to interact and so it raises my curiosity about future museum.

Future context

Since exhibits are the basic components of every museum no matter what form they are in, how museum will be like in the future will correspondingly influence the way museums show their exhibits. Therefore, as a new way of providing interactive opportunity to fine art museum visitors, the exposition setup of 3D printed replica has the possibility and potential to lead the visiting experience towards such propositions, in the meanwhile, comply with visitors' expectation and motivation.

Therefore, The study on future trend is based on the collection of ideas shared by curators in five reports. Their insights are worthwhile to study since they formulate their proposition by balancing technological development, social trends, needs from future visitors, policy and even the perspective sponsorship. Moreover, just like the company to its boss, curators have to think carefully and seriously about how it may develop. In that case, their ideas tend to be inclusive and rigorous which provide reliable directions of museum experience in the near future. (The selection and categories of quotes can be seen in the appendix XI)

Future museum features

The insight from curators in articles are excerpted on pieces of papers with a symbol on the top right to show what theme they belong to (T, S and D stand for technology, society, demography respectively). they are clustered into 6 categories in terms of what kind of experience museums are trying to provide in order to comply with social, technological and demographic trends. **The conclusion can be summarized as Museums will become engaging, agile and collaborative, and the experience of which is going to be authentic, sharable and delightful.**

Engaging

- **Engage new functions**

The the boundaries between institutions and the public space, as well as between functions within audience-centered institutions, are quickly disappearing [5][7]. A cafe can be an office, an airport can be an art gallery (e.g. Gallery Toto in Terminal 2 at Tokyo's Narita International Airport). **In order to capture the attention and imagination of modern public, museums have to engage in new locations or embrace new functions.**

- **Engage diverse communities**

Thanks to more functions (e.g. educating, relaxing) that are merging into museums, museums are able to learn from other sectors from performance and education to social justice and training. As a result, it becomes possible for museums to engage diverse voice from various communities as well [1][5][7]. Different groups with different agendas will provoke new conversations and museums have to ask and respond rapidly to comply with this new trend [1]. **Therefore, developing engaging techniques is becoming increasingly important for museums to attract diverse communities.**

- **Merge technologies to engage**

Besides keeping stories and ideas fresh and open, what museum can do to engage their communities both internally and externally is emerging technologies which also enable people to immerse into the content deeply [1]. People who are unable to make a physical trip to a museum are able to access its collections and respond by viewing exhibits online. While curators and museum specialists are working closely more than ever with technologists and educators to seize the opportunities brought by digital resources to enhance multimodal learning both online and in the museum [2].

- Online

With the help of Intelligent Machine, the collections of museum can be more accessible and useful to general public, since an AI expert is not only familiar with the museum's own collection data but also the related scholarship on the internet [4][7]. In order to fully engage the conversations between diverse communities, the ability to read and interpret large sets of data will become increasingly necessary. And because in some region in the world, people still are not able to access the internet, museums have the opportunity and responsibility to ensure people to gain digital literacy skill [2].

- Onsite

Natural user interfaces are filling the gap between human and computers as new platforms that incorporate touch, voice and even gestures (e.g. Microsoft Kinect). It is quite possible to allow visitors to become part of the installations by using certain technologies [2].

Location-based apps can knowingly guide visitors through a museum by directing visitors to exhibits that match their preference or suggesting routes with accompanying digital displays and features to interact with (e.g. Audio tour in Louvre museum) [3].

Overall, the involve of new technologies and innovative programs (e.g. escaping room) can promote ongoing interest of visitors since they are able to examine, explore and participate easily.

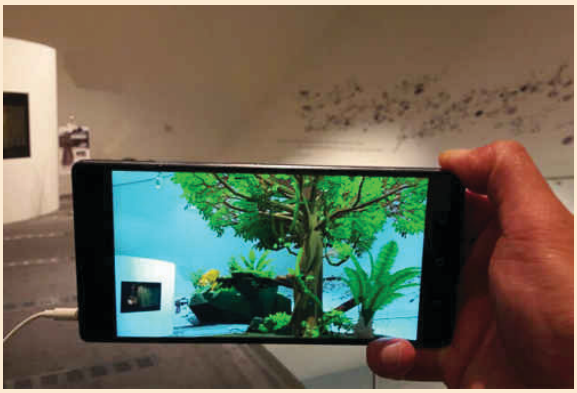
- **Engage new generation**

Amongst all the communities that museums are trying to attract, the millennials, in particular, is one of the most important target group, who are more interested in social interaction, participation and self-discovery than traditional way of learning [3]. Those features poison them as pioneers to the technologies-merging-exhibitions. In that case, investing in the creation of rich and varied experiences will be a significant consideration for museums. While museums are transforming into engaging hub, it will continue to be young learners' classrooms.

- **Engage to incubate empathy**

As museums gradually engage more and more communities and immerse them deeper into the content with the help of various cutting-edge technologies, this way of storytelling can engender empathy, which is highly needed for new generation as well as migrants and refugees. For new generations, empathy can benefit their creativity as well as the healthy relationship between their friends even business partners in their future career, however, there is a decline of social-emotional skills especially for the new generation [4]. While migrants and refugees always hold particular needs when visiting museum, where they want their tensions and fears can be eased and healed by relating to certain collections and historical perspective [4]. Thus, Museums have the opportunity to take advantage of its resources to cultivate empathy in order to increase educational and emotional success of their communities.

Example:



"Into the Wild" by Brain Nothing Tan, virtual experience at Art-science museum, Singapore

Thanks to Tango, a cutting-edge MR technology, it transforms over 1000 square meters of museum into a virtual rainforest, which visitors can explore using smartphone device. While visitors plant a tree in the virtual world, a real tree will be planted in a rainforest in Indonesia. The adoption of the new technology, cinematic story as well as the fresh idea of connecting virtual and real world helps the museum to engage increasing number of visitors and let them empathize the serous situation that the Indonesia rainforest is facing.

Potential directions for the Smart Frame:

By taking advantage of new technologies, the Smart Frame may provide versatile interaction to engage different communities with different concern and expectations. This is also done by incubating their empathy by immerse them in a story or educate them in refreshing way.

Agile

• Become agile by providing seamless experience for physical and virtual visitors

Whether ordering tickets, viewing exhibits or simply browsing the museum's website, visitors are always expecting to have a consistent experience through their device [1]. As productivity is continuing play an important role in the concern of modern people [2] and the border between public and private space are gradually blurred by digital landscape, increasing number of people are inclined to carry their laptop or other smart devices with them everywhere to get information whenever they want [2]. **Consequently, lots of apps are developed and provided by many museums for way finding and comments sharing (e.g. Mauritshuis museum). And those apps are expected to present the right content quickly, easily and seamlessly not only from both physical and virtual visitors.**

• Become agile by providing flexible way of storytelling

Museums guard their heritage not only because those assets can tell story about the past but also because the way to present and interpret those exhibits can help spur discussion and inspirations on contemporary issues (e.g. terrorism, racial discrimination and etc) [1]. With the help of technologies, it allows museums to easily reuse and repurpose their exhibits by constantly update gallery and content online [4]. **Thus, adapting to the fast-changing world to the way of telling a story should be a concern to museums.**

The flexible way of narrative is also a trend to comply with people's flexible working hours. Resulting from the booming of freelance, contract labor as well as 'sharing economy' jobs, people visit museums with different schedule. Museums may also find themselves employing more part-time labor in the near future [3].

Example:

"The Pen" by Ideum, interactive museum guide at Cooper Hewitt, Smithsonian Design Museum, New York

It combines two main technologies. Its interface with the interactive tables employs the sort of conductive materials common to touchscreen styli. Its interface with the object labels employs near-field communication technology. A sensor in the end of the Pen reads the information on small NFC tags embedded in the object labels. This information is stored in the Pen's onboard memory and can be read at the interactive tables. When visitors leave the museum, they are given an URL to access to their personal collection anywhere at anytime.

Potential directions for the Smart Frame:

The interaction of the Smart Frame can be synchronized with smart phone or integrated with audio tour so that visitors don't need to shift to an extra device for input or output. The content of interpretation can be updated periodically and triggered in accordance to different visitors' expectation

Collaborative

• Become collaborative by cross-institutional collaboration

As one corollary to attract multiple communities and not to lag behind the rapid changing technologies, economy and lifestyle, **museums will never be a standalone institution, they will find a way to cooperative with other institutions to enrich their exhibit and make the visiting experience versatile** [1][5]. Multi-institutional collaboration will also occur at data level in order to provide visitors more information about scholarship.

• Become collaborative by co-curating with visitors

In the near future, museums will be cultural network that everyone can be part of, since visitors and communities are integrating in museums in terms of making curatorial decisions and developing innovative way to share knowledge [1][4].

Online

With the arrival of multiple digital technologies, there are already many museums having experimented digital project (e.g. online learning) in visitor studies [1]. As the network between museums are strengthened and the working pattern becomes flexible, staff from the museum will work with other teams even with participant outside the museum [1]. Such a collaboration will help museums to create engaging exhibitions and programs by linking insights on the internet, visitor service, designers and curators. It will also help museums to better balance the visitors' demands and museums' resources.

Onsite

The new form of curating is not limited on virtual level, it can also happen on the real world. Namely, museums can recruit visitors to test prototypes in order to improve the final design [4]. Meanwhile, it is also a form of engagement in which museums can be humanized from mystery while audiences feel they make contribution to the outcome.

Example:

"Measuring the Universe" by Roman Ondák, performance at MoMA, 2007, courtesy: MoMA, New York

The exhibition starts as a blank white wall and begins to fill when museum guards mark visitors' height along with their name and the current date. The exhibition is created by the participation and collaboration of visitors.

Potential directions for the Smart Frame:

The Smart Frame can be designed in modular, which makes it convenient to transport between museums. The comment from visitors can be recorded and added to the interpretation of the painting.

Sharable

- **Connect with diverse communities**

In the future, museums will no longer promote for themselves by telling how interesting they are, instead, the communities will take the responsibility to do it [1]. Thanks to the engaging of different institutions into museums together with different communities, **museums will be created as a platform for different communities to share and learn about each other consequently.**

- **Online and onsite**

With the emergence of various advanced technologies (e.g. AR and VR), museum are looking to creating emotional experience to inspire visitors from compassion to action and share with their friends and family [3]. In this digital world, the appeal of the analog world is continuing to grow, museums will provide unique physical social experience which is augmented by digital applications [1]. **This will result in a growth of people who share their experience online and museums will embed more sharable experience in their galleries.**

Example:

Dubbing junkbox, Museo Interattivo Del Cinemal, Milan

The junkbox have a big collection of classic plot in various films and animations, which allows visitors to select and dub for their favorite one as voice casts, visitors can try as many times as they want in the museum, then share to SNS or just save for their private collection.

Potential directions for the Smart Frame:

Visitors' experience with the Smart Frame can be upload online or share to their friends.

Authentic

- **Eager for the real**

In a world where everything can be counterfeited, from art, news to consumer products, people have stronger will to experience the real thing. Coincidentally, museum is such a place where public trust them [1]. With this value proposition, museums have to assist visitors to better understand what is real.

- **Make story simple, make interaction intuitive**

As technologies are expanding human sensory and cognitive abilities, more museums are realizing that a simple and intuitive design is good to exhibiting [3]. A trustworthy way of telling a story should be simple and intuitive.

- **Make knowledge transparent**

Since the new generation is encountering an identity crisis, museums can use its trait to assist them to understand their social role and value by mirroring history to present. Led by this mission, museums are more focused on aesthetic and scientific meaning of exhibits to bear various perspective based on people's cultural background [1][3]. Moreover, **in order to validate and acknowledge those perspectives. museums have to demonstrate explicitly and transparently how knowledge is developed, shared, or revisited to help audiences to explore with confidence and promotes engagement through nuance and diversity** [1].

- **Be an advocate to illuminating civils**

While museums are welcomed by diverse communities, which are facing different fallout of economy, culture and policies, museums are being called on to act as advocates for social justice [4]. **Museums will change from place of learning or house of collections into civic connectors to illuminate local concern and re-image people a more livable world.**

Example:

Multisensory sculpture by Ezgi Ucar, Project from Medialab at the Metropolitan Museum of Art, New York

It is a small, touch-sensitive replica of the figure that has its own smell and sound. Visitors can better understand the original use of this figure and figures like it (inspiring reflection on the consequences of transgressing established codes of social conduct).

Potential directions for the Smart Frame:

The Smart Frame can be a storyteller that assists in making the explanation of the painting or the information beyond painting simple but transparent.

Delightful

• Apply fresh approaches to win the competition

The museum of the future will not be conservative. Instead, **it will be confident to take risks to adopt creative business models and to be unique amongst other museums** [1]. Where there is a collaboration, there is a competition. Museums are also competing to offer fresh ideas and surprises to visitors, who expect to access to accurate and interesting information and high-quality media [1][4]. Only in this way can museum develop a deep connection to audience who want to come back and who will come (e.g. millennials who prefer spend money on experience rather than staff).

Example:

"How Do our Bodies Inspire Art?", interactive games at Gallery One, Cleveland Museum of Art (CMA), St, Ellensburg

The interactive games encourage visitors to connect actively with the collection and see themselves in the art on view. "Make a Face" offers visitors the chance to investigate the museum's collection of portraits through face-recognition software. A webcam records their facial expressions and matches them to works in CMA's collections. "Strike a Pose" invites visitors to explore figurative sculpture by asking them to match the pose of a sculpture they see on the screen. A motion sensor records their pose, and the interface shows determines how closely the visitor has approached the artist's sculpted body. Those innovative approaches attract visitors into the galleries with great enthusiasm and excitement about the collection.

Potential directions for the Smart Frame:

Visitor can interact with the device in a way beyond their imagination but provide them surprise.

Visionary context

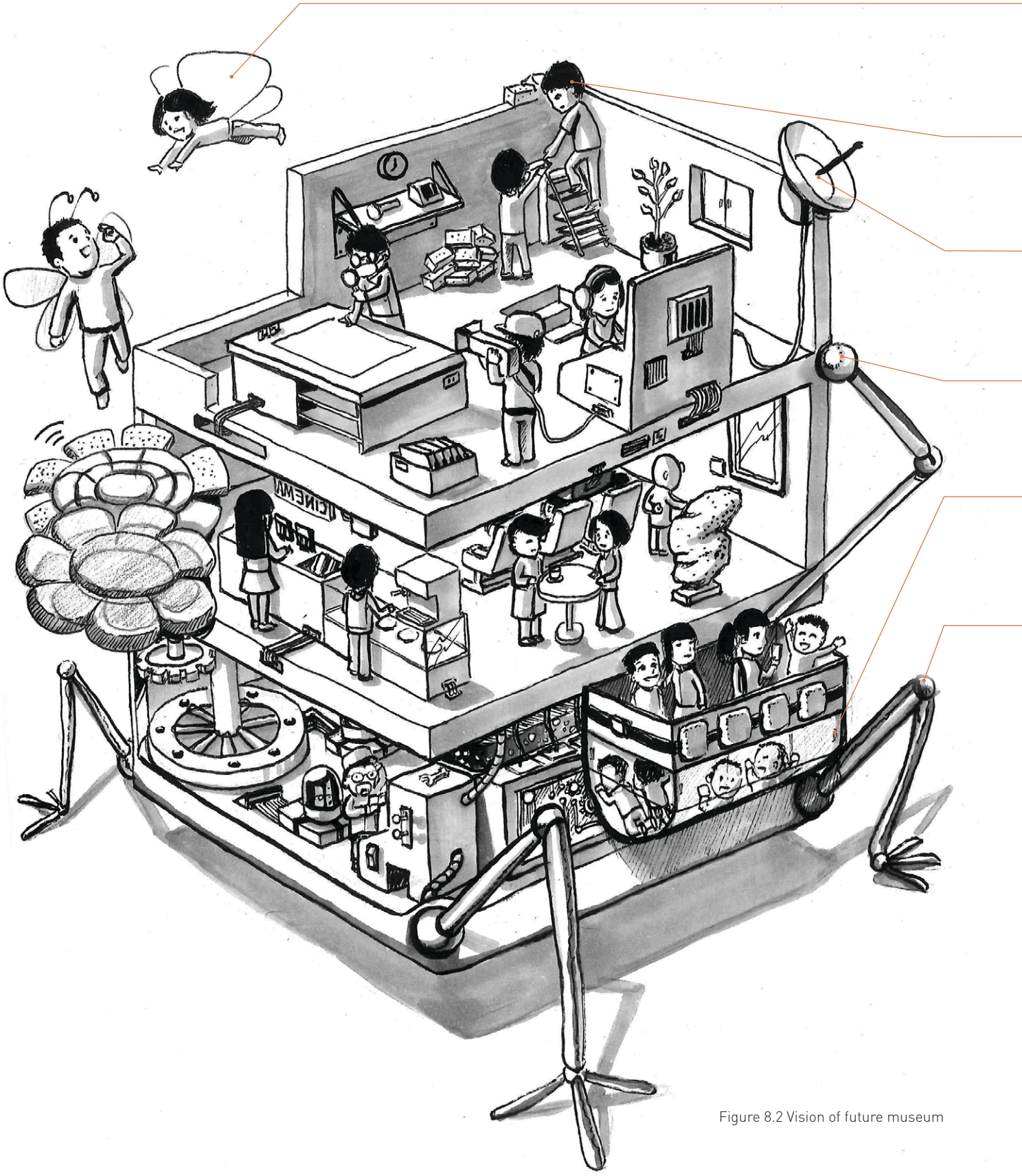


Figure 8.2 Vision of future museum

- **Engaging diverse communities and new generation by merging technologies and new functions**
- **Being collaborative by cross-a collaboration and co-curating with visitors**
- **Sharing with diverse communities onsite and online**
- **Being delightful by applying fresh approaches**
- **Being authentic by making knowledge transparent and making interaction intuitive**
- **Being agile by providing seamless experience and flexible way of storytelling**

Conclusion

Coupling with the current role and future development of museum, a vision is created to demonstrate how art museum will be like in the future.

In the vision, art museum turns to be an moving castle which can constantly intake fresh ideas from the environment to comply with the fast changing world.
One the ground floor of the castle, the whole moving mechanism is shown to public to make knowledge transparent and authentic.

On the first floor, new technologies like holography and stereo are installed to attract different communities (as in butterfly-human in the vision). In addition, it also served as cafe and cinema in order to engage and incubate communications. Hinging on the ceiling of first floor, as an unprecedented approach to the museum, a flexible robot arm brings visitors (especially young visitors) to the experience of theme park to make them delightful.

On the Second floor, the restoration programme of an ancient painting is going on and sharing to the whole world, meanwhile it also offers to on-site visitors in real time. At the corner two visitors are helping the museum to grow higher, since collaboration is one of the principle of this future museum.

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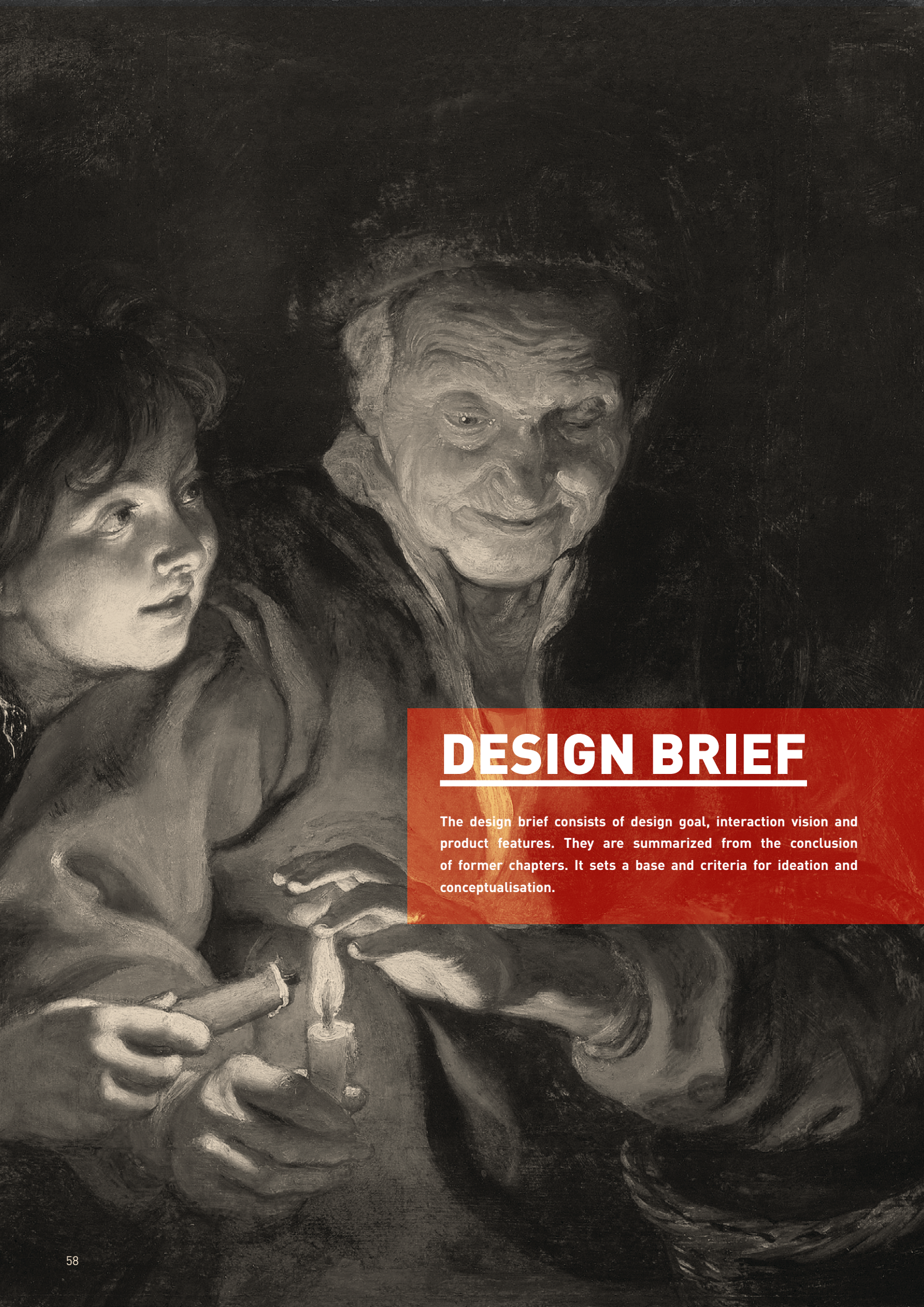

DESIGN BRIEF

The design brief consists of design goal, interaction vision and product features. They are summarized from the conclusion of former chapters. It sets a base and criteria for ideation and conceptualisation.

Synthesis

Conclusions from different parts of the research are translated into the design goal and interaction qualities then envisioned as in experience vision and interaction vision. As shown in figure 9.0, characteristics of target group, potential aesthetic value of 3D replica and finding from current experience of the Smart Frame are taken into account to the formulation of design goal and interaction vision. The settlement of the design goal also includes the some of the experience qualities of visionary context.

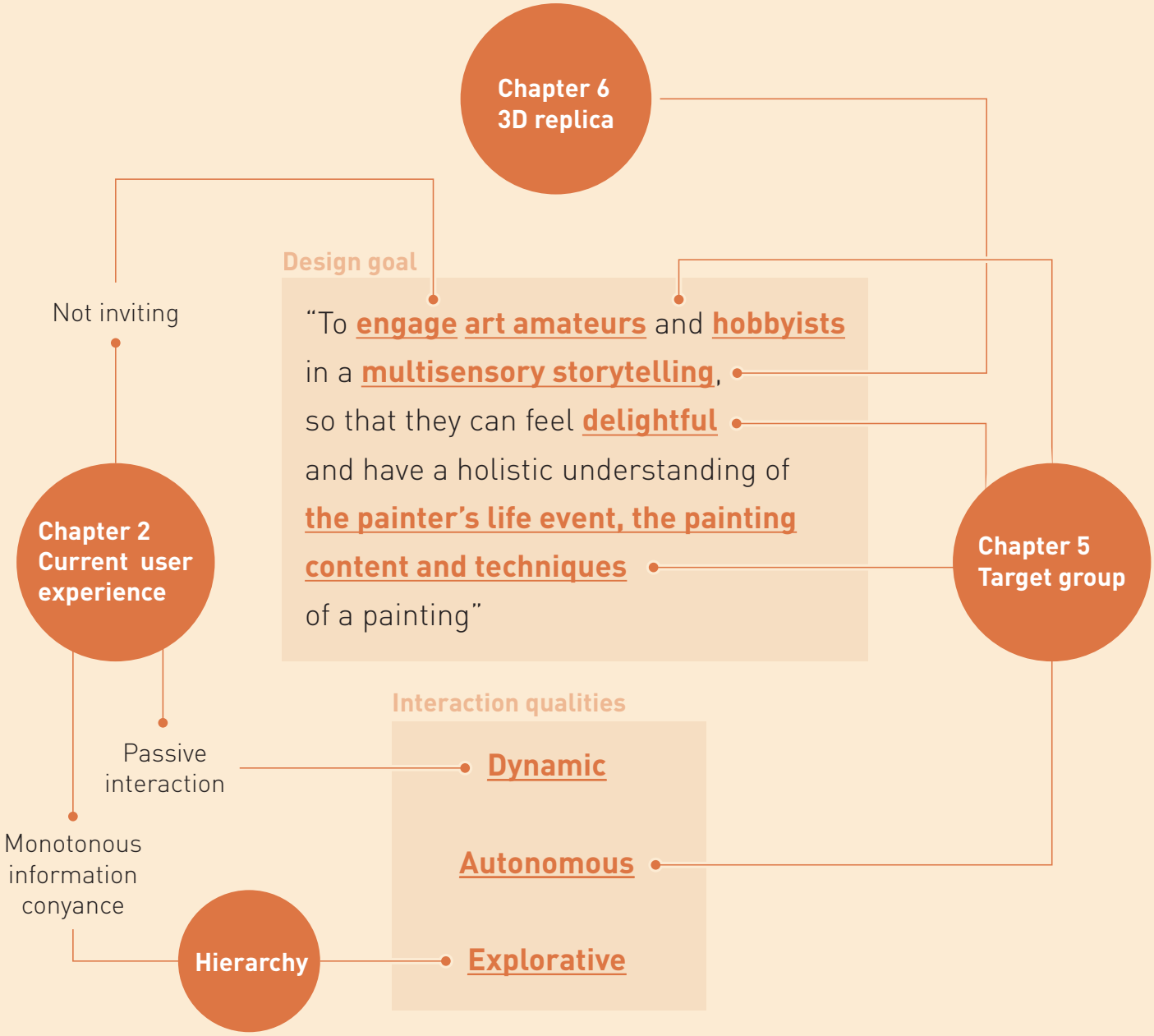

Figure 9.0 Components that come to the design goal and interaction qualities

Design goal

Starting with the interest fields of the target group, the design should provide information about painting content, techniques and painter. The efficiency of such education can be improved by a multisensory way of storytelling with the help of 3D replica. The experience can also be improved and promising if people are better engaged, since it is a weak point from the former design but required in the experience qualities in visionary context. The design should also let people feel delightful, which is the signal if they get the meaning of a painting and also one of the experience qualities in future art museum. Thus, the design goal for the Smart frame 2.0 is:

"To engage art amateurs and hobbyists in a multisensory storytelling, so that they can feel delightful and have a holistic understanding of the painter's life event, the painting content and techniques of a painting"

Comparing to the design goal of former report which was

"To design a (standardized) exhibition setup for a reproduction that provides specific information regarding the content of the painting and technique of the painter."

The design goal formulated in this project is shift from the perspective of integrated product design into design for interaction. It is embodied as the consideration of new target group, the clarity of the effect and the deepening of the provided information.

Hierarchy of information

Talking about painter, the first thing popping into our mind is the his or her style. Painter's style is always fit into a general style, but such way of introducing a painter conveys knowledge declaratively which is not a engaging way of storytelling, instead, a more narrative way of introducing is through their life event, which also influences their works in terms of content, color and techniques. For van gogh's life events as example, Gauguin is the reason why he paint sunflowers; it is the encounter of impressionism in France open up his exploration on impressionist which result in the twist of his style from his previous one, he started to use broken brushstrokes; his madness makes his brushstroke twisting, like starry night.

Every gene is unique in this world, so as style of painter. As the gene of painting content and painting techniques, the formulation of individual style can be the story to explain the expression on the painting. Individual style of a painter, is a distinctive manner which permits the grouping of works into related categories [2]. As an inevitable result, art historians develop conventions for style fixing. The results of those conventions are translated into knowledge published and taught to people. Such education plants an impression into people that artists are godlike, however, they are human like us who are just sensitive to what they went through and able to translate them into eternal artworks. The ability gradually becomes a systematic procedure by which their style is conveyed [5]. So, essentially, their style is just the embodiment of personal way of communicating and expression in terms of the pattern of subject matters, the use of color and light, brushstroke and even psychological status. Such hierarchy can be visualized as in figure 9.1. Comparing to regard individual styles as typical examples or variations of an academic framework, tracing their origin and making them personal would be helpful to revivify artists as human instead of god and thus their story can be more accessible and authentic. In return, viewers are able understand the content, techniques and the meaning of the painting more easily [1].

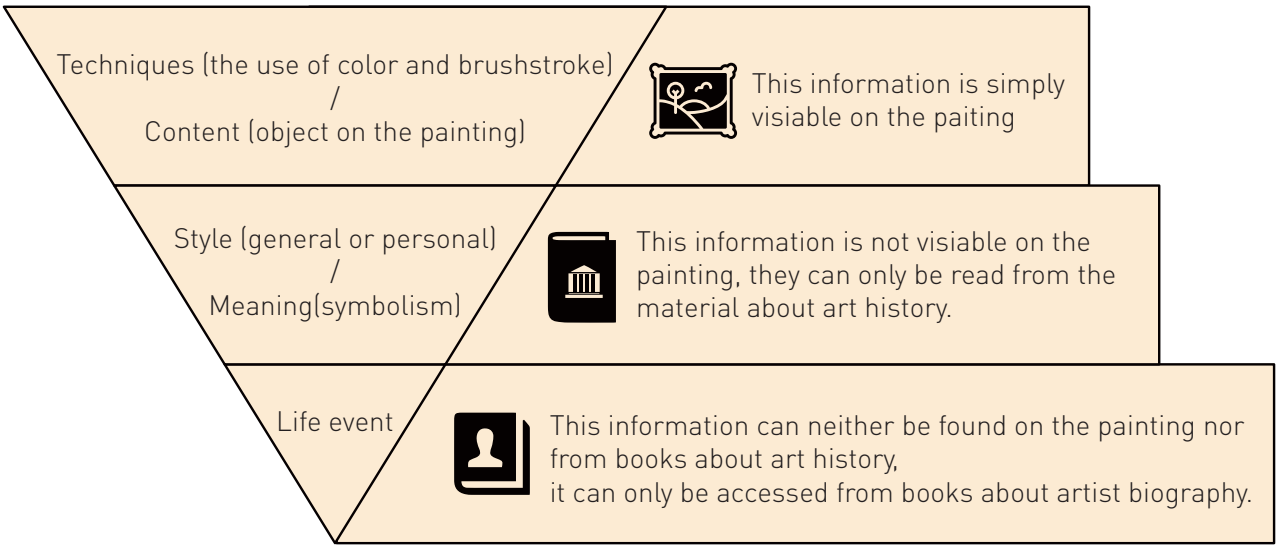

Figure 9.1 hierarchy of information

Figure 9.4 Screenshots from the animation 'The painter' by Roel Bogers (2017)

Experience vision

An experience vision [Figure 9.4] is selected to visualize the effect of design goal.

The painter used numerous techniques to paint a series of paintings which were based on his dream after inhaling the odour of palette, but no one could understand them because the painter ended up with merely pure color paintings. However, after the visitor was invited to have intimate interaction with the painting, he realized what the painter was trying to impart which made him very delightful. Then everybody did the same to understand those paintings.

Desired interaction qualities

Dynamic: The interaction should consist of multisensory stimulus so that user can actively being engaged in the experience.

Explorative: The exhibition setup should include explorative teaching process to result in long term memory [3]. In addition, user will be triggered to explore different layers of knowledge and different parts of the painting step by step with certain guidance.

Autonomous: In the user research, personal preference could been seen between individuals, although they perform a certain pattern. So the device should allow user have the right to choose the subject that they feel curious to know and trying out with their own understanding, even if the guidance is given.

Interaction vision

An interaction vision has been created for the user-product experience. It is created by taking account of all the desired interaction qualities. The purpose of this vision was not to use it as a guideline for the design phase, but rather as inspiration for the generation of ideas and as reference to look back to.

Immersive theater

In immersive theatre, the audience are not merely passive bystanders. They are part of the story, however small their role may be, and they are in the middle of the action. In an immersive theatre production, the audience in some way plays a role, whether that is the role of witness or the role of an actual character.

"That is not to say that 'immersive' is the same thing as 'site-specific,' nor that it is a synonym for 'interactive' or 'participatory,' though all three concepts do tend to go together."

As the immersive theater also tend to stimulate all senses, it will be more natural to link to desired interaction qualities and more helpful in providing insights.

By breaking the frame of proscenium, audiences can also step on the stage.

Normally, the theater is designed to transform into new institution in order to let audience step in the story; The immersive theater is aiming to evoke unique experience for individuals, this is achieved either by the leading of performer (as in Then She Fell) or by self-exploration (as in Sleep no more). As a result, audience can be part of the performance as a co-actor, or participate in the storyline they are interested in; In some immersive theater, audiences are given some tasks (e.g. The Grand Paradise and The Alving Estate) in small groups, those playful interaction or inexplicable tasks help audience immerse in context as well; Although the unfolding of the story seems not as important as tableaux in majority of immersive theater, the connection of original story (e.g.Then She Fell) still benefit the sense of achievement [4].

Product qualities

With the reference of interaction vision, four product qualities are identified in order to provide insights for desired interaction qualities:

Helping in role transforming though the design of the product or specific tasks - explorative, dynamic

Multiple storylines to follow - autonomous

Making the story based on the original ones for better acceptance - explorative

Nicholas Bruder and Sophie Bortolussi with audience members in Sleep No More.

A scene in which audience volunteers get soaked in "Take Care" at the Flea Theater.

Figure 9.5 interaction vision

Design requirement

Demands

Performance:

- The product must react to user's input within 1 second
- The product should accurately detect user's input
- The product should not harm to replica
- The product must be useable by international visitors,
- The product should allow users can achieve different result based on their preference
- The way that information is provided should compensate people's viewing instead of distracting

Environment

- The light used in the product should be strong enough without the need of extra setting but not harm to user's eyes

Usage:

- The product must be used by one person at least
- The product must be Inviting to interact
- The product must have use cues to guide the user in terms of use
- The product must offer enough information for user to interact
- The process of product using can be stopped if the user want

Aesthetic:

- The product must have simple appearance not distracting the visitors from replica

Production:

- The exhibition setup must be able to be assembled on the spot
- The exhibition setup must be able to be used for different size paintings
- The exhibition setup must support paintings smaller than 1m and 1m in size
- The light source(s) of the exposition setup must be existing product(s)
- The production cost of the exhibition setup must be as small as possible

Safty:

- The product must not damage the painting or reproduction, the product must not contain sharp edges
- The use of light should not harm to user's skin or eyes

Wishes

- Preferably, there should not be another device required, if so, the additional device should be designed simple with only necessary functions.
- Experts and laymen shall also benefit from the using of the product

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IDEATION

This chapter is about the exploration of ideas orientating to achieve the design goal and desired interaction qualities. It includes a generative session about painter's style which provides numerous starting points. Those ideas were developed further into two design directions by taking account of interaction qualities and design requirements and one idea was finally selected.

Chapter Overview

In order to achieve the design goal, the model of creative problem solving is applied [1]. Hence the whole ideation process consists of two 'diamonds' and each 'diamond' included two stages which are 'divergence' and 'convergence' (as shown in figure 10.0). The first diamond encompassed a creative session, the ideas from the session are brainstormed and sifted again in the next diamond. The two design directions from the second diamond are then compared and finally one of them are selected for conceptualization.

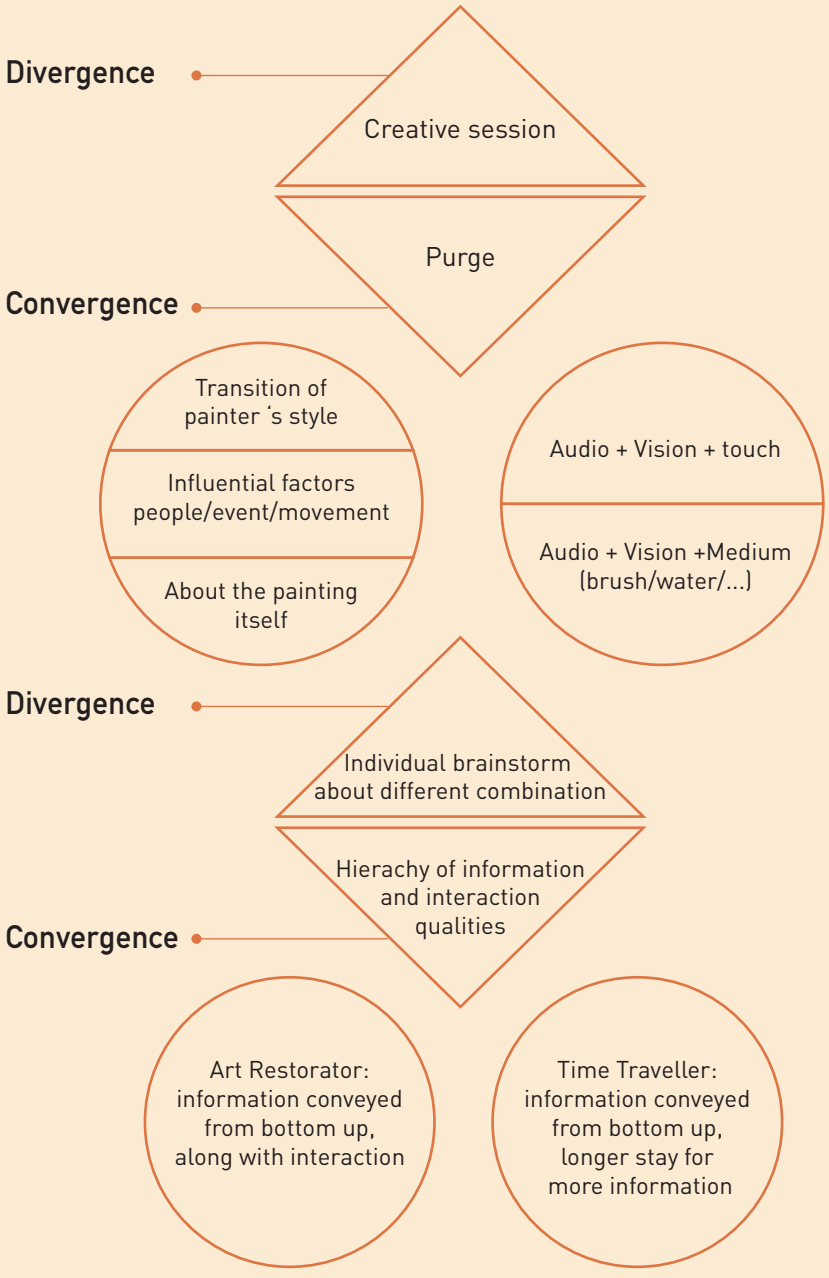


Figure 10.0 Overall process of ideation

Creative session

Setup:

A creative group session was executed with design students of Politecnico di milano.
Resource groups were composited by 4 design students who are specialized in different field including furniture design, service design, material design and sound design.

The process for this session has been formulated according to Tassoul (2009) that can be found in Appendix XII. The main structure of the session can be seen in figure 10.2

Introduction:
Three criteria were announced first: Ponsponding judgment; Hitchhike other's idea; think out loud. After that, the original "How-to" question (How to let visitor know about the painter's style through the interaction with 3D printed replica?) was carried out and explained to resource group.

Problem definition
"Flower association" was used to get their initial idea about artist's style. Then they were asked to select and combine related features to create their own artist
Divided into two groups and each group were asked to put themselves into shoes of the artist they just created then draw on a newspaper with 'their' style.

Idea generation & selection
Stepping out of the persona, participants were asked to imagine they are visitors who drop in to visit the works of the artist
Each of them were assigned a color of post-it with a specific sense (smelling, looking, listening and touching) then they start to generate ideas based on the assigned sense.
Idea improvement
After three 3D printed replica samples were shown to them, they were asked to refine their idea by linking their previous idea to the replicas.
Result can be seen in appendix XIII-A

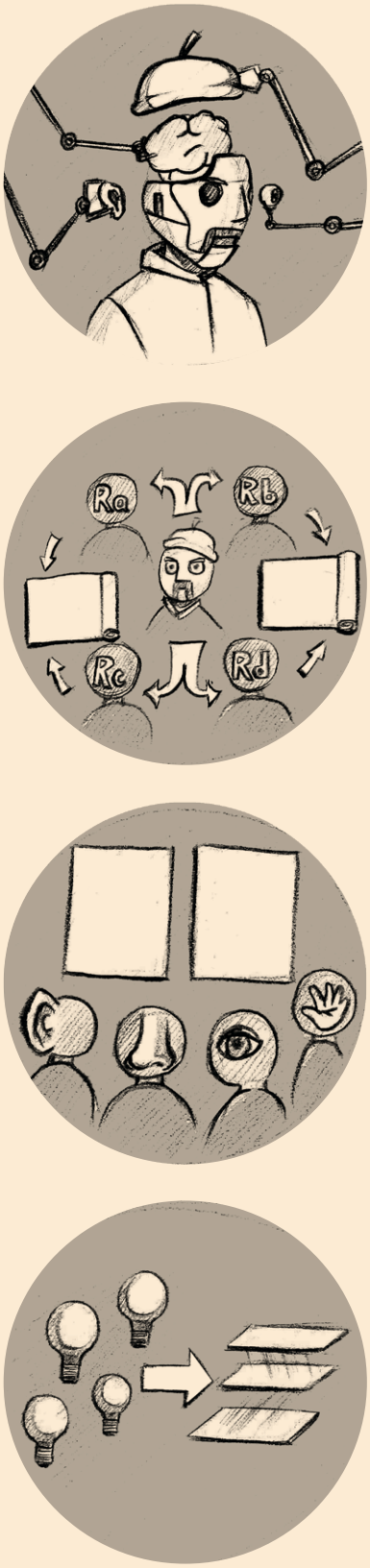


Figure 10.1 process of creative session

Ideas development

Ideas from creative session were sifted (as shown in Appendix XIII-B) then clustered into two categories, which were content for storytelling and way of interaction (the result can be seen in Appendix XIII-C), since lots of ideas were can only meet part of the design goal. In the second diamond, ideas from the two categories were selected and combined to become more complete in the individual brainstorm session (the result can be seen in Appendix XIII-D). After taking account of information hierarchy mentioned in the design brief, two design directions were concluded, the name of them was given based on what role the user is going to play in the whole experience.

Design directions

The two design directions are visualized in figure 10.3 and 10.4. They are distinguished by the way of information conveyance and the role the user is going to play during the experience.

Art restorator:

The 3D printed replica performs in front of user with lots of areas fading, user needs to play a role of art restorator to restore those parts by using different tools, meanwhile, information about the painting will be told to user.

The information conveyance is from bottom to top in the hierarchy. User firstly get the information about what has the painter experienced to make him or her paint such a painting, then the information about the meaning and style the painter wanted to convey will be told to user, so that the user can relate to the part they are working on.

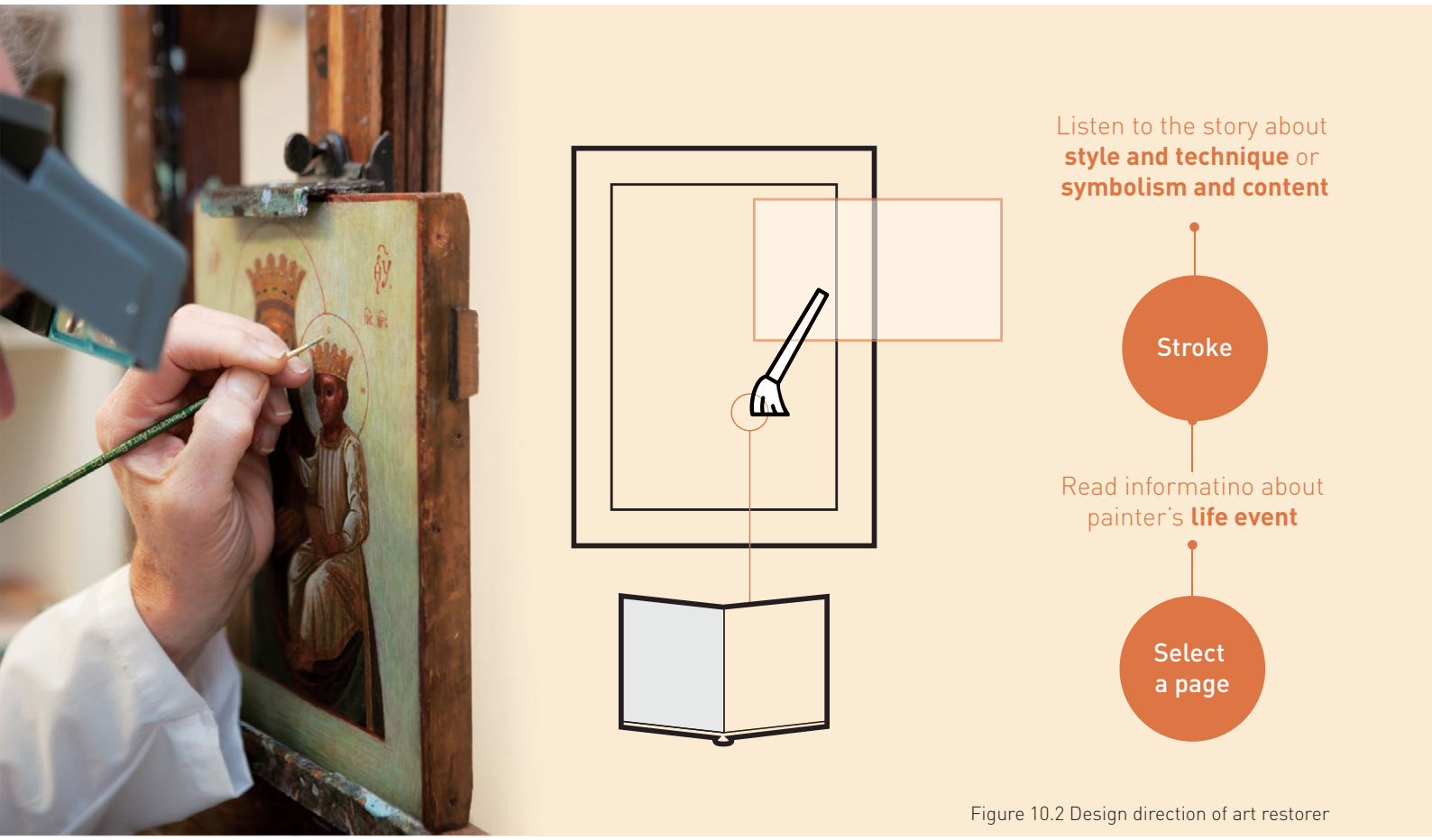


Figure 10.2 Design direction of art restorer

Archaeologist:

The 3D printed replica transforms into a antique for user to excavate to find deeper information.

The user just needs to use their bare hand to touch the specific part of replica, the longer user's hand stays on the specific part, the more information the user will be told.

The information is conveyed from top to bottom in the hierarchy, it starts from how the same object was painted in different period of the painter, then the information about the transition of style and subject matter will be triggered. Finally the life event of the painter, which resulted in the transition and symbolism will be told if the user's hand keep staying.

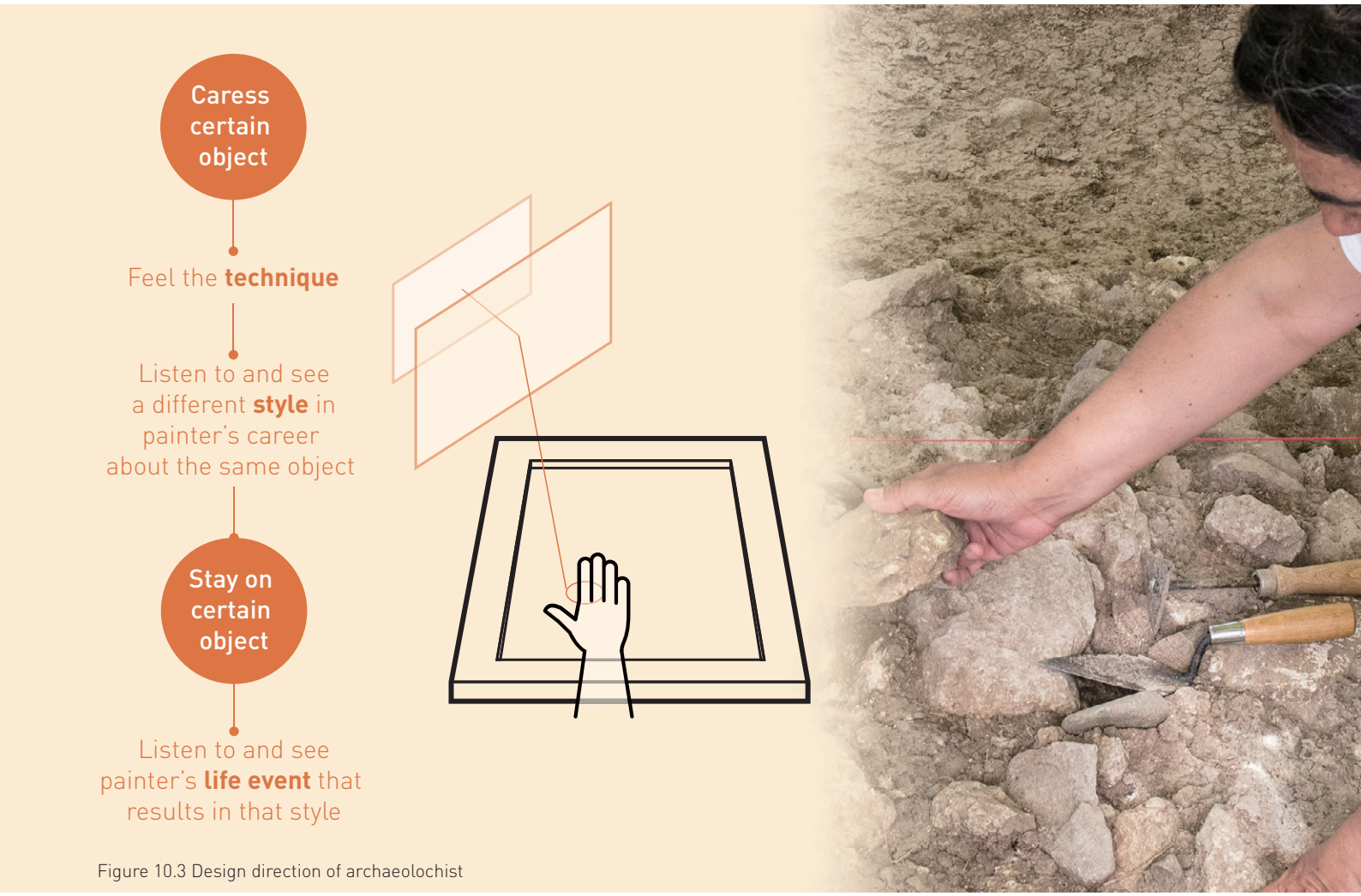


Figure 10.3 Design direction of archaeolochist

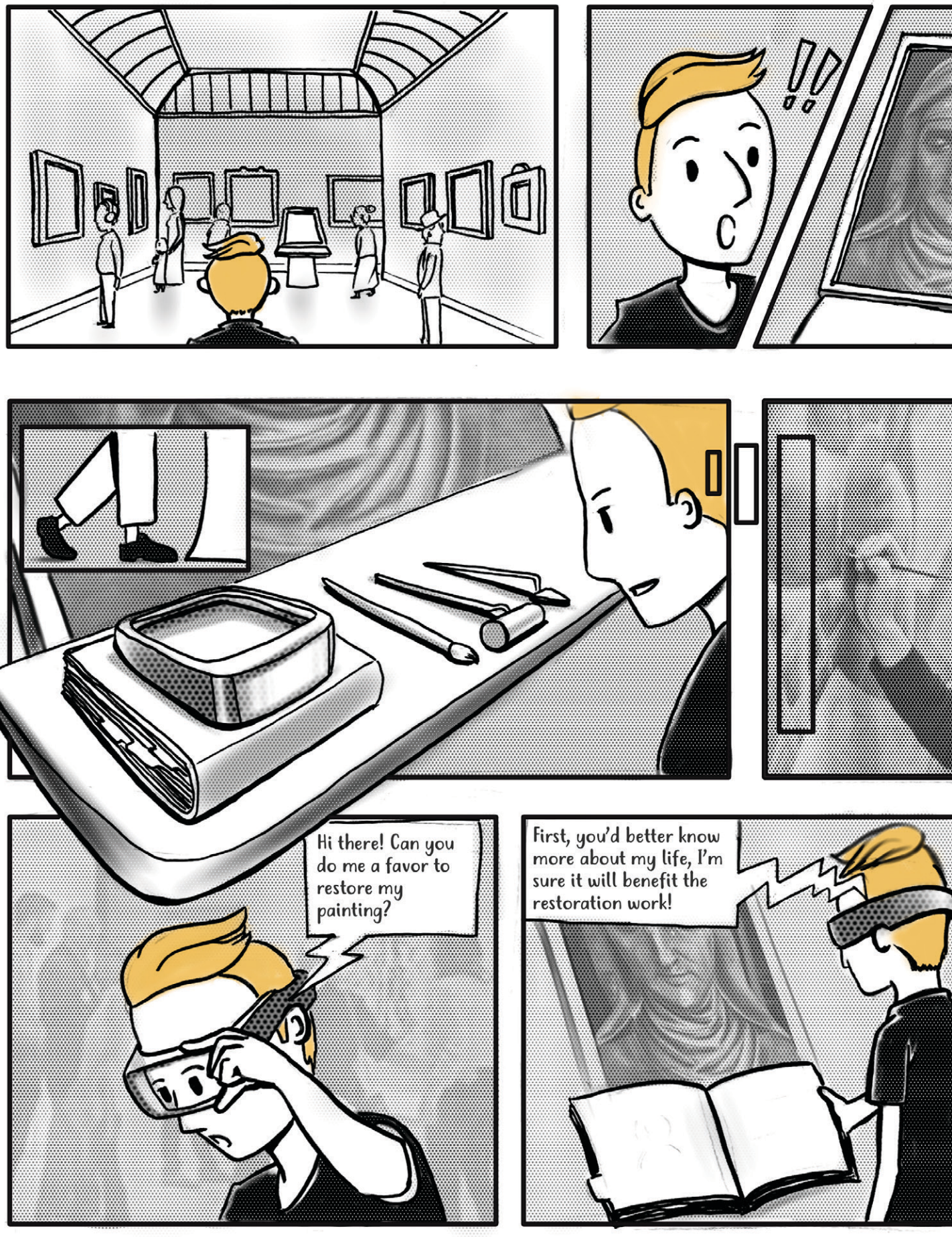
The final idea

Eventually, the chosen direction was the 'art restorer', since it fit the context of art museum better, comparing to the direction of the 'archaeologist'. Large art museums, like van Gogh museum and Rijksmuseum in the Netherlands has their own institution of art conservation, and they have open workshop for visitors sometime, so having such experience in museum won't be impenetrable for museum visitors as well as curators. Besides, being an 'art restorer' may also helpful in eliminating the unnatural feeling of touching a painting, as it allows indirect interaction with the 'painting'. For the consideration of making the design more inviting in art museums, the 'art restorer' was chosen as design direction.

The details of the idea can be seen in the scenario, as shown in figure 10.5.

Firstly user has to wear a pair of magnifying glasses with earphones integrated, then choose which part he or she wants to restore, at the same time the user gets to know painter's life event related to specific part from audio and story on the book. During the process of restoration, the user will hear the information of technique related.

[1] Tassoul, M. (2009). Creative facilitation. Delft: VSSD.


Hi there! Can you do me a favor to restore my painting?
First, you'd better know more about my life, I'm sure it will benefit the restoration work!


I have marked the area that need to be restored and also the tool you need, just go ahead to discover what it should be like!

CONCEPTULISATION

Looking back to the final idea, there were various parts needed to be validated, which included whether such way of interaction is intuitive and whether it can achieve intended effect. The phase of conceptualization was not only aiming to validate but also to gain insights from testing interaction to refine the final idea.

Chapter overview

Firstly, the types of deterioration of oil painting is compared to find the most appropriate one(s) for the concept, since it may lead to different interaction. The criterion for selection is that it won't involve complex process and interaction potentially. The decision is taken to explore how corresponding deterioration is restored according to people's impression, because it helps to design the interaction and setting more intuitive. Meanwhile, the envision of interaction qualities can also be explored.

Based on the insights about the most envisioned interaction and setting from test 1, the first prototype can take shape, thus, the goal of test 2 is to ascertain whether it can achieve the design goal. In test 2, former design is used for making comparison in order to make participants speak out their opinion easily. There are three terms for the comparison, which are interaction, storytelling and setting, this is not only because they are three important benchmark when experience design meets exhibition design [2].

Eventually, the final concept can be formulated on the basis of features that can fulfill interaction qualities from test 1 and result of comparison from test 2.

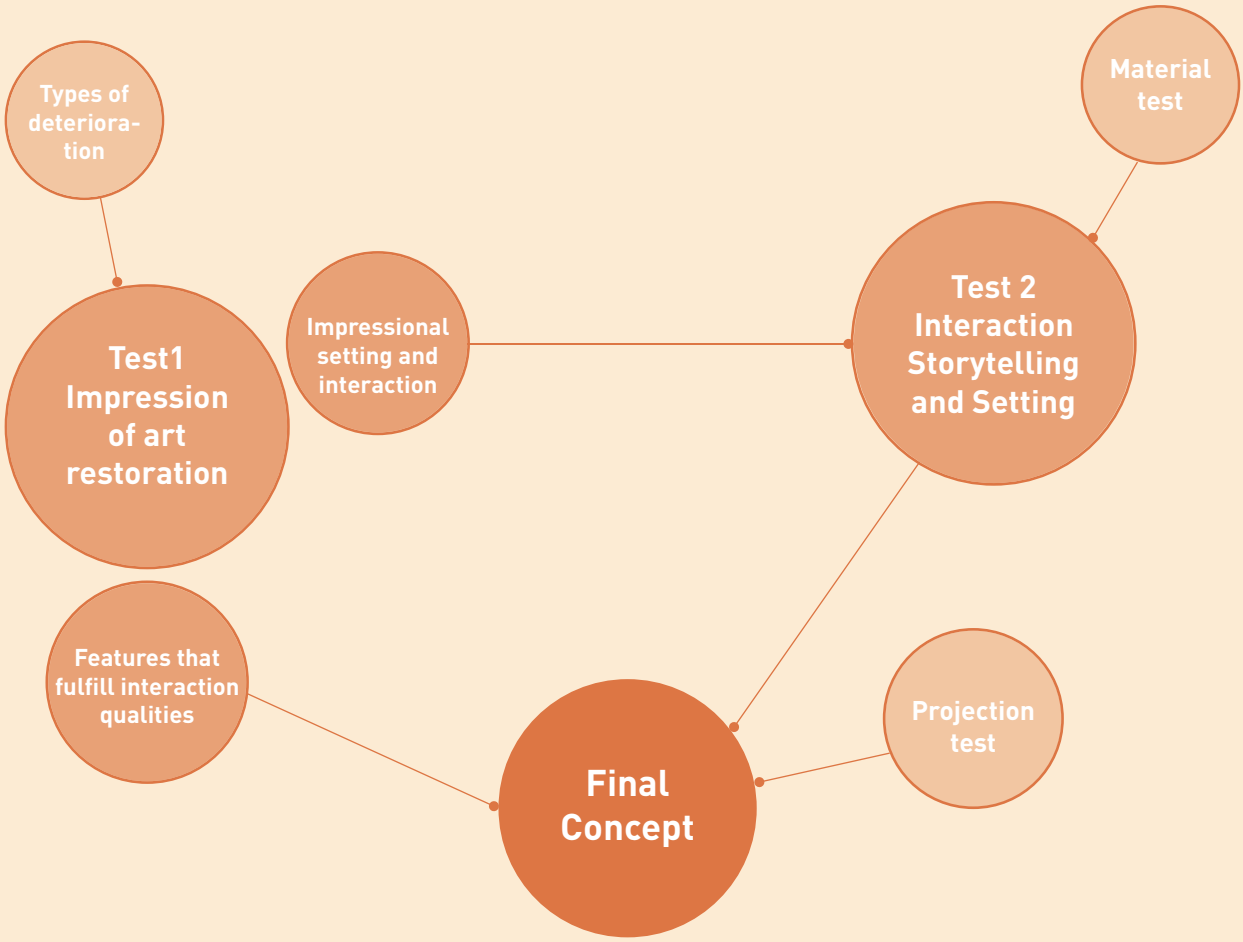
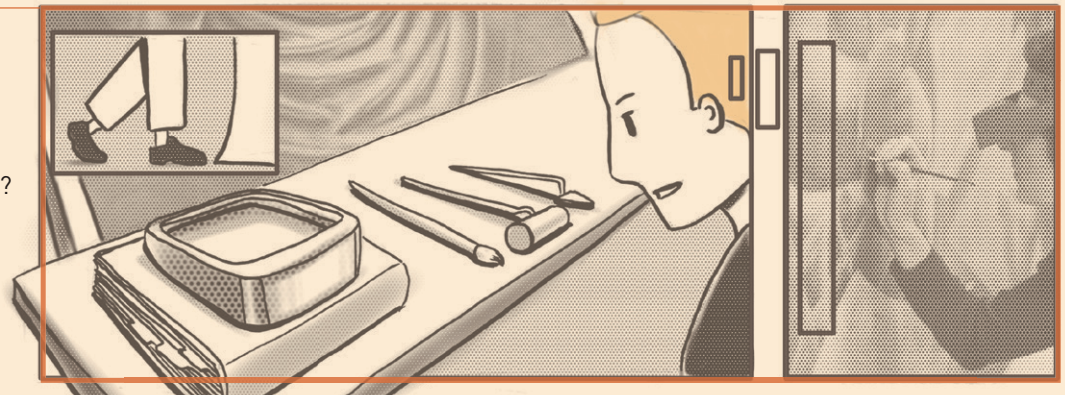


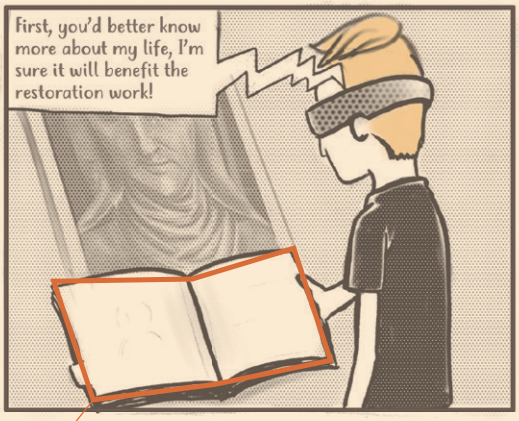
Figure 11.0 Tests that contribute to the final concept

Will people like to experience art restoration in art museum?

Flaking or craking?
Fading or darkening?

What tools are needed?
How to interact?





Whether they know they can pick up the glasses first

What kind of information should be on the book for visitor to read

Figure 11.1 questionning about final idea

Goal

Looking into the scenario of the final idea, there are couple of questions can be discovered as shown in the figure 11.1, those questions can be concluded as below:

- The appearance of the new Smart Frame
- What kind of deterioration happened to the painting
- The tools needed to bring visitor into the scene of art restoration
- The fulfillment of interaction qualities (what interaction is needed)
- The indication of using order (glasses first)
- Whether it can fulfill design goal as envisioned

Types of deterioration

Moisture, heat, light, pollutants, and pests can slowly or suddenly cause damage to a painting [1]. These agents of deterioration impact all of the components that make up a painting in various ways which can be seen in figure 11.2A to figure 11.2D.

The deterioration of fading and darkening always happen to the whole painting, and reagents cottons and tweezers are needed for conservation and restoration. In comparison, cracking and flaking happen only on specific parts of painting, paints and palette are needed. The restoration of the damage to artifacts caused by careless handling is always a complicated process with the needing of various tools beyond merely paint and palette. Thus, flaking and fading effect are potential to apply in the concept, as both of them involve simpler process comparing to scratching

Impression of art restoration

Goal

This test was aiming to refine the setting and interaction in the concept according to the image of art restoration in people's impression, so there were two tasks to explore setting and interaction respectively. In task one, the tools that may need in the art restoration were recorded on images for participant to setup their own working environment by making collage. In task two, a flaking 3D replica was used in the test for them to envision the interaction qualities via role playing. In the end, participants were also asked about their preferred location to experience art restoration. To summarize, the goal of this test is:

- To define the setting of the new Smart Frame
- To see what kind of interactions and tools are preferred to fulfill interaction qualities
- To find preferred location of experiencing art restoration

Hypothesis

People may have their personal preference in vintage style and modern style of setting because restoring is different from painting but highly related, it is more precise, less artistic. As a result, the selection of pictures should have traditional tools but also modern ones as shown in appendix XIV.

Process:

The script of for the test can be found in appendix XV, the process consisted of six steps:

- Introduction: A brief was given to participant telling them that the test is all about their impression, there is no right and wrong.
- Personal information (questionnaire): They were assigned to a questionnaire about their art knowledge and art interest
- Task1 - Set-up personal working place: They were asked to choose pictures from the pile and built up their own working place and working process according to their understanding of art restoration, they were free to give their own interpretation and imagined function to their selection.
- Explain the reason behind (Interview): They were asked to explain why they chose those tools comparing the ones belonged to the same category.
- Task2 - Embody working style (role-play): They received a role that they had to act by taking advantage of their working setting, they were allowed to combine some tools, leave out some tools or change their working process, they were also offered a flaked replica as working target.
- Linking back to 3D printed replica (Questionnaire): They were asked about the location they preferred to experience art restoration if their returned to visitor.

Figure 11.2A Flaking on oil painting

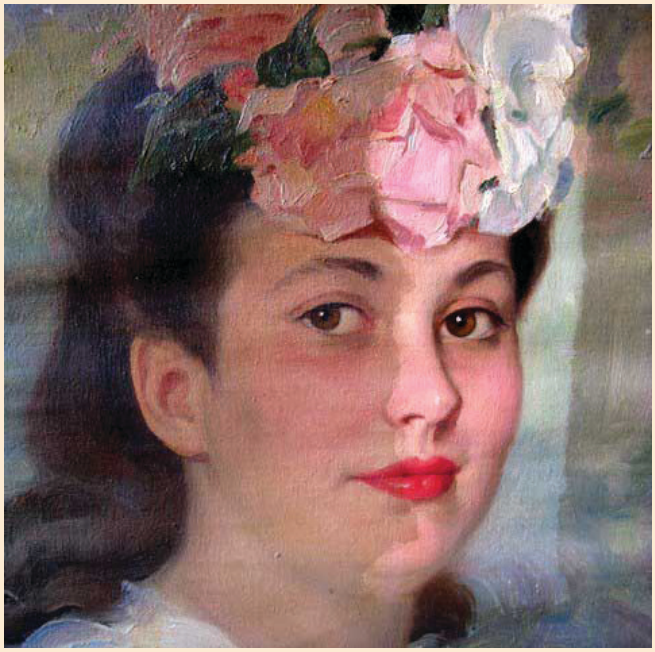


Figure 11.2C Darkening on oil painting

Figure 11.2B Cracking on oil painting

Figure 11.2D Torn on oil painting

Result

The selection of the tools is shown in the Figure 11.3, which were categorized by function and marked with the frequency of choosing on the top right corner. And it is clear that participants chose more than one tools in each category.

For Reference:

According to the answer from participants, the reference should include painter's information in terms of style and background. Participant preferred to have neat and guidance even with finial result. In order to find reference conveniently, seven out of nine also preferred documents with images, which were used as work log as well..

For Placement:

Four out of nine participants designed their working space into two area, one for inspection or general restoration as main area, and the other one for detailed operation as secondary area.

The working platform needed for the main area was always flexible and stable, while the high tech tables (on the bottom right) were understood for detailed inspection and drying placed in secondary area. The main platform should have both technology feeling (precisely control, reliable, multiple function) and traditional feeling (allowing to have empathy for the painter). That was why the other three were selected in which easels were favorited.

For Observation:

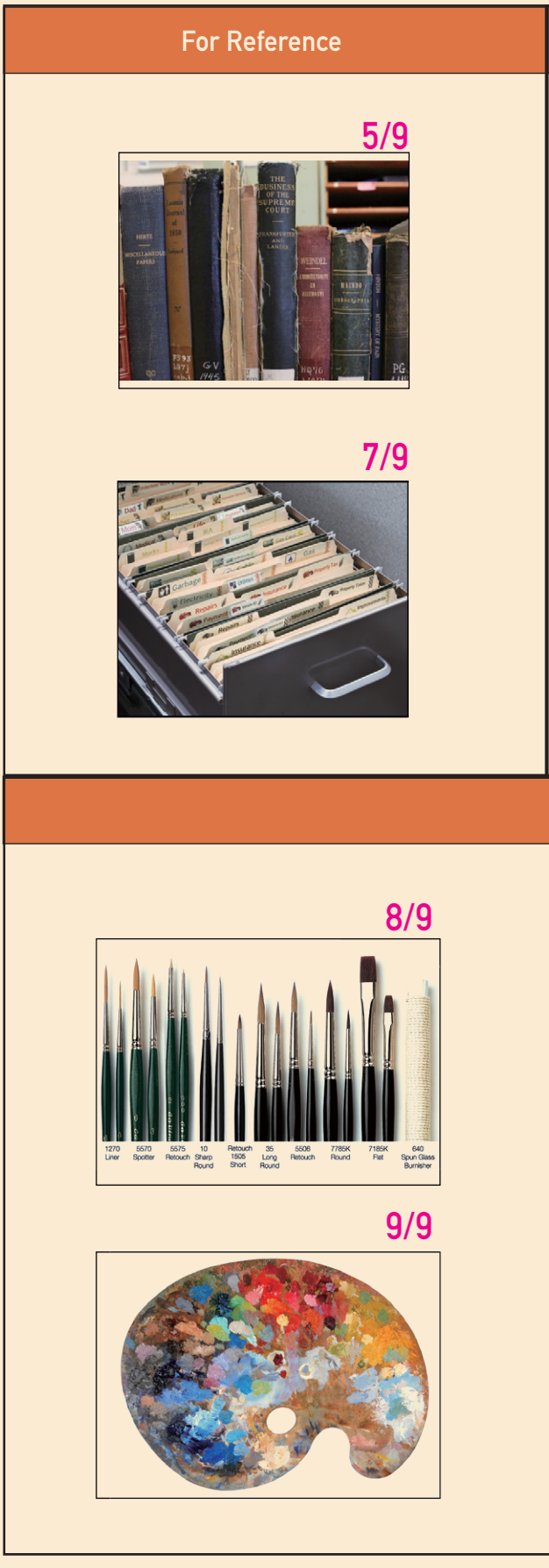
More than half of the participants liked portable magnifying glasses with light assistance for vertical working platform, while the microscopes were used for detailed inspection on horizontal working platform, especially the high-tech table.

For Painting:

A set of brushes and palette seemed as necessities for restoration, since they were needed for everyone. No more than three participants also chose a separate brush used for finishing.

Other Tools:

In most participant's perception, reagents and tweezers were always needed mainly for cleaning and glossy finish. Only four participants chose to wear gloves for carefully handling the painting, while others thought only by bare hand could they truly understand the thickness and pigments. Two participants gave function of detection to the machine on the bottom right corner.



For Placement

4/9

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For Observation

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For Painting

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Other Tools

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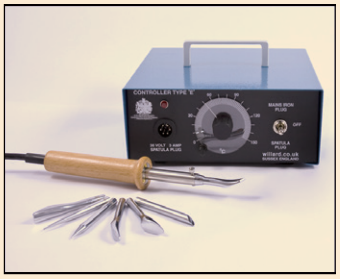


Figure 11.3 Summary of the selection of tools and reasons

Figure 11.4 A Participant was using light for inspection

Figure 11.4 B Participant was doing closed inspection

Figure 11.4 C Participant was assuming a reference beside

Figure 11.4 D Participant was trying out reagents

Figure 11.4 E Participant was setting similar canvas for color test

Figure 11.4 F Participant was changing tools

Interaction

From the role-playing, participants envisioned interactions in the context of art restoration as summarized below:

Explorative

Participants envisioned explorative interaction mainly in two aspects. One was to pay detailed examination by using magnifier and light assistance (as shown in figure 11.4 A and 11.4 B). And the other was to study the painting and the painter by checking reference beforehand or looking up related information during restoring for clear guidance (as shown in figure 11.4 C).

Automous

Participants envisioned autonomous interaction as only doing necessary or even no observation and background study, and using frequently-used tools, especially brush during the process of restoration.

Dynamic

Participants envisioned explorative interaction as trying out different combination of color and reagent on different material like wood or fabric before actually working on the painting or directly work on the painting (as shown in figure 11.4D and 11.4E); For the use of tools, they would like to keep changing the use of different type of tools or use one of the tool creatively (as shown in figure 11.4F); One participant mentioned that he liked to keep turning the pages for acquiring knowledge about the painting,

Desired location of experience art restoration

All participant suggest that they would like to experience art restoration in art museum. For the consideration of having a final effect to refer to or as a guidance, six out of nine people chose to experience it beside the real one. Two participants also wanted to experience it in a specially prepared room since it gave them the right atmosphere apart from visiting experience. One participant chose workshop as it fits most for the goal of in depth learning, but he admitted that his second choice was beside the real one, if clear guidance (such as spotlight) could be given.

Conclusion

Selected tools

The selected tools were based on the ones that were frequently selected for setting and also the ones that have the affordance to fulfill interaction qualities. The amount of the tools should be as less as possible not only for simplify the process but also to comply with autonomous interaction as envisioned by participants. The selection and reason behind were listed below:

- One brush with palette or reagents for dynamic and autonomous tryout
- A pair of portable magnifying glasses with light assistance for close examination
- Visual or verbal reference for guidance
- An easel which has both technical and traditional feeling as main working platform

Features that contribute to interaction qualities

The way how participants envisioned dynamic interaction reveals their pursuit of precise restoration by comparing the effect of what they have and what they need to achieve. While autonomous interaction was envisioned as efficient operation and rigorousness, which asked for the providing of guidance for being precise. The use of different brush, closed inspection and checking reference before or during the process envisioned in explorative interaction also demonstrated both the pursuit of being precise and the need of guidance. To summarize, there are three elements the setting should encompass in order to fulfill desired interaction qualities. Those elements are being precise, allowing comparison and providing guidance.

The way how participants envisioned dynamic interaction reveals their pursuit of precise restoration by comparing the effect of what they have and what they need to achieve. While autonomous interaction was envisioned as efficient operation and rigorousness, which asked for the providing of guidance for being precise. The use of different brush, closed inspection and checking reference before or during the process envisioned in explorative interaction also demonstrated both the pursuit of being precise and the need of guidance. **To summarize, there are three elements the setting should encompass in order to fulfill desired interaction qualities. Those elements are being precise, allowing comparison and providing guidance.**

Material test

Goal

As a preparation for test 2, this test was to find an appropriate material that can simulate the effect of flaking but also react to user's behavior. The paint should be translucent and quickly turn to be transparent after user's interaction, and turn back after more than 190 second (the time period of audio tour). Therefore, two types of smart material - hydrochromic and thermochromic paint - were selected to compare.

Method

Those two types of paint were applied on flat poker cards in different thickness, in order to check the coverage of pattern but also to compare the reaction time. The thickness of one layer equal one layer of tape. The samples can be seen in figure 11.5 A.

H1 to H4 were poker cards that applied with hydrochromic paint. H1 and H2 were applied with one layer for comparing the coverage of black and red since they are original white. H3 were applied with two layers while H4 with three layers, after three layers the pattern of poker was fully covered.

T1 to T4 were poker cards that applied with thermochromic paint (27ºC). The paint was the mixture of thermochromic powder and glue, which is a transparent medium and can be easily peeled off. T1 were applied with one layer, and T2 with two layers. The paint consisted of the same weight of glue and thermochromic powder as recommended. While the paint for T3 only consisted half portion of the powder to increase transparency.

Result

It was clear from figure 11.10A, H1, H2, H3 and T3 have the better translucent effect than others.

After using moist brush painted on H1 to H3 (as shown in figure 11.10B), H1 and H2 could immediately react to moisture and turned back within 200 seconds. While H3 took 5 seconds longer to react and turned back after 450 second. All of them could turn to completely transparent. T3 required 15 seconds to react to temperature of human finger (as shown in figure 11.10C) and 60 seconds to turn back. And it could not be as transparent as hydrochromic paint.

Conclusion

To conclude, one layer of hydrochromic paint fulfilled all the requirement and would be used for test 2.

Figure 11.5 A samples for material test

Figure 11.5 B Applying water on hydrochromic paint

Figure 11.5C pressing finger on thermochromic paint

Interaction, Storytelling and Setting

Goal:

Bringing in the result of test1 and material test, the initial prototype of the redesign could take form as shown in figure 11.6 A. It included a partial replica of Sunflowers, some part of which was covered with hydrochromic paint, putting on an easel. In front of the easel, there was a pair of magnifying glasses, a cup of water as reagent, a brush and a piece of paper with background story on it. Moreover, the whole painting of Sunflowers was also set beside as reference (as shown in figure 11.6 B). Besides, the story about technique was going to told to user via audio while he or she was painting on the stained part, as such scenario was envisioned by participants from test1. The test utilized the previous design as comparison for people to give their opinion on the interaction, storytelling and setting of both the new and the former design (from here we call it the Smart Easel). The goals for this test were:

Interaction

- To test whether the intended order can be understood by user (glasses first)
- To test people's view of point towards different way of interaction with replica (paint versus touch) by comparing the Smart Frame and Smart Easel

Storytelling

- To test people's view of point towards different way of storytelling, by comparing the Smart Frame and Smart Easel (once-for-whole versus split-up; introduction-before-interaction versus. introduction-during interaction; audio versus reading text and images)

Setting

- To learn people's impression of the setting (frame versus easel; button versus multiple tools)
- To see if having the whole painting beside can help or not
- To test if the setting including a 'flaking' painting can remind people art restoration
- Crowd
- To see whether people feel stressful or embarrassed as worried in test 1.

Setup

Participants:

There were eight participants participate in the test. They were equally divided into two groups and in each group there was one visitor and three observers.

Process:

As shown in figure 11.7, firstly, the visitor was asked to interact with the Smart Frame, then the Smart Easel. After each, there was a interview with the visitor (questions can be seen in appendix XVI). In each process, no instruction was given and the visitor has to experience the device when three observers were around. Before and after each process, observers needed to fill in a questionnaire (see in appendix XVII).

Result

Transcript of answer from the visitor of each group can be found in Appendix XVIII

Opinions from observers and visitors towards the four aspects were collected and shown in figure 11.8.

Visitor from each group were intuitively use the magnifying glasses first.Some behavior of participants can be seen from Figure 11.9A to Figure 11.9C

Figure 11.6 A The setup of the Smart easel

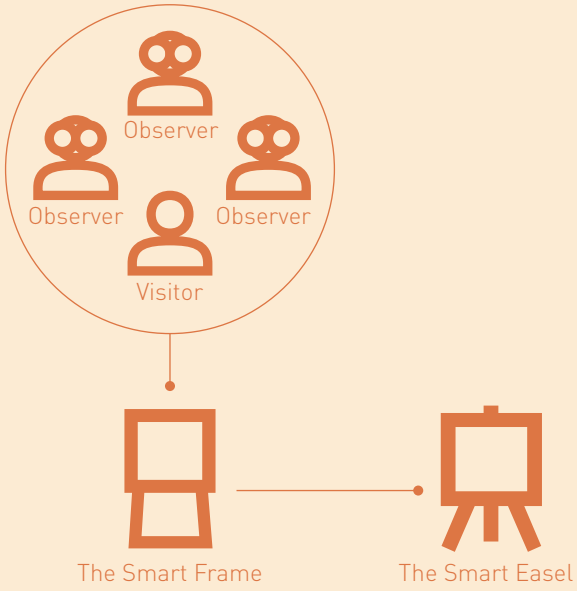


Figure 11.7 Porcess of the test

Figure 11.6 B The setup of the Smart easel

	Smart Frame	Smart Easel	Opinions from visitors	Opinions from observers
Interaction	Touch	Paint	Touching texture helped to understand stroke direction and it triggered imagination; Brushing was better for people who were interested in art or wanted to learn art, it was a suitable way to learn techniques	Both can draw curiosity
Way of story telling	Audio playing before touching	Audio playing while touching	The visual index was liked, which provided a feeling of research or exploration; They couldn't concentrate if audio and interaction were simultaneously going on.	The audio stopped playing if the visitor stopped interacting, and such pause made them lose interest
	Once for whole story telling about everything	Interacting for the story of technique via audio, reading for the background story	The story from the Smart Frame triggered curiousity to know more beyond technique; It required patience to read, while the segmented story from audio was liked for its length and content	Telling the story in one go made it hard to follow; Reading took time, but painting as way to activate story triggered their curiosity
	light and audio as guidance	self-explore	Light and audio guidance was intuitive; Interacting to activate story was interesting	Guidance (light and audio) helped paying attention to certain part; It was unclear where to look at and what to see if without guidance
Setting	Buttons	Glasses and brush	The 'touch' button was confusing; The intention of using brush was not clear	Light on button and touch could draw attention; Glasses and brush could draw curiosity but intention was unclear.
	Without reference of the real painting	With reference of the real painting	Reference provided link to the replica and a better overview	
	Frame	Easel		Easel gave clear indication that people could interact with it
Crowd	Surrounded by people		No stress for both because both devices kept their attention.	The visitor couldn't be distracted even if they were very close.

Figure 11.8 Opinions from participant about the Smart Frame and the Smart Easel

Figure 11.9A Participant was picking up the glasses first

Figure 11.9B Participant was reading the story on the paper

Figure 11.9C Participant was painting on the white part of replica

Conclusion

Interaction

The interaction of brushing had more potential to make users better understand technique compared to touching.

Storytelling

In the Smart Easel, the completeness of the story depended on how complete the visitor painted the related part, namely, the more they painted, the more story they got. Such way of storytelling could be easily understood by the visitors, although only one part of story was included in the prototype. However, the visitors felt hard to pay attention to the audio playing along, while interacting with the device

Comparing to audio playing, reading required more attention and effort, which would distract the visitors from the painting. For the consideration of making the whole interaction more effortless, a book with extra visual information convey was not necessarily needed as long as such information was provided via audio. Besides, the painter's life event and technique should be connected to help user have a holistic understanding, and such story should better be told before or after they painted on the painting.

Setting

The align of multiple tools was able to trigger people's curiosity, and the magnifying glasses was the visitors' first choice to interact, but proper guidance was still needed in order to tell them the meaning of wearing glasses and brushing, which could also help immerse user into the setting of art restoration.

Comparing to frame, placing 3D replica on easel made it more friendly to interact with. Having the placement of complete painting beside, the visitors could skip the questioning of whether they can interact with the device or not. It also communicates clearly where they should focus on and interact with by showing the flaking area on the painting.

Crowd

Both devices helped people to concentrate so that they didn't influenced by the crowd around. One of the visitor also mentioned the Smart Easel made her more relaxed than the Smart Frame, but because of the order of testing and low fidelity of prototype, this required a further testing.

Projection test

Goal

If the story will be separated into multiple parts, the length of each will be shrunk and various. Then hydrochromic paint will be not suitable for such situation, since it is hard to customize the drying time for each part and using water is not allowed in art museums. For the better control of orientation and reaction time, projection was used to simulate flaking or fading effect. Therefore in this test, several ways of projection were experimented to find the best effect.

Method and result

Different ways of projecting flaking were executed in the test which can be seen from figure 11.10 A to figure 11.10 F.

Conclusion

The projection of yellow spot was decided to bring into final concept since it achieved best visual effect. Comparing to project bright background to the original painting, projecting only a color spot was more visible. Among all the visual effect of color spot projection, the yellow light spot resulted in the simulation of fading effect. In comparison, the colorful light spot made the rest of the painting fading visually, and white light spot brightened certain part of the painting instead of creating flaking effect, so both of them deviated from the intended effect. Thus, the final concept was going to apply yellow light spot projection for further interaction.

Figure 11.10A Original replica

Figure 11.10D Project a white spot

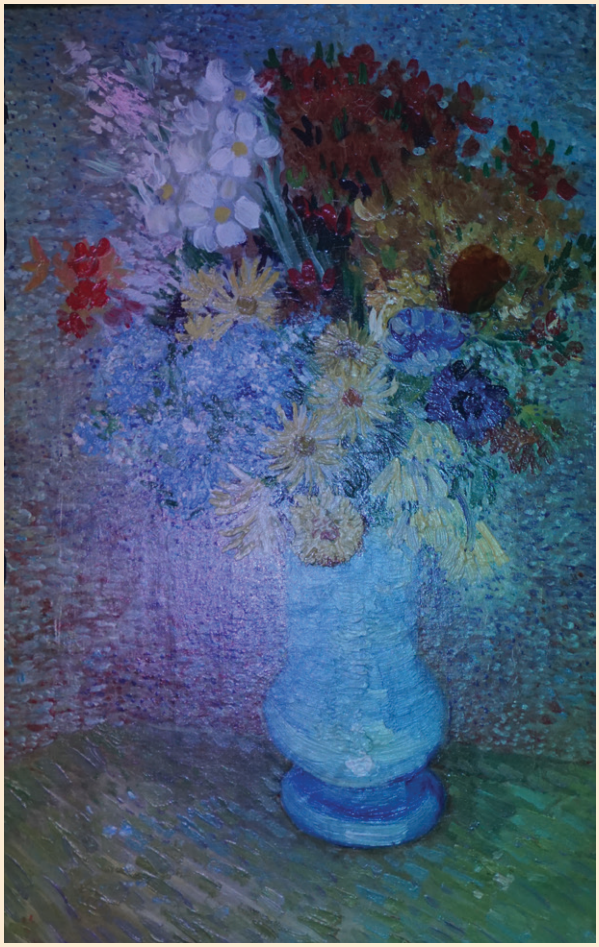


Figure 11.10B Projecting a black spot with white background

Figure 11.10C Projecting a colorful spot with white background

Figure 11.10E Projecting a yellow spot

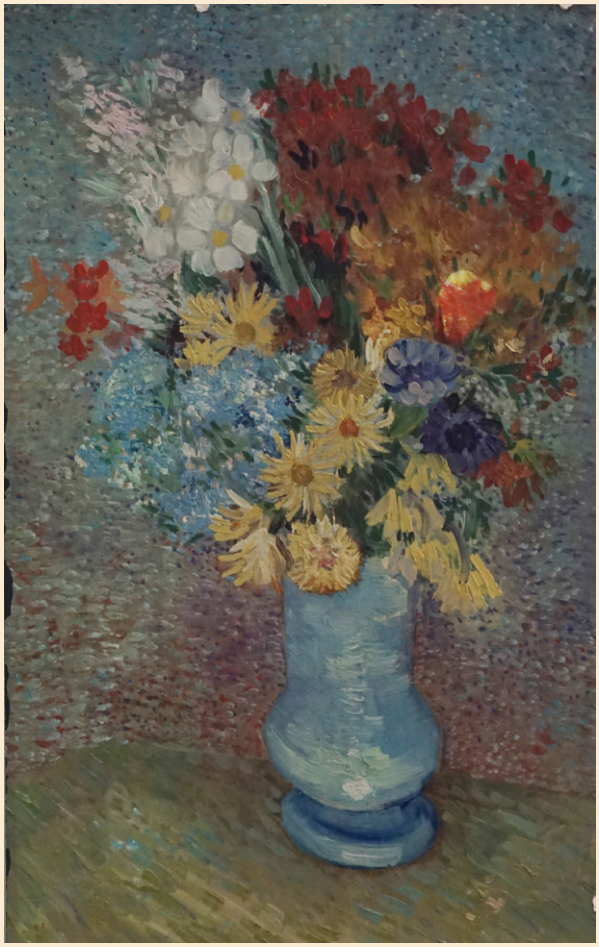
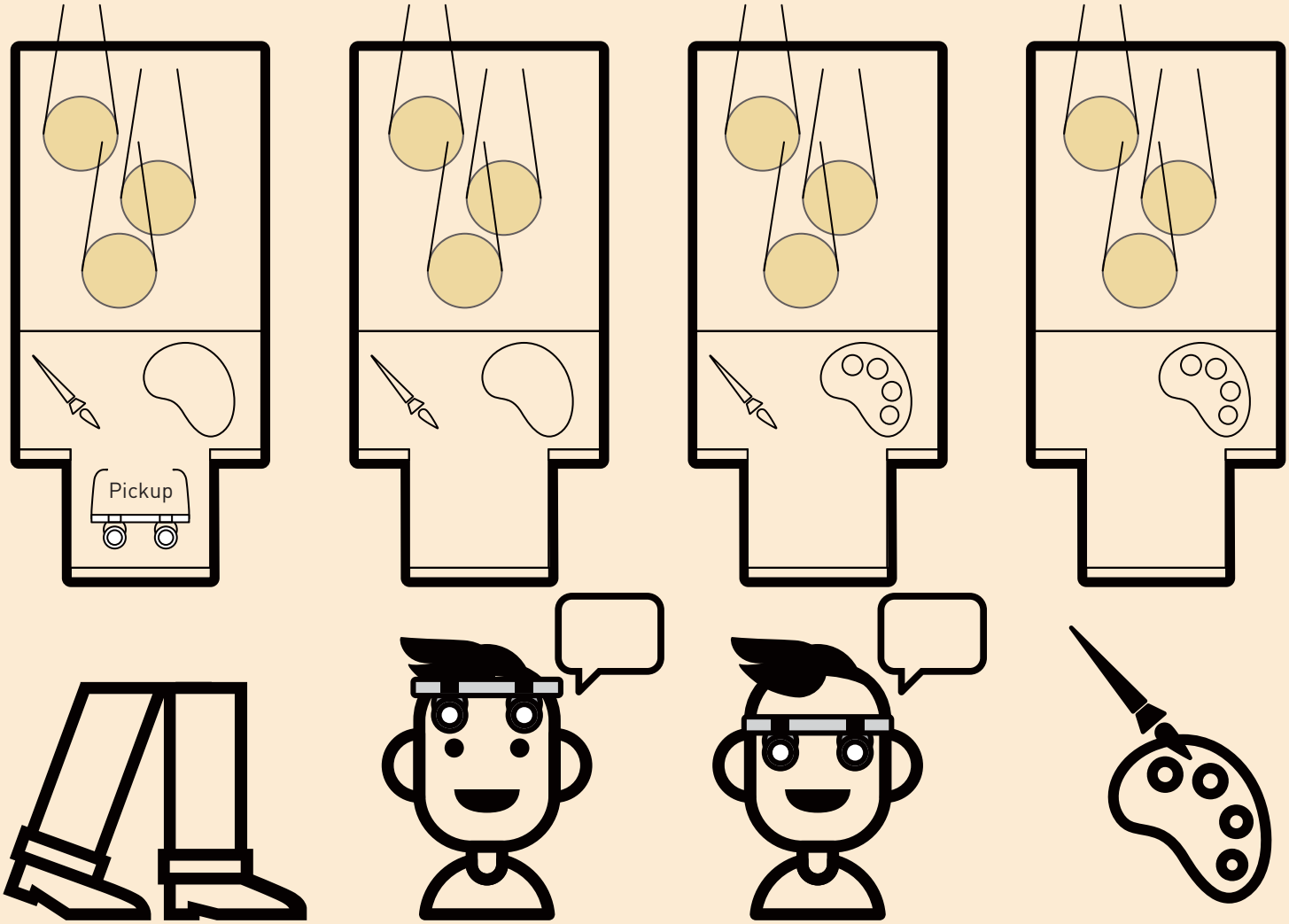


Figure 11.10F Projecting a spot of original color



1. A visitor is attracted by the setting and the flaking effec, then he sees the indication saying that he needs to pick up the glasses (earphone) first.

2. The visitor gets a request from the painter through earphone, asking him to do a favor to restore the painting (replica).

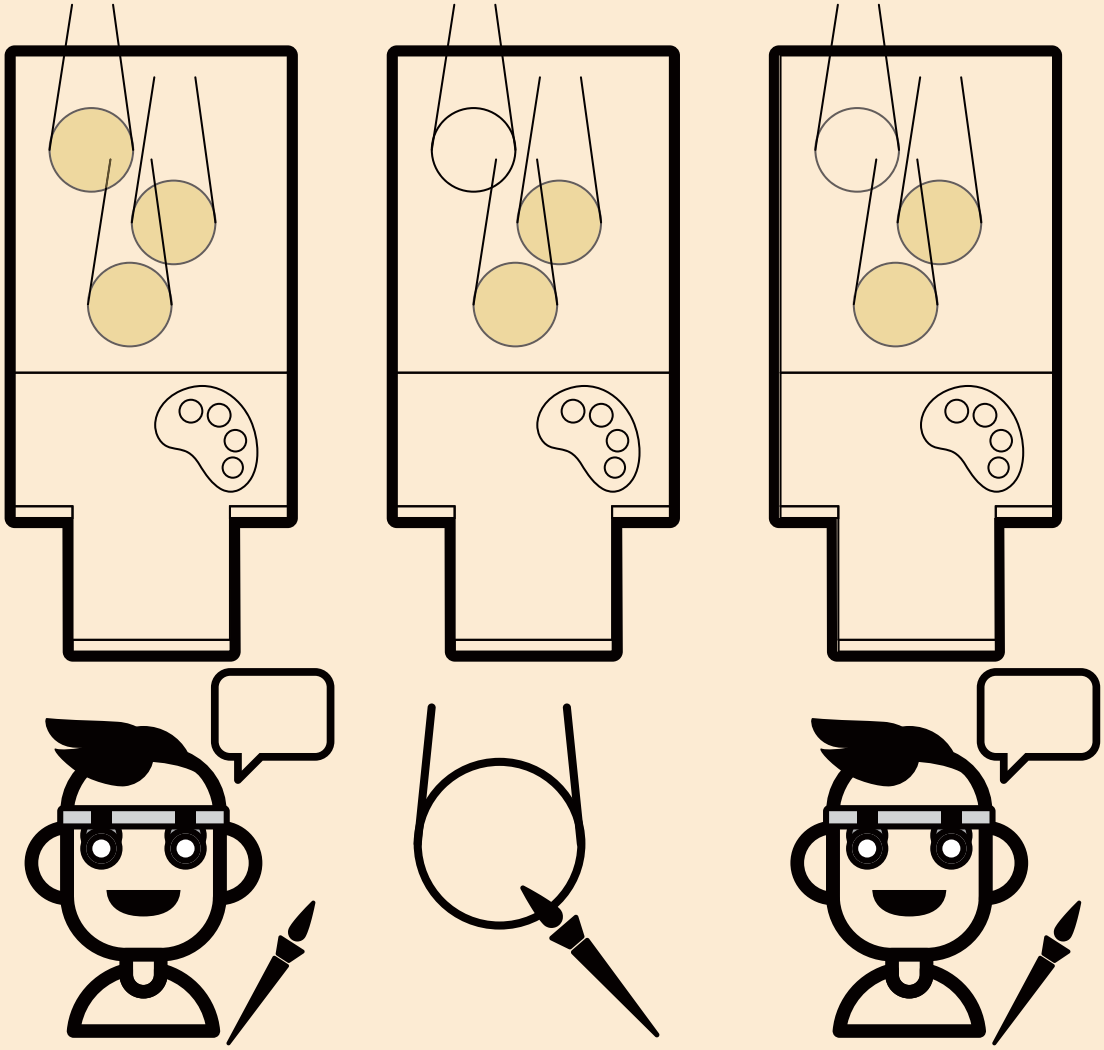
3. The visitor gets a brief introduction what he needs to do by the painter, at the same time the colors on the palette light up.

4. The visitor picks up a color by using the brush after making connection between the provided colors and the light spots on the replica.

From test conclusions to concept

The scenario of the final concept is shown in figure 11.23 while the detailed description can be seen in figure 11.24 on the next page, it was formulated based on the insights from tests. The insights included the features that fulfilled interaction qualities found in test 1, insights about interaction, storytelling and setting from test 2 and projection test.

As concluded from test2, the setting of easel, glasses and brush were kept in the concept; As for storytelling, in order to give user a clear idea of the setting in an engaging way, first person perspective storytelling was included into the concept, what's more, all the guidance would be given via



5. The visitor hears the story of the painter's life event that relates to his selection, visitor has to guess which part the color belongs to

6. The visitor can brush on the painting trying to imitate the painter's technique

7. After the visitor brushes on the right spot, the rest of the story about technique is told to him, and the visitor will recieve praise to let him continue the experience.

Figure 11.23 Scenario of final concept

audio and separate from interaction.

Taking account of the conclusion from test 1, three features were identified to fulfill interaction qualities, which were being precise, allowing comparison and providing guidance. The first two features was envisioned in the concept as showing user multiple colors on palette and yellow spots on the replica. The yellow spots simulated the deterioration of fading as shown in the projection test. With such setting user could make association, comparison and selection. In the whole experience, the interaction for user was picking color, paint and listen to the story he or she triggered, which was simple, intuitive and also embodied the interaction qualities.

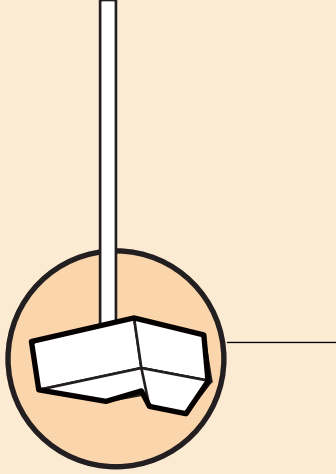
The concept

The concept has physical form and audio guide, the script of audio guide can be seen in appendix IXX while the physical form consists of two main parts which are a ultra-short throw projector and a platform. Tools related to art restoration are displayed on the platform, including a brush, a palette and a pair of magnifying glasses integrated with earphones.

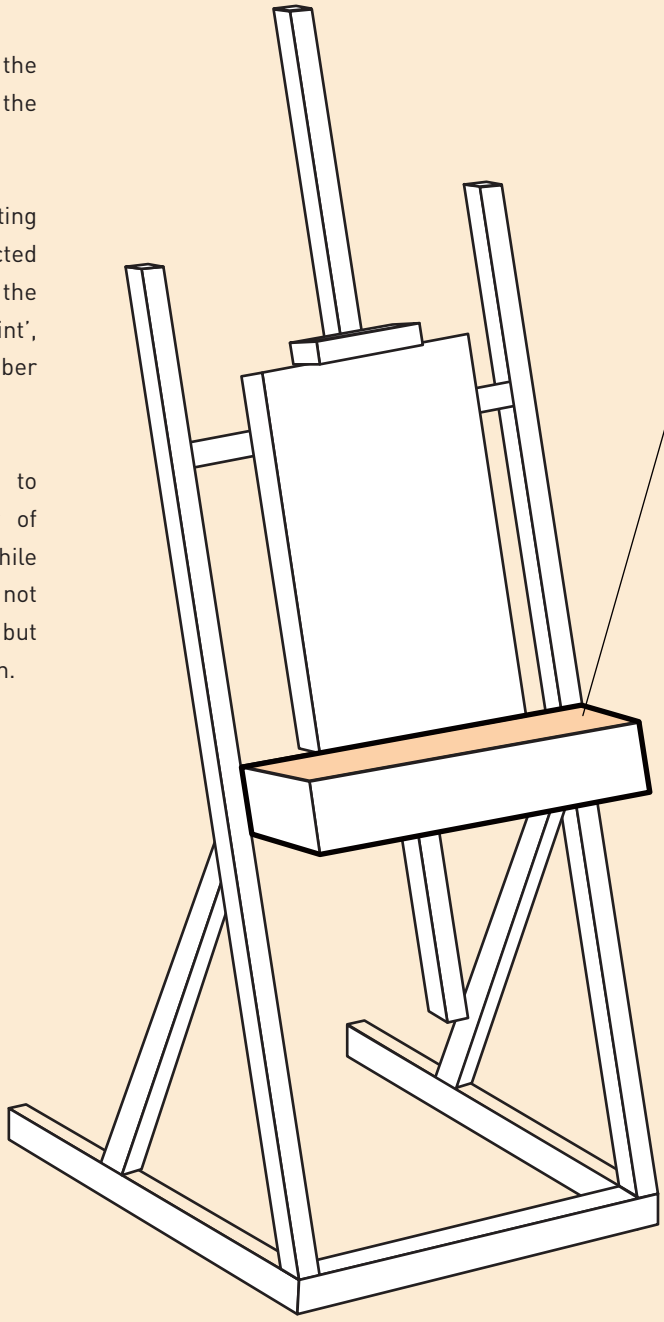
A ultra-short throw projector is employed to avoid the situation when user block the projection, it also save the room for the whole installation.

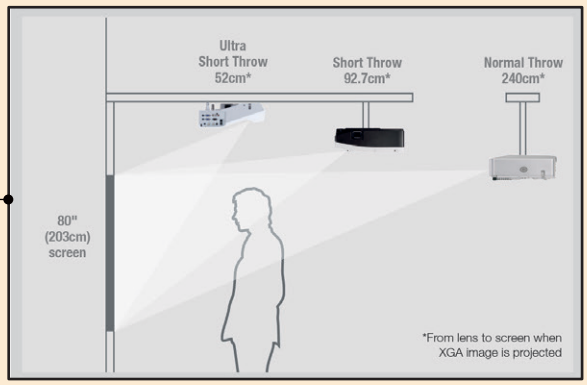
The variable LEDs on the palette light up as 'paint' indicating the original colors of the yellow 'fading' parts, projected by the projector. The LED inside the brush will turn to the corresponding color when user dip onto the certain 'paint', the color becomes visible with the help of optical fiber attached directly to the LED.

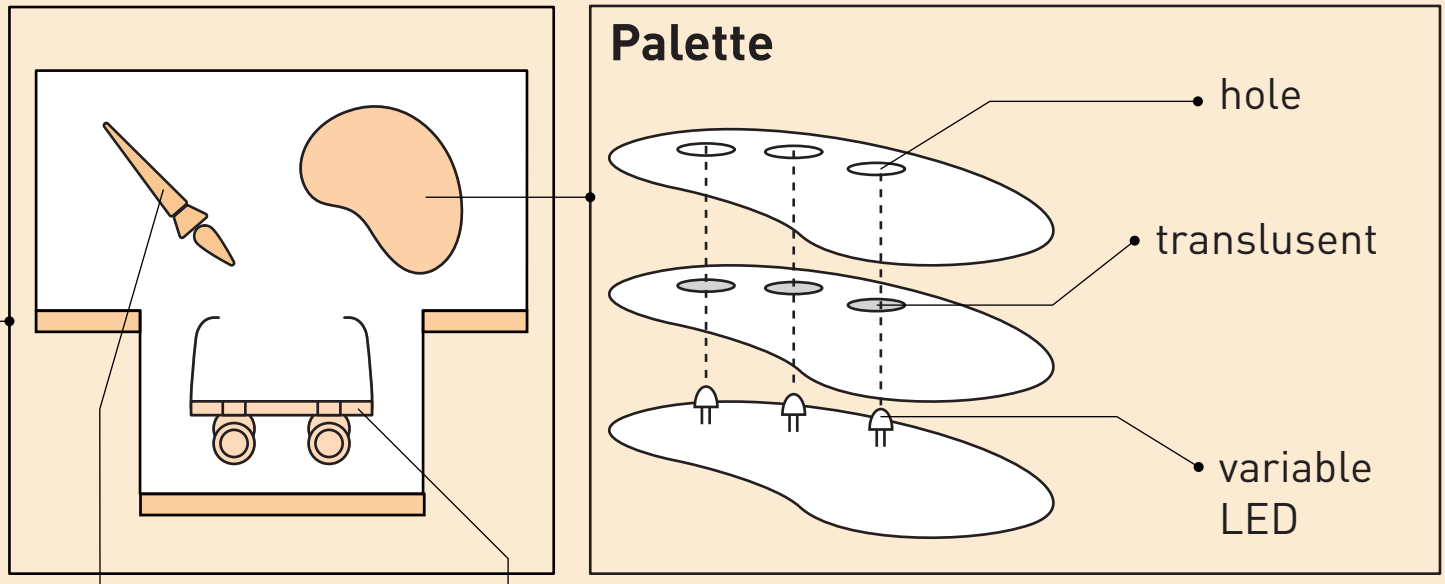
A pair of bone conduction earphones is integrated to the magnifying glasses, creating an immersive way of storytelling. User put on the earphone unexpectedly while wearing the glasses. The magnifying glasses itself can not only help user transform into the role of art restorer, but also allow to pay close observation when audio is going on.



Ultra-short throw projector




Ultra
Short Throw
52cm*
Short Throw
92.7cm*
Normal Throw
240cm*
80"
(203cm)
screen
*From lens to screen when
XGA image is projected


Palette
hole
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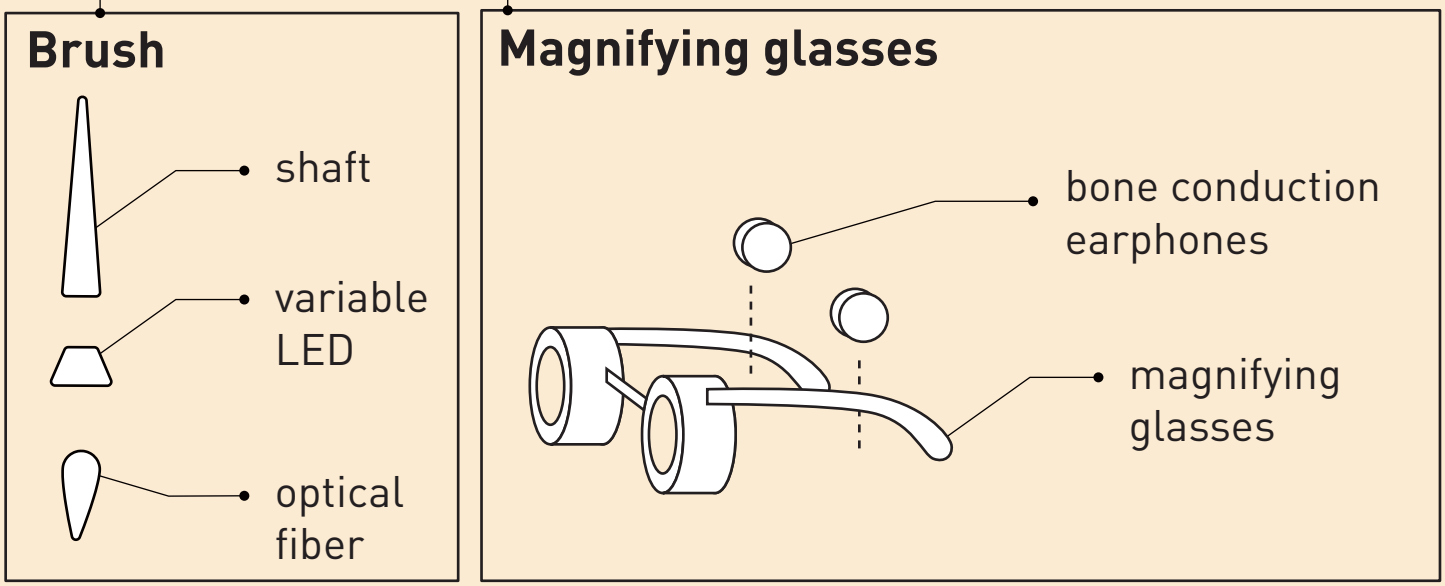
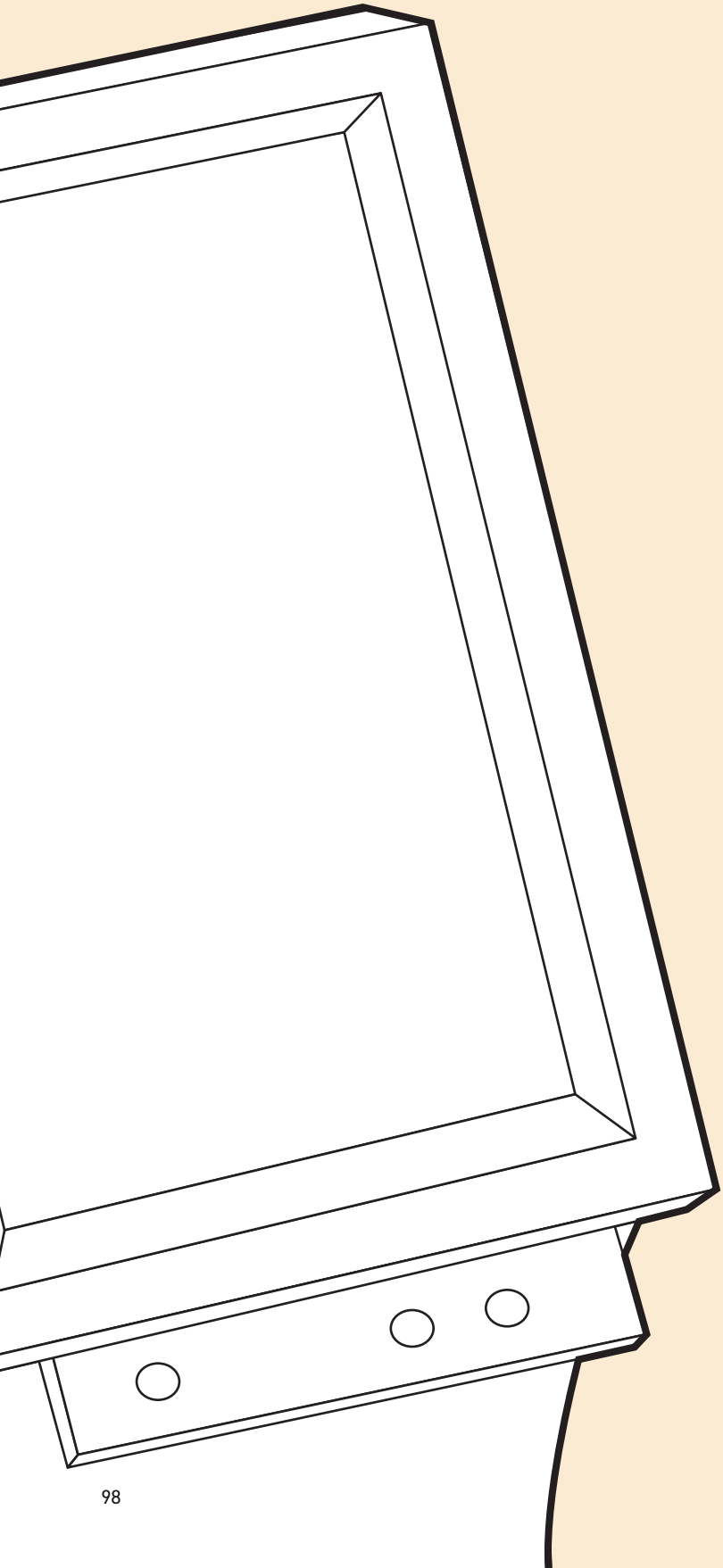
variable
LED


Brush
shaft
variable
LED
optical
fiber
Magnifying glasses
bone conduction
earphones
magnifying
glasses

Comparison to the former design



Smart Frame1.1

Everyone

Art museum

Intended effect

Provide information about technique and painting content

Similar to lecture desk

Need dark tent

Touch 3D replica to feel brush strokes;

Press button to activate audio tour

Once for whole story

Passive listening

From third person perspective

Smart Frame 2.0

Art amature and hobbists

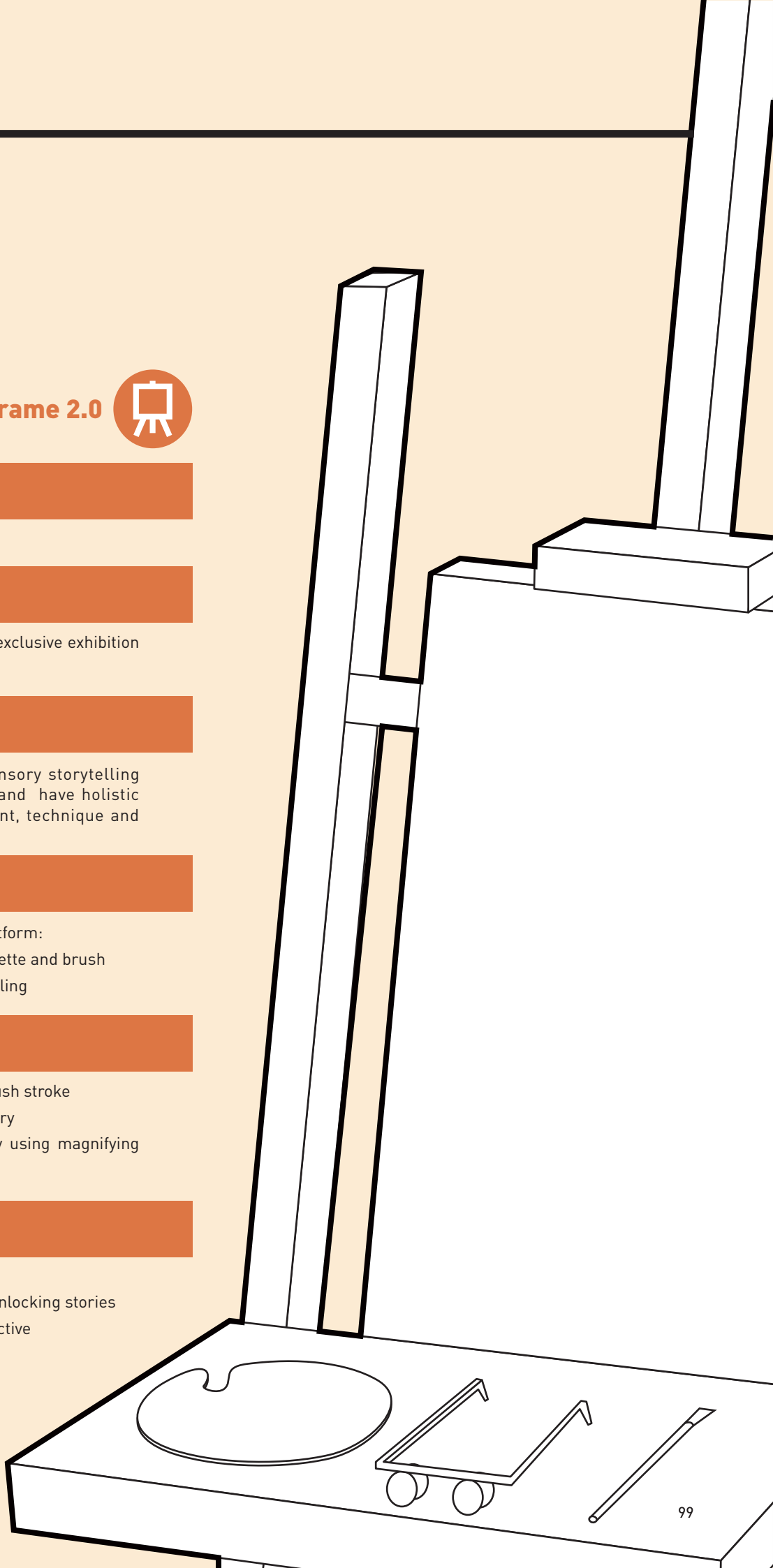
Beside the real painting or in the exclusive exhibition area in art museum

Engage target group in multisensory storytelling so that they can feel delightful and have holistic understanding of painting content, technique and painter

Similar to art restorer working platform:
Easel with magnifying glasses, palette and brush
Need projector mounted on the ceiling

Brush on the painting to mimic brush stroke
Pick color to choose part of the story
Allow to pay close observation by using magnifying glasses;

Part by part
Actively involved in selecting and unlocking stories
From painter's first person perspective



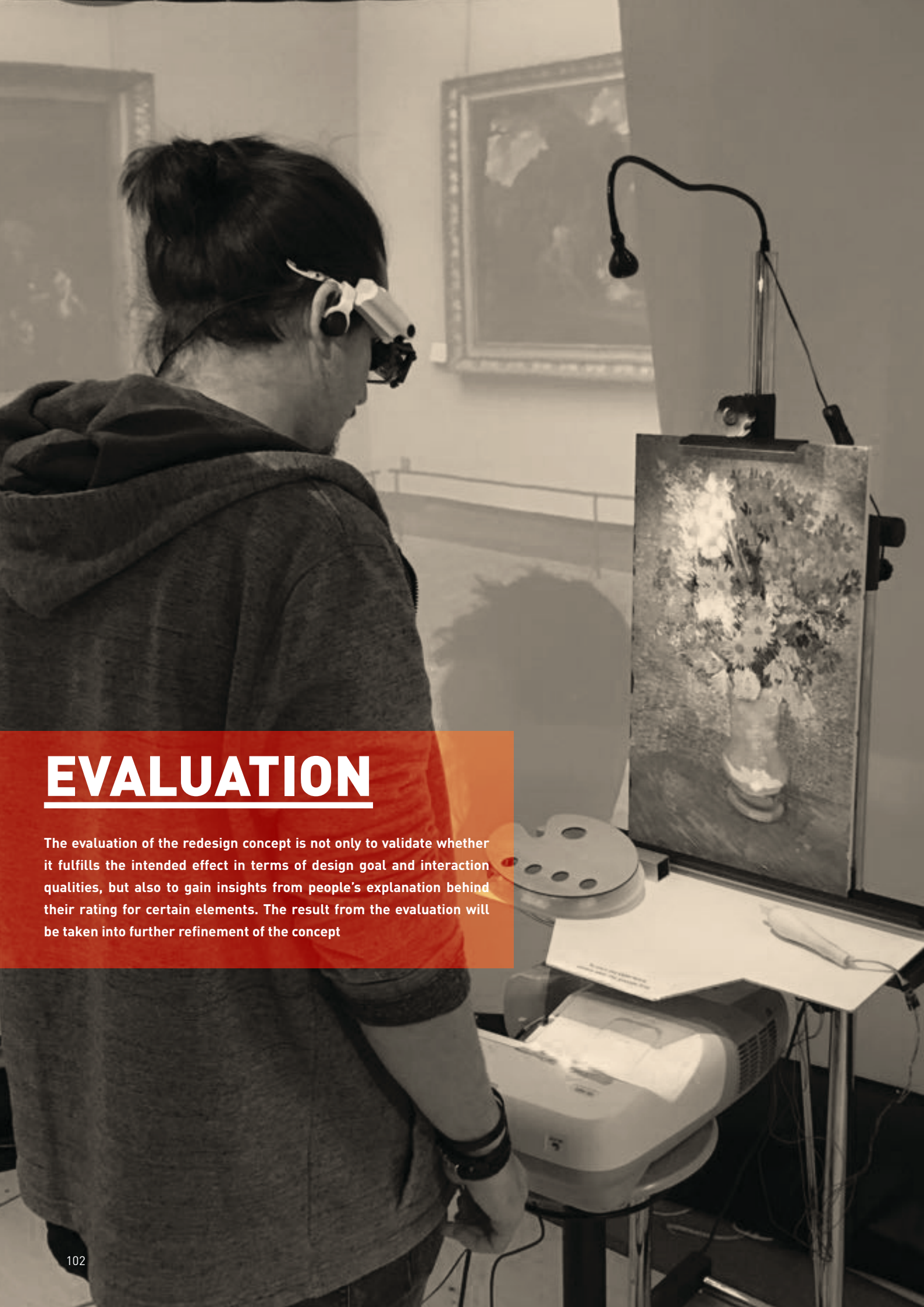
Conclusion

In order to identify the differences between the former design and the new one, six terms were used for comparison. The first three are from value proposition [1], which is the key for goal setting and measurement in user experience design. The other three are based on the criteria for interactive exhibition design [3].

In the light of the comparison result shown in last page, the contribution of the redesign could be embodied two aspects - it clarified the value proposition of the Smart Frame and improved it towards exhibition design focused on user experience.

[1] Fahey, M. (2016). The Care and Preservation of Oil Paintings. Retrieved April 8, 2017, from https://www.thehenryford.org/docs/default-source/default-document-library/the-henry-ford-oil-paintings-conservation.pdf?sfvrsn=2

[2]Liu, K. (2013). Designing visitor experience for open-ended creative engagement in art museums: A conceptual multi-touch prototype design.



EVALUATION

The evaluation of the redesign concept is not only to validate whether it fulfills the intended effect in terms of design goal and interaction qualities, but also to gain insights from people's explanation behind their rating for certain elements. The result from the evaluation will be taken into further refinement of the concept

Evaluation

Goal

The test was aiming to evaluation whether the concept achieve the proposed design goal and desired interaction. The redesign was only evaluated to examine whether it fulfilled the design brief, since the design goal and interaction qualities all came from the opportunities discovered from the former design, it would be justifiable to prove that the experience was improved if the design brief could be fulfilled. Furthermore, because the redesign established a proposition of the product, it was unfair to compare the redesign and the former one.

Regarding the desired effect of the design, research questions were specified as below:

- *Can user learn from the experience as they expect to learn before experience?*
- *Does user enjoy the experience?*
- *Does the redesign engage user with the setup and audio?*
- *Does the redesign help user transform to a role of art restorer?*
- *Does the redesign result in autonomous, explorative and dynamic interaction?*

Method

In order to evaluate the general experience but also specific interaction qualities, AttrakDiff 2 form was employed in the evaluation session. AttrakDiff 2 is a questionnaire that measures attractivity, hedonic stimulation and identity and pragmatic qualities of software or products [1], it has four dimensions, seven anchor scales, but some of the scales were left out since those are not associated with the quality of the redesign. Since the interaction qualities includes dynamic, autonomous and explorative which are highly related to hedonic stimulation (The attributes that encourage personal growth), hedonic identification (The attributes that all persons communicate their identity through things they use and own) and pragmatic manipulation (The attributes that indicate how successfully users are in achieving their goals using the product), the AttrakDiff 2 questionnaire was selected for evaluation along with interview.

Participants

People who have art knowledge of 3 or 4

Setup

As shown in figure 12,2 on the next page, Two ceiling mounted projectors projected on a curved screen to simulate the context of art museum. And another ultra-short throw projector was used to project light spots onto the replica. It was installed in front of the easel instead of on the ceiling due to the limitation of infrastructure. A camera was set beside the easel on the tripod to record participants' interaction with the device. The tools that were needed for participant to interact were shown in figure 12.3 on the next page.

Procedure

- Introduction (2min)

A brief of the project was be given to the participants at the beginning. After knowing the purpose and the process of the test, participants signed a consent form, in which their approval to use the photos and footages for the project was be asked. Then they will be taken into the simulated context of art museum.

- Pre-test interview (2min)

Participants' expectation of the 3D replica were asked from their first glance.

- Session (5min)

Participants were asked to experience the device by themselves. During the process two observers were walk around. On the one hand, observers did observation, on the other hand, such behavior was also part of the simulation to the real context.

- Evaluation interview with questionnaire (15min)

Participants were issued a AttrakDiff 2 questionnaire (as shown in figure 12.4) and they were asked to explain their rating when finished. Besides, they were asked if they feel stressful if other 'visitors' were around, if they were in the role of art restorer and if they learnt what they expected to learn in the beginning

Figure 12.2 Overall setting for evaluation

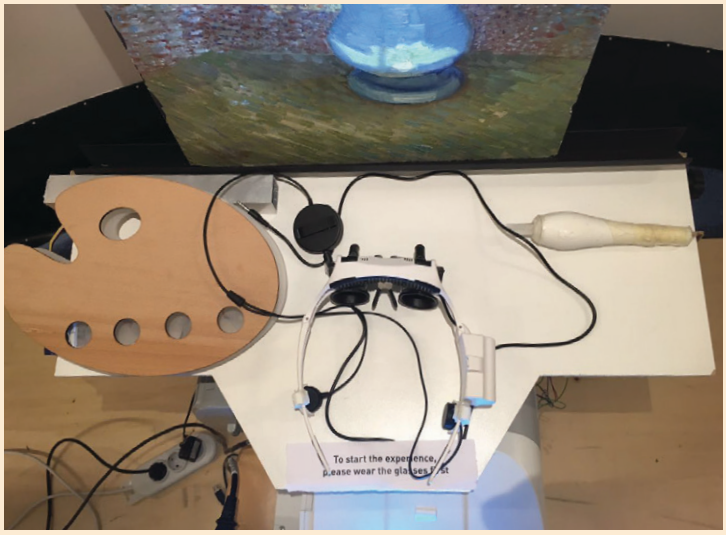


Figure 12.3 Working platform setting for evaluation

Attractivity - General aesthetic quality

Unpleasent	○	○	○	○	○	○	○	Pleasent
Repelling	○	○	○	○	○	○	○	Appealing
Discouraging	○	○	○	○	○	○	○	Motivating
Ugly	○	○	○	○	○	○	○	Attractive

Pragmatic quality - Clarity of interaction model, usability

Technical	○	○	○	○	○	○	○	Human
Complicated	○	○	○	○	○	○	○	Simple
Unpredictable	○	○	○	○	○	○	○	Predictable
Confusing	○	○	○	○	○	○	○	Clearly structured

Hedonic quality(stimulation) - Potential for reaching individual goal as perceived by the user

Dull	○	○	○	○	○	○	○	Captivating
Cautious	○	○	○	○	○	○	○	Bold
Undemanding	○	○	○	○	○	○	○	Challenging
Ordinary	○	○	○	○	○	○	○	Novel

Hedonic quality(Identity) - Resonation between self-perception of user and product

Isolating	○	○	○	○	○	○	○	Connective
Unprofessional	○	○	○	○	○	○	○	Professional
Cheap	○	○	○	○	○	○	○	Premium
Separates me	○	○	○	○	○	○	○	Brings me close

Figure 12.4 AttrakDiff questionnaire for evaluation

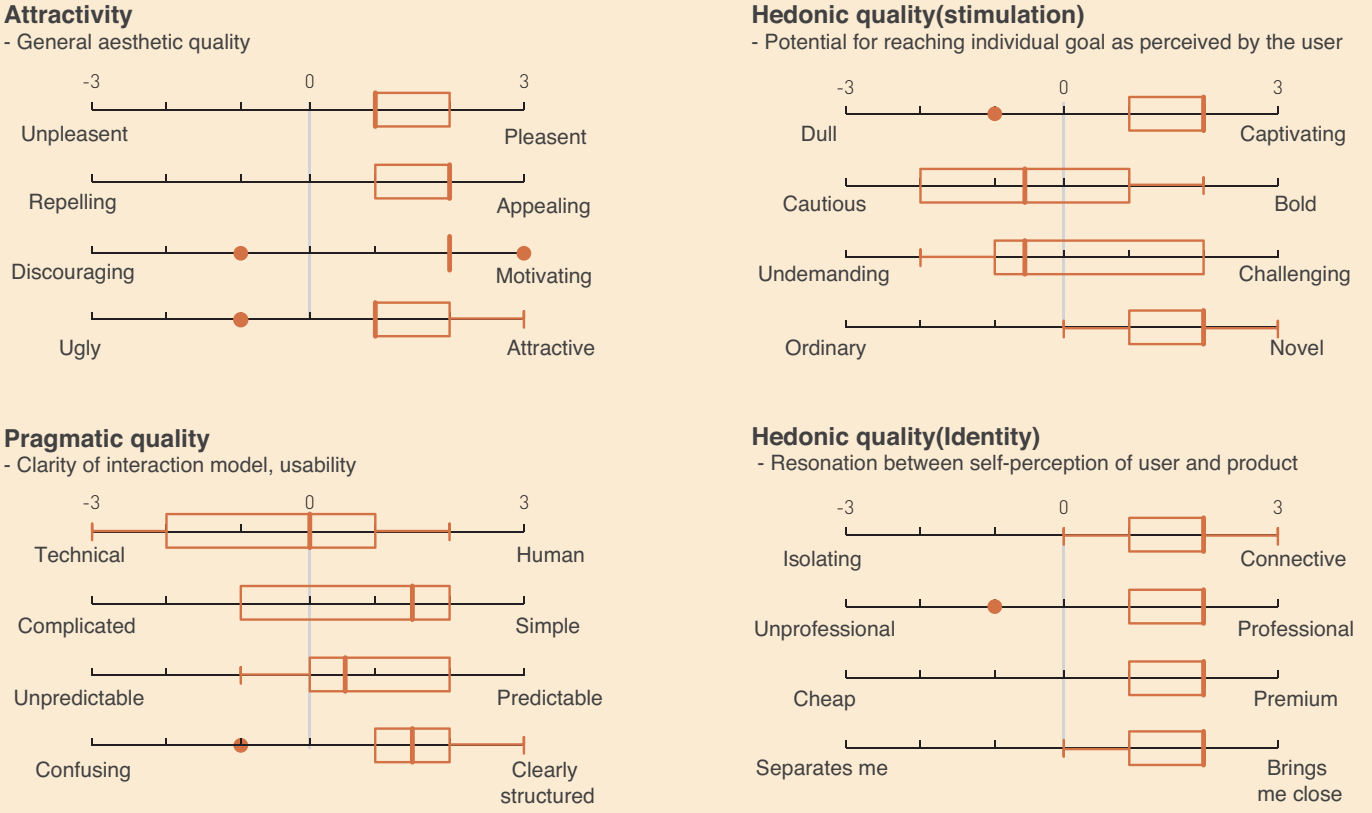


Figure 12.5 Box plot for every word pair of AttrakDiff dimensions for the redesign

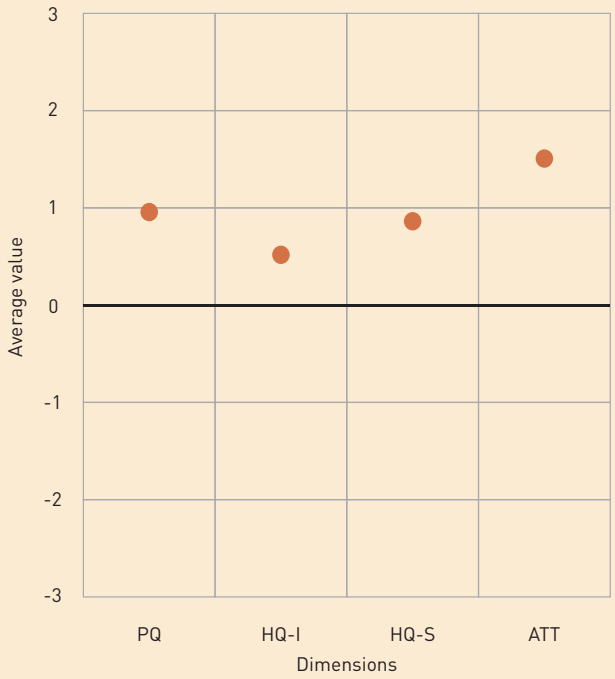


Figure 12.6 Mean value of the four AttrakDiff dimensions for the redesign

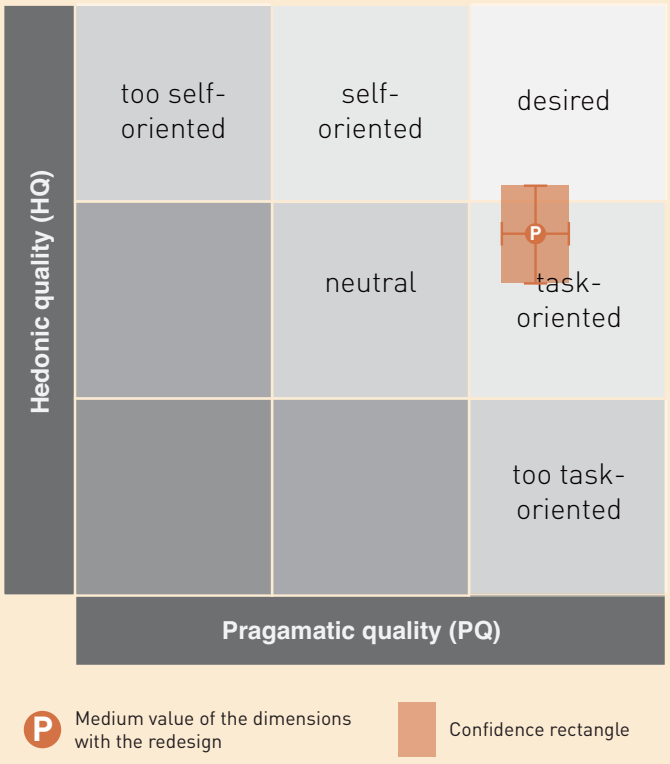


Figure 12.7 Portfolio with average values of the dimensions PQ and HQ and the confidence rectangle of the redesign

Result

There were six participants participated the evaluation session and their rating for every word pair of AttrakDiff dimensions for the redesign are shown by box plot on the figure 12.5, while the statistics of all the ratings can be seen in appendix XX. Besides, the average values of the Attrakdiff dimensions for the evaluated target are also plotted on figure 12.6. In the presentation hedonic quality distinguishes between the aspects of stimulation and identity. Furthermore the rating of attractiveness is presented.

It is clear that the redesign perform positively in Attractivity and hedonic quality although one or two had different opinions. While in the other two categories, participants gave quite various rating.

For hedonic quality (stimulation), most participants agreed that the redesign was captivating and novel.They couldn't reached a consensus on whether the experience was cautious or bold, the reason they gave is that they could choose color boldly but became cautious when brushing on the painting. According to participants, the redesign provided limited freedom for them to explore, which made them somewhat undemanded and even gave one of them an impression that the experience was bit dull.

With regard to pragmatic quality, the redesign seemed to have techinical feeling and clear structure with intermediate level of simplicity and predictability. From the perspective of participants, it was bit difficult for them to understand the whole process and the usage of the glasses in the beginning, which resulted in a threshold. Although it was not too high, it made their experience confusing and complicated to some extent. The technical feeling was mainly from participants' experience with magnifying glasses and the use of light.

There was only one participant rated product's attractiveness as unprofessional. It was explained as in a positive way in which it could also benefit people without too much art knowledge because the interaction was interesting.

In the portfolio-presentation on the figure 12.7, the values of hedonic quality are represented on the vertical axis (bottom = low value). The horizontal axis represent the value of pragmatic quality (left = low value). In the light of the character-region, the redesign was rated as 'practice-oriented' where pragmatic quality is clearly classified while hedonic quality isn't. That is because the confidence interval spills out over the character zone and hedonic value is just on average. Namely, the device assisted user optimally but there is room for improvement in terms of giving user more freedom and letting them have more fun.

On the basis of the final comments from participants, they learnt what they expected to learn from the experience, which made them delightful (as shown in figure 12.8 on the next page). The position of the earphones and the way the story was told could let them get into the role of art restorer (as shown in the figure 12.9 on the next page). However, the quality of the brush, especially the sound when optical fiber rubbed on the replica, isolated them from the experience Furthermore, the magnifying function of the glasses failed to be understood by participants in the beginning and the palette didn't give a clear affordance that it should be standstill, so those issues in terms of affordance also distracted them from enjoying the experience.

Figure 12.8 Participant was painting on the replica in the role of art restorer

Figure 12.9 Participant was suprised when the story she heard matched with her guessing about the style

Conclusion

- **Does the redesign help user transform to a role of art restorer?**

User is able to bind to the role of art restorer, since they ranked hedonic quality-identity above average. But it can be improved if the affordance of certain components of the design are clarified.

- **Can user learn from the experience as they expect to learn before experience? Does user enjoy the experience? Does the redesign engage user with the setup and audio?**

The redesign is inviting to user and can result in a delightful experience as the feeding of information is accurate and the storytelling is immersive. While the setup can be more aesthetically inviting.

- **Does the redesign result in autonomous, explorative and dynamic interaction?**

The redesign have the affordance to provide autonomous, explorative and dynamic experience. In the evaluation session, participants were actively involved in the experience in terms of painting on the replica, listening to the story and paying close examination, although it tended to be task-oriented, so the redesign fulfilled the desired interaction quality of dynamic, explorative and autonomous. However, the last two qualities can be improved further, if a overview was included in the instruction so that the threshold can lower down in the beginning and more freedom was given for people to explore.

[1] Isleifsdottir, J., & Larusdottir, M. (2008). Measuring the user experience of a task oriented software. In Proceedings of the International Workshop on Meaningful Measures: Valid Useful User Experience Measurement (Vol. 8, pp. 97-101).

FINAL CONCEPT

The final concept, viz. the Smart Frame 2.0, is rendered based on what have learnt from evaluation. In the end, couple of recommendation are also given for following-up studies.

FINAL DESIGN

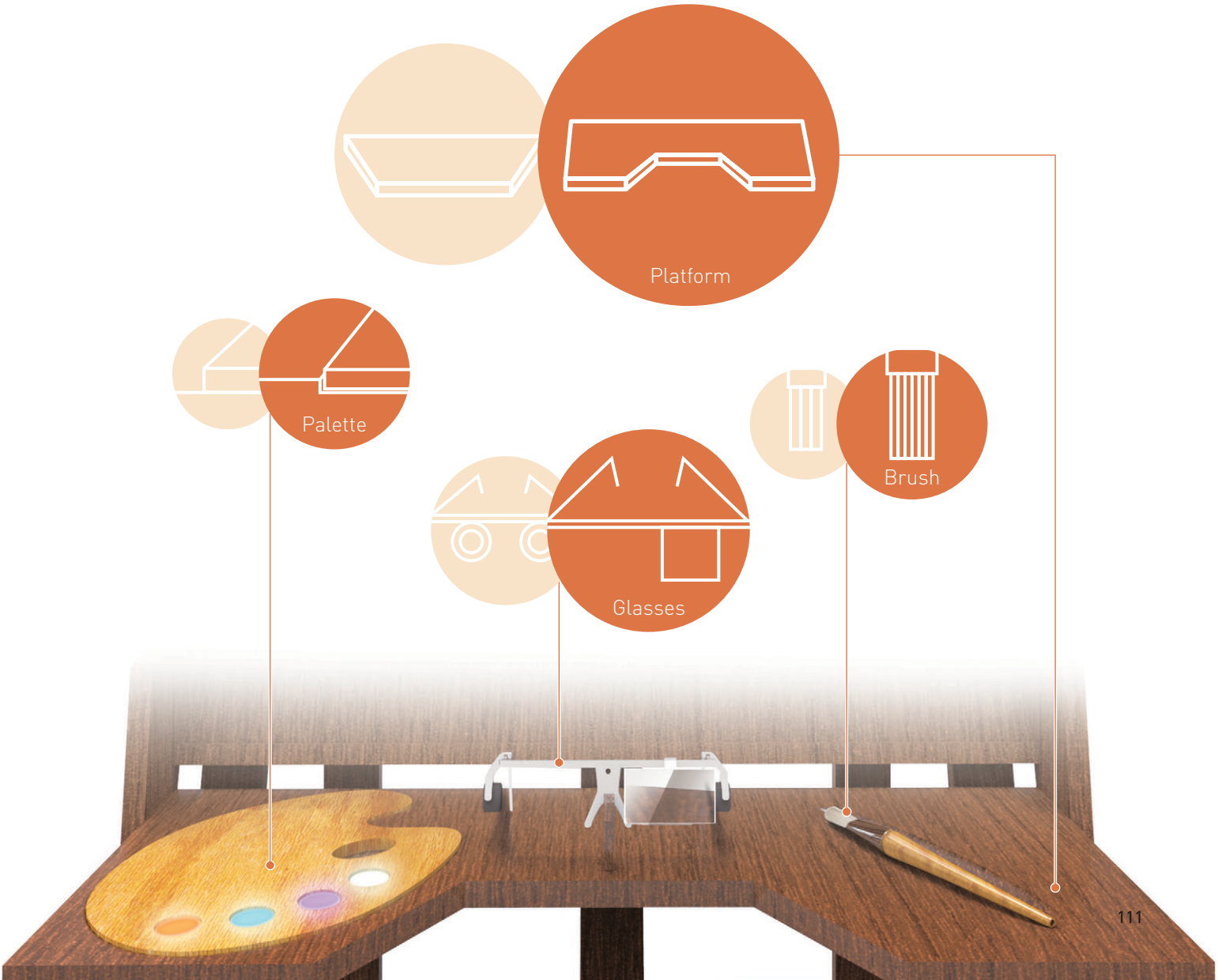
There were couple of changes made to the last version of the redesign focusing mainly on the affordance and immersivity. The changes are revealed in the figure 13.1 (features of the last version are shown in light orange circles, while the changes of those features are shown in orange circles).

In order to make the experience more inviting and immersive, the easel was changed to be tilted and the shape of the platform was refined to let user be closer to the replica. In addition, thinner fibers were applied to the brush and the appearance was designed to be closer to the real one.

For the consideration of clearer affordance, the palette was changed to be embedded in the platform in order to indicate it was not supposed to be lift up. In comparison, a shallow pit was made to place brush for the opposite indication. Moreover, the magnifying glasses was changed to monocle with more open vision so that the function could be clear to user, and an overview was also added to the audio.

The using context and details of the final design were also depicted in the figure 13.2, which can be seen on next page.

Figure 13.1 Changes from last vesion to the final concept




Projection areas

Figure 13.2 Context of using and details of the final concept

Recommandation

- **For people outside the field of design:**

The intended effect of the design can be easily achieved if the quality of projection and audio is improved

In the prototype, pixels were obvious in projection due to insufficient resolution, a higher quality of projector can be employed for better effect. There are already ultra-short distance projector available on the market which can project 4K image and small in size (e.g. Sony LSPX-P1)

The audio used in the prototype was composed and recorded by unprofessionals. It will be beneficial if more studies of the painter's talking style are involved and let professional voice cast takes the role, because the audio is from the perspective of the painter.

- **For product designers:**

The design of the magnifying glasses needs to be improved, it can take the need of users who wear glasses into consideration. Furthermore, the way of how those tools integrated with the easel can also be optimized.

- **For interaction designers:**

The interaction of touching was replaced by brushing in the Smart Frame 2.0, however, it is possible to merge tactile experience to such interaction, for instance, simulating the resistance of the paint when brushing. Therefore, the indirect tactile experience can also be a direction to be studied.

Tracking technology of the brush needs to be designed since the effect was achieved by wizard-of-oz in concept evaluation.

As observed from the evaluation session, majority participants started painting on the replica before the audio finished, so there can be a way to increase user's patience. It may work if there is a stool for user to sit, but the effect requires testing.

Although there was no direct comparison between the user experience of the former design and the redesign in the final evaluation, It would insightful for further improvement if such comparison is conducted.

The redesign focused mainly on the individual user although it allowed social interaction somehow thanks to the employment of bone conduction earphones, the design can be more promising if there is a test about the effect on social interaction since it was one important element that complies with the vision of art museum.

THANK YOU FOR ‘BREAKING THE FRAME’