The Mystery Game

Making families with children
explore the Mauritshuis together.

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Colophon

Master thesis

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Self-Portrait, c. 1567; Museo del Prado, Madrid.

Natura potentior ars. - Art is more powerful than nature.

- Tiziano Vecellio, ca. 1550.

Preface

I am Marisa Vrijdag, an Integrated Product Designer from the TU Delft, and this is my story on how I found the Mauritshuis as ultimate graduation opportunity.

Interest in art
From an early age I started visiting museums during family holidays, as daytrips with my parents or during school trips. My interest in specifically art gallery museums has not always been high, as the visits seemed to last too long and made me feel tired.. But my grandmother is a hobbyist painter and she took me to art gallery museums not to only make me look at the paintings, but also to paint together with me afterwards. We went to a variety of museums, from Van Gogh to Ton Schulten.

After following art (history) classes alongside technical courses at secondary school, my interest in art and technology came to a balance and that is when I decided to continue my studies through combining both in the study Industrial Design Engineering.

Interest in people
Besides my interest in art and technology, I am interested in connecting with people. Through conducting user research a goldmine full of qualitative data can be found about the fantastic worlds others find themselves in. It is wonderful to get dragged away and become inspired by other people their stories.

A place that holds a lot of stories is the Mauritshuis. Even though the museum has a vibrant history with Johan Maurits and a fire burning down the building, the stories of the past were saved with the help of the paintings and the stories of eye witnesses about them.

Spreading relevance
Among other subjects, the history of our country and developments in society can be seen in (art gallery) museums. But if it was not for family togetherness and turning the enriching stories into own interpretations, I might not have seen the relevance of these museums at a younger age, nor visited these museums until now. Therefore my goal is to spread the relevance of museums, making them tell their stories on the long-term and enabling people to reflect upon these before continuing.

Learning objectives for my professional life
The Museum Futures Lab of the TU Delft and the Mauritshuis in the Hague provided the possibility to combine art and Industrial Design Engineering in making the museum more relevant to families with children.
There was space for listening to personal stories of families and children to enrich my researches. At the same time this challenged me to step out of my comfort zone and get in contact with families in the first place. For children a well-

Portrait of me. (c) Vera Bos, 2019.

considered approach had to be made to obtain their stories and the insights from these stories needed to be translated into a concept design.
Another challenge was engaging the Mauritshuis in the process, making them interested in my proposal and at the same time keeping into account what is relevant to them. In order to communicate my ideas, I was challenged was to visualise them. Though I like painting(s) and art, I do not consider myself as an artist and thus had to improve my visualisation and prototyping skills.

Summary

This project
The aim of this graduation project was to find out how to make the Mauritshuis, an art gallery museum in the city centre of The Hague, relevant to visiting families with children. Thereby the focus was on how to engage the families as soon as they enter the permanent exhibition of the museum and make the museum more relevant to them accordingly. The Relevance by Play Framework (Vermeeren & Calvi, 2019) was taken as reference.

To understand the message and experience that the Mauritshuis wants to provide to its visitors (and mainly families with children) with the help of the permanent exhibition, the content of the permanent exhibition, the management mission / vision and museum employees are consulted. Additionally the strengths and weaknesses of the current family product in use are reviewed as reference. The scope is broadened by looking at how other museums approach families with children.
Parallel to getting to know the core of the Mauritshuis, research has been conducted with families, both parents and children, with the aim to understand their motivations, roles and interests before –and during a visit to museums in general, or the Mauritshuis specifically. This was achieved through a literature review, observations, questionnaires, interviews and generative sessions .

The project vision
The research outcomes resulted in an interaction vision:
"I want that the Mauritshuis becomes like an exciting exploration of a goldmine.

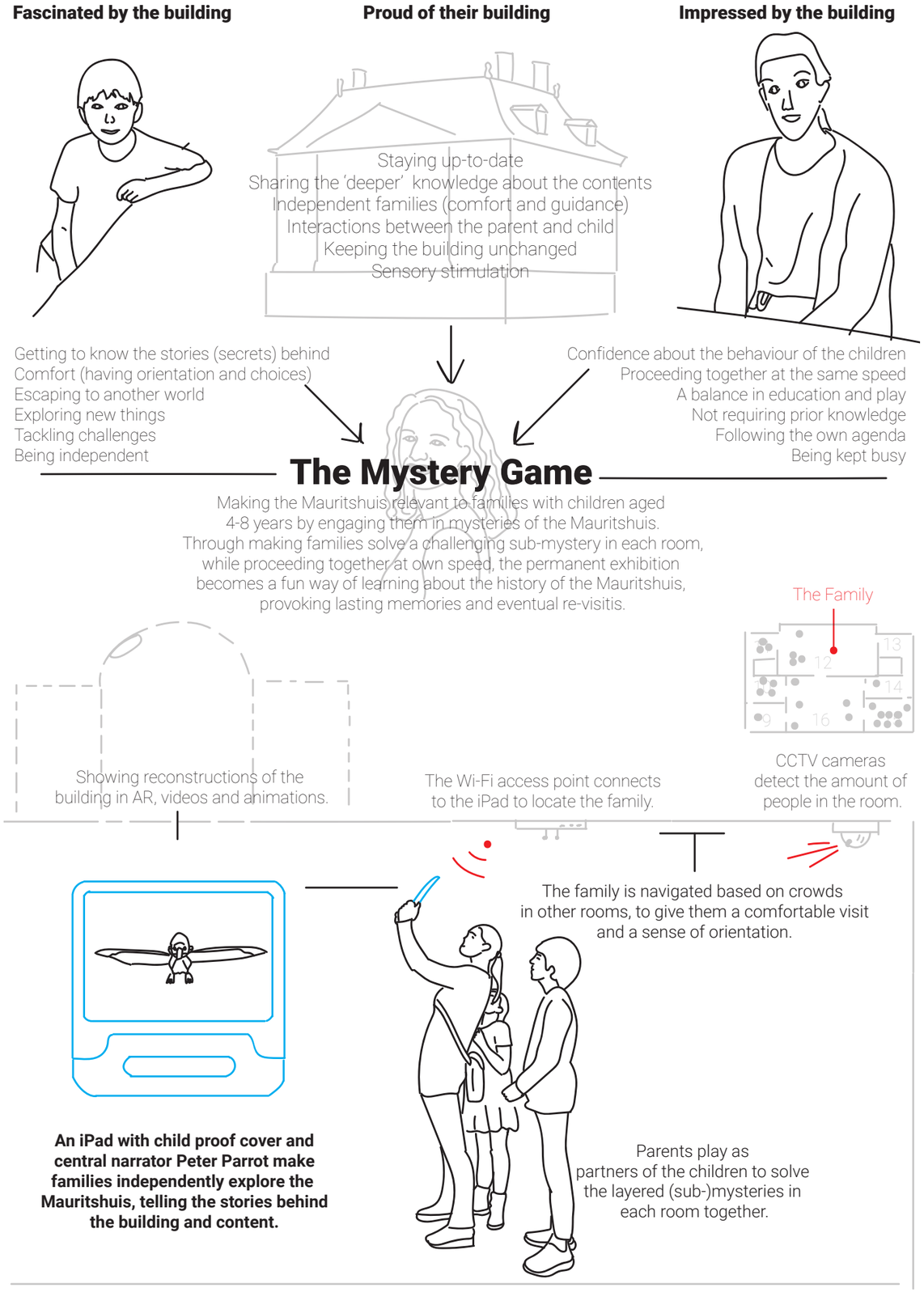
Corridor systems give confidence and guidance to curious families that decide to walk autonomously through the goldmine. When gold is discovered, it can be substracted from the mine and taken home as a reminding reward to proudly share with others."

The vision was used as base while generating product ideas. Through engaging employees of the Mauritshuis in the idea generation, a concept is developed that was assumed to be relevant to both the Mauritshuis and visiting families: the Mystery Game.

The Mystery Game
The Mystery game is storytelling application on an iPad, which keeps the family together while travelling through the Mauritshuis. The family is helped to immerse in the stories behind the building: they can see a reconstruction of each room of the year 1704 when inside the rooms, with the use of animations, movies and augmented reality. The present is mixed with the past and the family is challenged to find the link between them through solving a mystery in each room.

A prototype has been made of this concept as proof of concept and in order to test its relevance.

For an overview of the research –and design outcomes of this project, see Page 7.



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Additional to this report are some Appendices:

Appendix A:
Extended information that links to this report.

Appendix B:
All insight cards from the generative session with children.

Appendix C:
The models (application simulation and AR files) and computer programming code.

Appendix D:
The fundraise leaflet and a storyboard for a concept video that was planned to make on February 26, 2020.

Appendix E:
Confidential appendix with
- Project planning;
- Personal reflections;
- Relevance by Play Chapter;
- Consent forms of participants of the researches.

1. Introduction

1.1 The Mauritshuis.

The Mauritshuis is an art gallery museum in the city centre of the Hague. Their mission is to share the best of Dutch paintings of the time of Rembrandt and Vermeer in their house (mauritshuis.nl). This mission shows the pride the museum has for its collection and the building they are in: most of the art collection is permanently exhibited in a seventeenth century building (Figure 1).

The Mauritshuis does not only enhance its historic character: the museum is restored and expanded in 2014 to twice its size, with a modern underground foyer leading to a space for changing exhibitions, education and meetings (Figure 1). This emphasises the societal role the Mauritshuis wants to take: they want to be relevant to an as diverse audience as possible.

Figure 1. The Mauritshuis.

1.2 Families with children in the MH.

For this project the targeted audience was individually visiting families with children (families that do not visit the museum in an organised group visit). As the Mauritshuis mainly shows paintings on the wall, it was assumed that this makes the audience of families with children less likely to visit the museum, as children often like to touch things. To become more relevant (fun, interesting and accessible at acceptable effort, through play and with high meaning making (Vermeeren & Calvi, 2019)) to this audience, the Mauritshuis already organises different (family) activities inside the museum, does not charge entrance fees for children under 18 years and offers the "Family-do-Package" (Figure 2) to individually visiting families.

Figure 2. The Family-do-Package

1.3 The project brief.

The initial project brief can be found in Appendix A1.

1.3.1. The problem definition
The Mauritshuis started the collaboration with this project with the aim to update the current "Family-do-Package" in use (Figure 2). The product can be bought at the ticket desk of the museum and should be taken in –and out of the exhibition rooms. The aim of the product is to make children and parents interact during their visit to the museum. More information about the contents of the product can be found in Appendix A2.

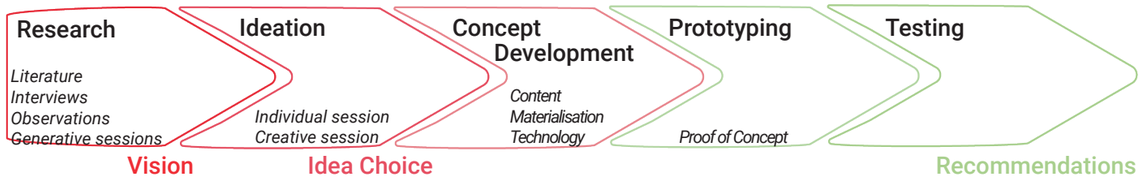
Unfortunately the 'offline' product requires regular updates after changes to the permanent exhibition and after each use. This tends to negatively influence the workflow of employees of the museum. Therefore the Mauritshuis wanted to find out to what extend the museum is relevant to visiting families with children and how to become more relevant to them, while staying relevant to themselves.

Based on the aforementioned standards of -and errors with the Family-do-Package, some initial requirements for a new product were set:

Requirements:

- **The product should stay updated after (small) changes to the permanent exhibition;**
- **The product should fit into the current workflow of employees;**
- **The product should enhance family interactions during the visit and should be fun for both the parent and the child;**
- **The product may not be placed in the exhibition rooms permanently, thus preferably should be taken in- and out of the exhibition room.**

1.3.2. The project approach
The project is executed in five main stages and in each stage different design methods are being used:



2. Research

The research set-up is structured with the help of the Relevance by Play Framework by Vermeeren & Calvi (2019), see Figure 3. Based on the initial requirement that a new product should enhance family interactions, the focus of the research was on getting to know how to engage families with children in the Mauritshuis.

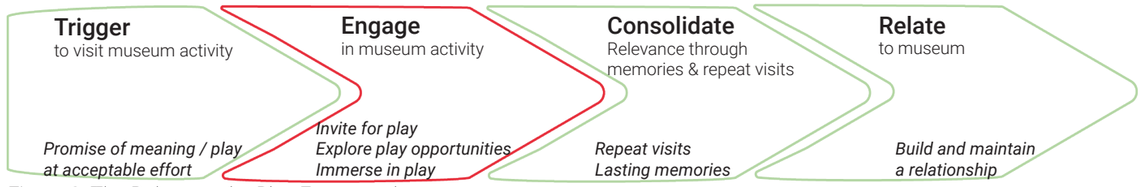


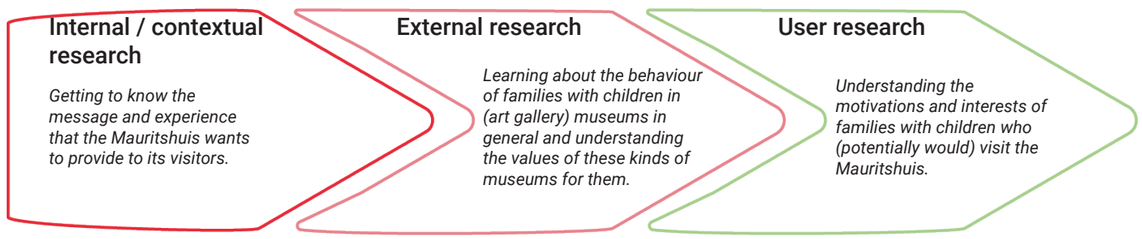
Figure 3. The Relevance by Play Framework.

2.1 Research objective.

In order to engage all family members during a visit to the permanent collection of the Mauritshuis, the research objective was to find out how to make the Mauritshuis relevant to both (grand)parents and children during their visit.

2.2 Research approach.

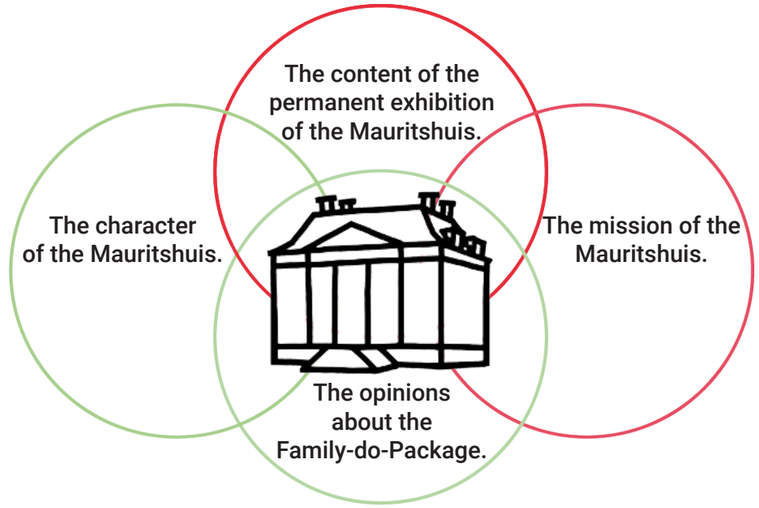
The research was set up in multiple stages:



2.3 Internal / contextual research.

To accomplish making the museum relevant for families with children, first internal research is done. The goal of the internal research was getting to know the message and experience that the Mauritshuis wants to provide to its visitors.

This chapter is split in four internal/contextual researches:



2.3.1 The content of the permanent exhibition of the Mauritshuis.

The Mauritshuis is the only museum that specialises in Dutch paintings of the 17th century. Based on a guided tour by Geert-Jan Borgstein, employee Adult Education and Visitor Support at the Mauritshuis, the most important themes of the museum were found (see Appendix A3).

2.3.1.1 *A representation of reality.* It was found that a reoccurring theme was that the paintings are all a representation of reality and thus not reality itself. For example: Johannes Vermeer adjusted the placement of the church and the shadow of the gate in his famous “View on Delft” (Figure 4), in order to make the painting look more tranquil and balanced.

Figure 4. View on Delft, Johannes Vermeer.

2.3.1.2 *Art is bigger than nature.*
Another theme that can be found in the collection is that art is bigger than nature. For example: in the painting “Vase of Flowers in a Window” by Ambrosius Bosschaert (Figure 5) multiple flowers that normally grow in different times of the year are put together in one vase. The message is that that the real flowers will wither, but that the painting of it will remain.

Figure 5. Vase of Flowers in a Window, Ambrosius Bosschaert.

2.3.2 The mission of the Mauritshuis.

As stated in the introduction, the mission of the Mauritshuis is to share their collection and the knowledge they have about it with an as diverse audience as possible.
A potential new approach of transferring the knowledge about the collection was experienced during a small course ‘Visible Thinking Strategies’ in the Mauritshuis, see Appendix A4.

The Visible Thinking Strategy is not about telling visitors the facts about the collection, but about letting them come up with their own interpretations about one painting by looking at it closely or even experiencing it. The strategy has three pillars:

- **It is accessible:** the strategy is used in small groups (4-8 people) and no prior knowledge of art is required. The museum guide, the one primarily in charge of the experience, is called a companion rather than a guide, as he/she participates in the session too;
- **It is qualitative:** during the session only one painting of the collection is discussed over a long period of time;
- **It is actual:** the theme of the session is based on what is actual in the news and changes each session.

2.3.3 The character of the Mauritshuis.

In order to understand the character of the Mauritshuis, information/ticket desk employees, museum teachers and security employees are interviewed. The employees were asked about their typical day at the museum and their attitude towards a new product for children. For the complete interview set-up and the results, see Appendix A5.

2.3.3.1 *Pride*
One of the findings was that the employees are proud of the building and see it as an important part of the museum, beside the collection it contains. Therefore they demanded that a new product would be stored and maintained somewhere clean and central, without the need to change the (visible) architecture. Also, in order to keep the museum clean, a new product should not have small particles that can get lost easily.

2.3.3.2 *Trust*
Another finding was that the employees have a mutual trust among each other, but also want to build trust with the visitors of the museum. They do so by supporting visitors in having an overview and orientation inside the museum and giving them confidence in individually exploring it (also with children). Thereby the employees do not only think it is important that visitors behave during their visit, but mostly that they stay aware of their environment. The museum and its contents are classical and although a new product might be modern, it should provoke careful looking at these classical contents.

2.3.3.3 *Independence*
A third finding was that the employees strive for independence of visiting families. Though a new product should be challenging for families in terms of going into detail for a focussed content / theme, it should be self-explanatory, without needing a lot of further explanation and guidance of the employees. It should also ensure that security does not need to keep a close watch on the children. Keeping the children busy and giving them a task might help with that.

2.3.4 The Family-do-Package

To get some insights in experiences of families that visit the Mauritshuis with children and make use of an entertaining product, a research about the current “Family-do-Package” is reviewed. The research was conducted in 2014 by the Mauritshuis. For the research questions and results, see Appendix A6.

2.3.4.1. *Research set-up*
The questions asked were about the duration -, difficulty -, positive points -and points of improvement of the Family-do-Package.

2.3.4.2. *Results*
23 families participated with a total of 43 children between 2-13 years old. The families had different family sizes and within a family children had different age ranges (e.g. 0-4 year, 4-8 year, 9-12 years etc.).

2.3.4.3. *Conclusions*
It is concluded that most families with children that made use of / had interest in using the “Family-do-Package” had children aged 4-8 years. Not every family had multiple children with the same level of knowledge or who could interact with each other.
Overall the families indicated that the use of the product should take a maximum of 3 hours, but preferably should not take too long to use.
Lastly the families indicated that they, in the future, would like to have a designated place to make use of the product, in order to not stand other visitors in their way.

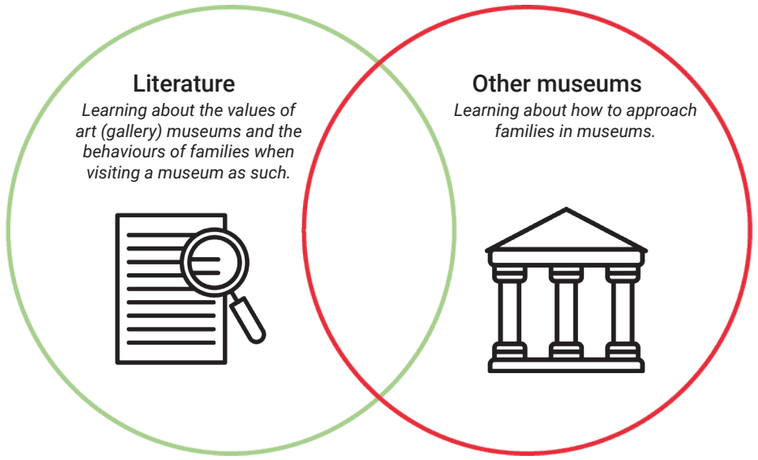
Requirements:

- **Could interchange between reality and sur-reality.**
- **Could reconstruct what is lost, with the help of the stories that remained.**
- **Should make families come up with own interpretations of what they see, hear or think, based on received information.**
- **Should have one focus during a visit to make it qualitative.**
- **Should enable changing the focus during a next visit.**
- **Should make parents work rather as companion with -than guide of the children.**
- **Should not require prior knowledge about the museum of family members.**
- **Could focus on the building.**
- **Should keep the building physically the same and clean; could potentially be stored in a locker.**
- **Should keep / make families aware of their environment.**
- **Should give families orientation, guidance and confidence during the visit.**
- **Should be children proof.**
- **Should be comfortable in size and weight.**
- **Could be something to touch / hold / carry for children, in order to keep them entertained.**
- **Should keep into account families of different sizes.**
- **Should be suitable for families with children aged 4-8 years and parent aged 18+ years.**
- **Should give families a choice in time to spend and what to do in the museum.**
- **Could make use of crowd-dependent navigation to give families a more comfortable visit.**

2.4 External research.

In order to be able to design a product that fits to the general behaviour of families in a museum and presents the value of the museum to the maximum, external research is conducted.

Two kinds of external research are done:



2.4.1 Literature

To get to know what motivates families to come to a museum and how families generally behave in museums, literature is consulted. For the complete literature research, see Appendix A7.

2.4.1.1. The value of art gallery museums for families
Wu & Wall (2017) state that art museums are important places of learning / education for families. Dierking & Falk (1994) add that the own agenda of a family influences the learning experience in the museum.

Furthermore Wu & Wall (2017) mention museums as being venues for relaxation, enhancement of family relationships (togetherness) and meeting social obligations. The findings by Sheng & Chen (2012) about (Taiwanese) museum visitors are similar. According to them, museums are expected to be:

- Easy and fun (having a relaxing -and interesting experience);
- Culturally entertaining (finding familiarities with yourself);
- Personally identifiable (being with / seeing companions with similar interests);
- Historically reminiscing (making you revive historic content and feelings);
- An escape (having a dreamy experience, hope and vision).

Other studies imply that families visit art museums for good parenting (Cox et. al, 2006) and active participation for memorable effects (Hood, 1993).

2.4.1.2. Family behaviour inside a museums
<u>The role of the parent</u>
Beaumont (2010) and Brown (1995) observed different roles of parents during a family visit to a museum, see Appendix A7. One of these roles was the parent being a Player with / Partner of the child. The Mauritshuis emphasized their wish for parental play in the museum and likewise Shine & Acosta (2000) emphasized the importance of the parent taking this role. According to them children are found to reconstruct representations of the world through pretend play (Tamis-LeMonda & Bornstein, 1993) and develop positive family play relationships when they engage in warm, mutual engaged, verbally responsive play with their parents (Göncü & Tuermer, 1994; Howes, Unger, & Matheson,1992; Sutton-Smith, 1993). However, in the study of Shine & Acosta (2000) parents were found to be declined to engage in play.

<u>Engaging parents in play</u>
According to Downey, Krantz & Skidmore (2010) one of the issues parents have with engaging in play is the lack of confidence and knowledge of how to play with their children. Borun & Dritsas (1997) mention some ways of engaging the parent in play:

- Have multi-user-interactions in an assignment, that allow for several sets of hands (or bodies);
- Make the exhibition accessible so it can comfortably be used by both children and adults;
- Have a multi-outcome exhibition, to foster group discussion (also at home);
- Make the exhibition multi-modal, so it appeals to different learning styles and levels of knowledge.

These factors are proven as efficient in a follow-up study by Borun, Chambers, Dritsas, & Johnson (1997).

<u>The value of engaging both parents and children</u>
Besides engaging parents in play, engaging children in play also has added value. According to Schiffer (2011) young children are naturally adept at looking closely at art and often notice details missed by more-experienced visitors. This potentially enriches the museum experience of the parents. On the other side, the parents can enrich the museum experience of the children through letting them experience being a part of a story. They can do this by reading texts out loud, explaining the exhibition and asking / answering questions about the museum together with the child. Borun & Dritsas (1997) found that this increases learning levels of both the parent and the child.

<u>Requirements:</u>

- **Should be both entertaining and educative; could be educative in a fun way.**
- **Should enhance a feeling of escapism (to another world).**
- **Should require group participation.**
- **Should be multi-outcome to prevent a feeling of having failed during the visit.**

2.4.1 Other museums.

The results of interviews, conducted by Van Houten (2018) with Science Centre Delft and Aviodome, are consulted to find out more about how to (successfully) approach families with children in museums. See Appendix A8 for the interview results.

2.4.2.1. *Control and uniqueness*
Families are found to be attracted by having the visit under own control. Thereby they like being able to get in touch with something unique, something other people do not get in touch with.
Moreover, children are found to lose attention if they cannot touch or control things, making a museum visit boring to them.

2.4.2.2. *Insecurity*
It was found that parents do not like to show their children that they do not know certain things about the contents of a museum. It even obstructs them from the role of being a partner in activities with the children.

2.4.2.3. *Information sharing*
A museum can be quite overwhelming, making children only remember a view paintings. Therefore, as best way of sharing information, it was advised to give visual information, make children do things themselves and give them sensory stimuli. The information should fit to prior levels of knowledge in order to make the visit relevant to everyone and make everyone experience the museum at the same speed. This was also found during an interview with a parent (Appendix A14).
Furthermore, children were found to be more willing to engage, learn and pay attention in a museum if they know beforehand that the information they gain will later on be used to complete an activity and if they do not feel like getting an overload of information.

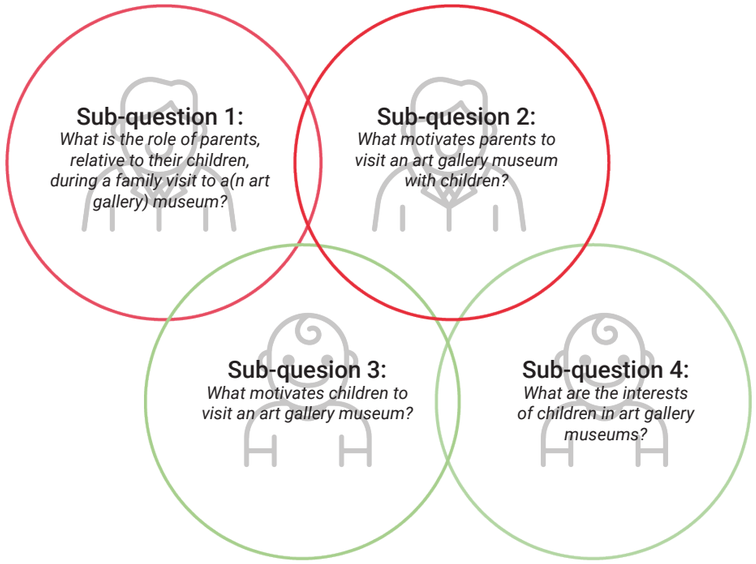
Requirements:

- **Should make families independently visit the museum.**
- **Should make families explore stories and context that other visitors do not automatically explore.**
- **Should be self-explanatory.**
- **Could be story-telling.**
- **Should make the family proceed together at the same speed.**
- **Should be visually stimulating.**
- **Could give parents the task to translate information to their children.**
- **Should be something to do.**
- **Should keep families motivated to continue absorbing information.**

2.5 User research.

The third stage of the research is the user research.
The goal of the user research was to get an answer on the main research question:
How to engage children (aged 4-8) during a family visit to a(n) (historical) art (gallery) museum?

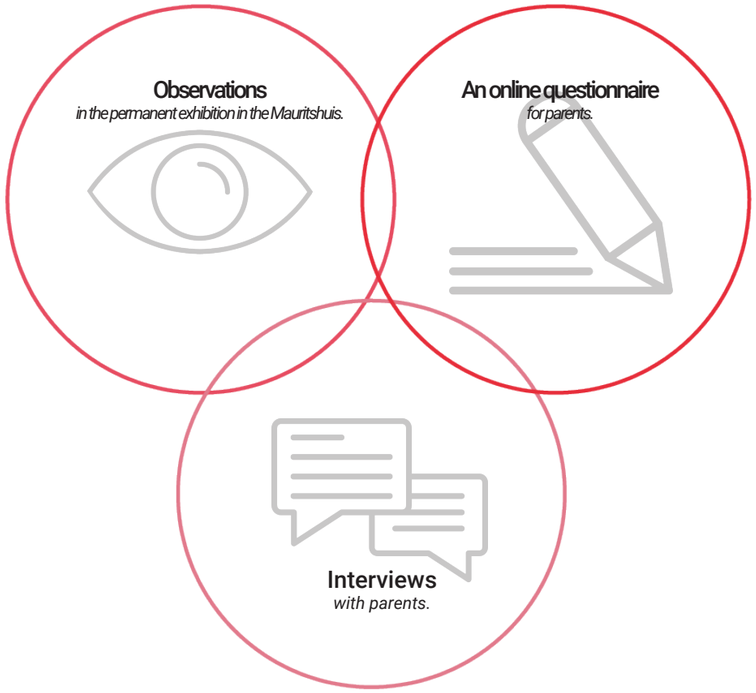
In order to get to an answer on this question, four sub-questions needed to be answered:



2.5.1 Sub-questions 1 & 2

To answer the first -and second sub-question, three research methods are used.

Each research method was used to validate the findings from the papers as presented in Chapter 2.4.1, to enrich the findings from the papers and to get to understand the attitude of families towards the Mauritshuis.



Approach
Three fly-on-the-wall observations are done of a complete visit of a family to the permanent exhibition of the Mauritshuis and one fly-on-the-wall observation is done during a children's birthday party. Also some small fly-on-the-wall observations of families passing by in the permanent exhibition / foyer were done. The set-up, results and conclusions of the observations can be found in Appendix A9.

With the observations the role and behaviour of each family member was found during a visit to the permanent exhibition of Mauritshuis.

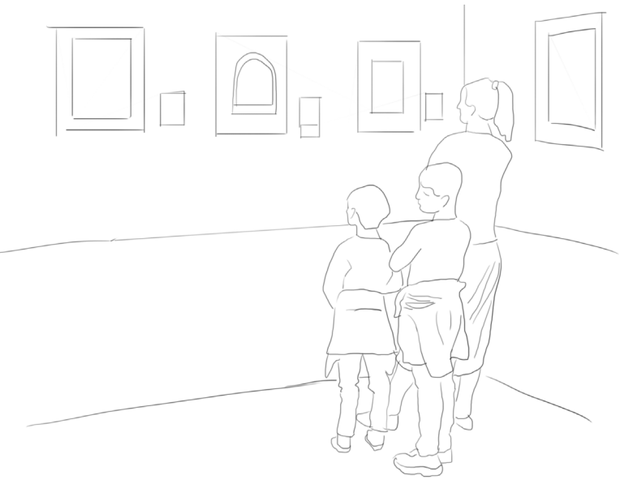
Observed issues with play
It was observed that parents mostly did not play with their children in the Mauritshuis:

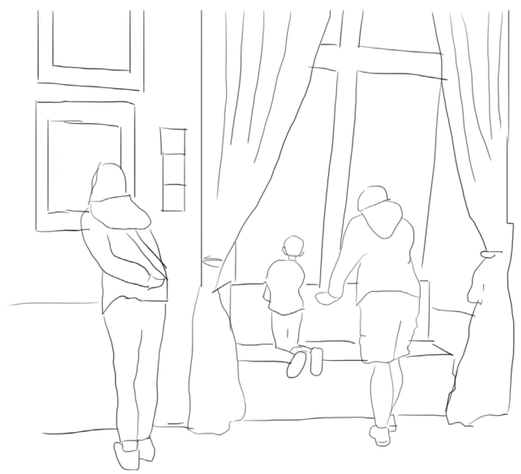
- One family seemed to skip half of the exhibition to get out of the museum as quickly as possible. The children were kept quiet;
- One family split and kept the children on a couch to ensure they would be calm in the museum. This also gave the mother time to see the whole exhibition on her own in the meantime;
- One family had a mother that was ashamed of her daughter running around the museum, even more when she saw she was being observed. She then more or less apologised for her daughter's behaviour.

Conclusion sub-question 1.
What is the role of parents, relative to their children, during a family visit to a(n art gallery) museum?

From the observations it is validated that some of the roles as found in Chapter 2.4.1 were found among the families that visited the Mauritshuis with their children:

- In one family the parent dragged the children along while the children tried to find alternative distractions. The parent had the role of interpreter.
- In one family first the children were dragged along with the parents, but later on the family split to let the mother watch the paintings thoroughly while the father took care of the children who looked out of the windows of the museum. The parents had the role of being a supervisor or 'distracting entertainer'.
- In only one family the parent played / partnered with the child, but thereby skipped 75% of the museum.





Approach
A questionnaire was spread online (on LinkedIn, Mauritshuis intranet and via family). In the questionnaire 12 questions were asked about the kind and amount of family trips families do, the roles of the family members in going to a museum, the motivations and barriers to go on family trips and the family composition. For the online questionnaire and questionnaire booklet, see Appendix A10.

Through the questionnaire more insights are gained about the attitude of parents before visiting the Mauritshuis with children.

Respondent information
13 people responded on the questionnaire, of whom six visited the Mauritshuis with children, three without children and four never visited the museum at all. Most families existed of two parents with two children. Altogether the families had 35 children in the age from 2-15 years. Most children were aged 4-10 years.

For all results, see Appendix A11.

Issues with play
From the questionnaire issues why the parents would not play in the Mauritshuis became clear:

- The Mauritshuis is less of a children's museum than other museums;
- The children are of different age ranges and thereby not all museums (or trips) are fun for both the younger and the older child;
- The lack of distraction and possibilities to touch stuff and run around in a museum like the Mauritshuis;
- The fear of the behaviour of the children inside a museum like the Mauritshuis.

Conclusion sub-question 1.
What is the role of parents, relative to their children, during a family visit to a(n art gallery) museum?

From the questionnaire the role of the parent before visiting the museum did become clear: three of six parents that visited the Mauritshuis with children mentioned that the children had to go to the museum as the parent wanted to go. One of these three parents mentioned that the child had the role of influencer in the final decision.

Conclusion sub-question 2.
What motivates parents to visit an art gallery museum with children?
Some motivations for parents to come to the Mauritshuis with their children and engage them in the museum were mentioned:

- Being cosily together and having something to explore;
- For educating / learning something and enriching both the children and themselves;
- Having fun contents / a fun environment (especially for children).

According to six responding parents, the Mauritshuis could motivate them more to come through:

- A special event, workshop, activity/action or exhibition for children;
- A recommendation of someone about the museum;
- If the children are likely to behave in a museum as such;
- If the museum is found to be beautiful and fun for children.

These reasons are similar to the findings in the papers (Chapter 2.4.1) and the issues of play from the observations (previous page) and interviews (next page).

Approach
From the interviews insights are gained about the attitude of parents before visiting the Mauritshuis with their children and how the parents would like to proceed through (art gallery) museums.

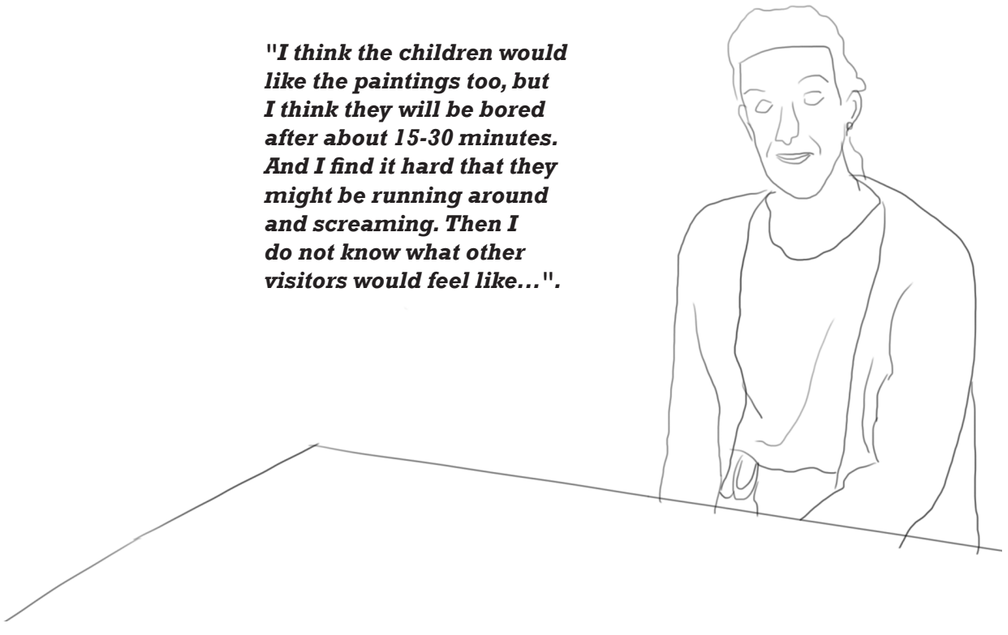
Respondent information
One interview is done in the Mauritshuis, with two parents that were about to visit the Mauritshuis with two children (aged 3 and 9 years, interview A). Another interview is done at BSO Jonas with a mother of two children (aged 4 and 6 years, interview B).

See Appendix A12 for the interview set-up and results.

Conclusion sub-question 1.
What is the role of parents, relative to their children, during a family visit to a(n art gallery) museum?

Before the visit
From interview A it was found that before the visit to the Mauritshuis the parents had the roles of initiator (deciding to look online for museums in the Netherlands), information gatherer (looking at reviews of certain museums) and decision-maker (deciding to go to a museum with good reviews) (Wu, Holmes & Tribe, 2010). The child of the parents indicated to be okay with trying the Mauritshuis out, as he did not have the information to make a well thought-out decision himself. He thereby did not try to influence the parents (see also generative session A, Appendix A14).
From interview B it was found that the parent gathered information before going to a museum, and based on that made assumptions if the museum would be fun or not for the children. Also, previous experiences in a specific museum influenced if she decided to go to a certain museum with the children or not. The interviewee also states that the children often ask to go to one and the same museum (Kinderboeken museum). During generative session D and E (Appendix A15), the children of interviewee B state that they always ask if they can go to a museum if they think they want to: *"but if we keep asking it, my parents can decide that we will not go, because we are being annoying".*

"I think the children would like the paintings too, but I think they will be bored after about 15-30 minutes. And I find it hard that they might be running around and screaming. Then I do not know what other visitors would feel like...".



During the visit (and the issues with play)
During museum visits interviewee A wants to keep the family together and more or less co-learn about the contents of the museum. One issue with play is the struggle with the differences in knowledge levels of themselves and their children, causing that the family cannot proceed at the same speed.

During museum visits interviewee B plays with the children, but has an issue with understanding the value of play:
"In museum Meermanno you could sit on a school desk and the children could play the teacher. That was really fun. But this seemed more like fun than learning, which is fine because they still learned something, but I think learning is (most) important in a museum."

The interviewee also mentioned the issue of having differences in interest among family members and that the children dislike standing still at one object for a long time:
"At the Esscher museum there was a movie and I thought it was fun, but the children did not think it was interesting. Then we proceeded."

Conclusion sub-question 2.
What motivates parents to visit an art (gallery) museum with children?
Interviewee A would be motivated to visit art gallery museums if the family can proceed together at the same speed, making every family member discover something new based on prior levels of knowledge.

Interviewee B mentioned that she would be motivated to visit the Mauritshuis if she would be more secure about the behaviour of her children and if she was assured that something could be learned: a museum should have something to do for children, or make them investigate. This would ensure they could spend more time in the museum, be kept busy, making it less boring for them. A positive development that the interviewee likes in (art gallery) museums is their accessibility: children can 'grow' into new subjects of the museum, which makes the museum more varied / educative on the longer term.

Requirements:
- **Should make the parent a player with / partner of the child.**
- **Should keep the family busy.**
- **Should be varied in content, to stimulate revisits.**
- **Should give parents a feeling of security about the behaviour of their child.**

2.5.2 Sub-questions 3 & 4

To answer the third and fourth sub-questions, generative sessions with children are done.

Approach
The session existed of an energizer, where children were asked to draw what first came to mind when hearing the word 'museum'. After the energizer some open questions were asked. The session finished with an assignment where children had to draw how their own museum would look like (both internally and externally).
For the detailed set-up of the generative session, see Appendix A13.

The parents of the children that participated were asked to sign a consent form, determining whether pictures and audio recordings could be made and used. During the session, the children themselves were also asked if they agreed upon this. For the consent forms, see Appendix F.

Respondent information
- One pilot generative session is done inside the Mauritshuis with a child of 9 years old, see Appendix A14.
- Six sessions with Dutch boys and girls are done at BSO Jonas in the Hague. Some of these sessions are done in duos (brother with sister). The eleven children that participated at the BSO were between the age of 3 and 10. See Appendix A15.
- Nine sessions are done at the Rembrandtschool in Delft. The nine children were both Dutch boys and girls between the age of 6 and 11. See Appendix A16. It should be noted that the Rembrandtschool visited the Mauritshuis a week prior to the research and thus the results might be biased.

Some pictures of the session can be seen on pages 30-31.

Clustering
The transcriptions of the sessions and made into insight cards as can be seen in Appendix B. Half of the insight cards are clustered into themes during an individual session and the other half is clustered during a group session, to make the clustering more objective. During the group session two other students participated: a Strategic Product Design -and Medicine student. Appendix A17 shows the clustering results.

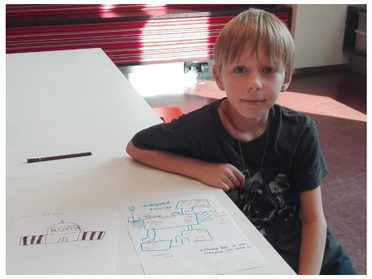
With the help of the clusters, the conclusions on what motivates –and interests children to visit an art gallery museum are found.

Conclusion sub-question 3: What motivates children to visit an art gallery museum?
Social - Pleasing others
Children are willing to amuse their family members and friends, so they just go with the flow to please them when deciding to go to the museum.

Education - Learning something & making memories
Children are curious and eager to get to know the stories behind art, including hidden details. As a museum has another approach than school, children are attracted to visit a museum and learn something in a different manner. As a museum trip is something special, it is likely to make new memories there.

Being in another world - The building & immersing in the museum
A museum is different to the regular locations a child visits in daily life; it has a big, old, luxurious building and there is a lot to see. The Mauritshuis is even partly underground, making the child (feel) immersed in another world. Museums inspire children to make their own things. These can be shown or given to other people, creating a spotlight for the child and making them proud.

Intrinsic motivation - Having fun
A museum enables fun through play.



Conclusion sub-question 4:
What are the interests of children in art gallery museums?
Social – Pleasing others
Children want to take care of others; take responsibilities on the things they (are about to) do. They like sharing experiences with anyone they care about.

Education – Learning –and teaching something
Children want to learn about the stories of the museum; the past, reality and the hidden details in them. They are good at copying and use that to proudly show / teach what they have learned to others.

Being in another world - The building & immersing in the museum
Children are interested in the internal connections of a museum; how the content of a museum is embraced by the building around it. They want to understand this and engage others to help them with that. At the same time they like to keep their independence / autonomy. A museum allows children to mix their fantasies with reality or create own stories by deficit.

Intrinsic motivations – comfort, accessibility and exploring new things
Children want to do things at their own speed. They do not like waiting and standing for too long at one place. They like to take their chances to make themselves comfortable at seats and with other facilities.
Children like to use skills they already have and be secure; although they want to explore a variety of new things, the museum should be logical in terms of giving orientation and objects that fit to the story of the museum. They should be given a choice and not be forced into doing something.

The vision
Based on the conclusions of the roles -and motivations of parents -, and the interests and motivations of children to go to an art gallery museum, an interaction vision for the new family concept is created. Some quotes of the parents (Page 27) and children (Appendix A18) were used as inspiration for the set-up of the vision. See next page.

2.6 Research conclusion: the vision.

I want that a visit to the Mauritshuis becomes like an exciting exploration of a goldmine.

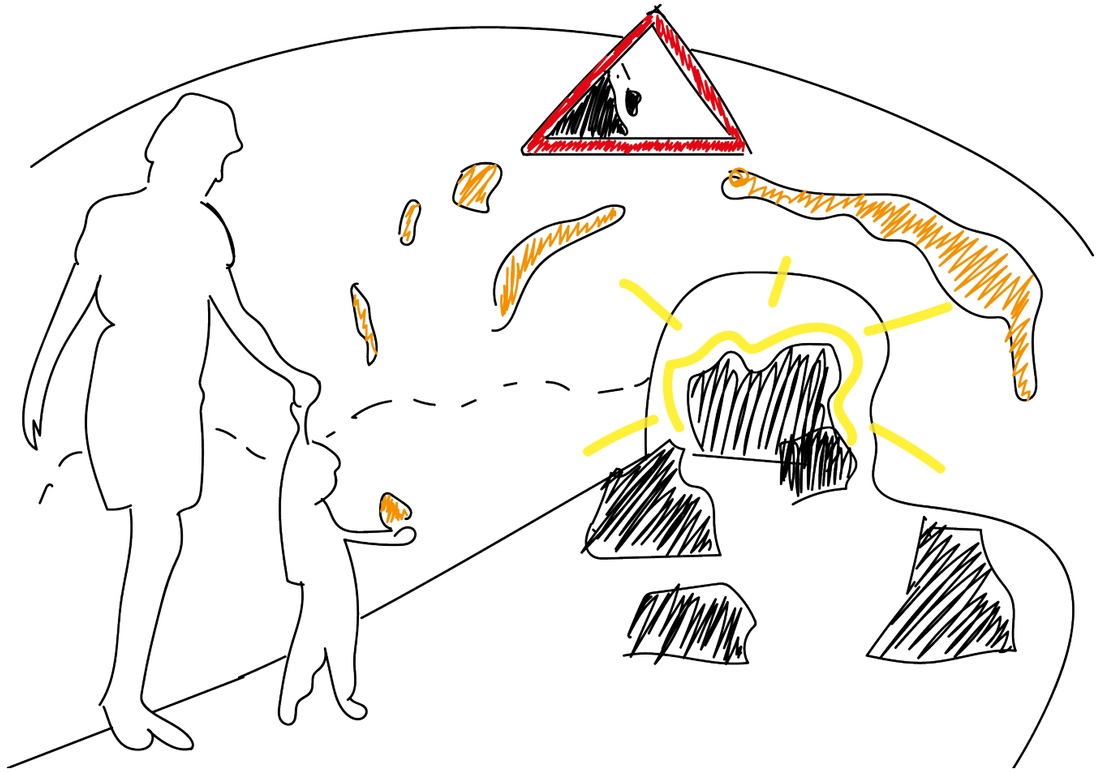
Corridor systems give confidence and guidance to curious families that decide to walk autonomously through the goldmine. When gold is discovered, it can be subtracted from the mine and taken home as a reminding reward to proudly share with others.

Challenging, Sensory stimulating

Story-telling

Independence for the child

Confidence for the parent



3. Programme of Requirements (PoR)

The Programme of Requirements and Wishes is based on the research outcomes and set up on the base of Pugh's Checklist (Roozenburg & Eekels, 1998). The list updated during the design process (ideation and conceptualisation). The complete PoR can be found in Appendix A19.

The most important requirements/wishes, the ones that make the concept more 'unique' compared to the Family-do-Package or similar products in the same product category (products for families in museums), are as follows:

1. Should stay updated after (small) changes to the permanent exhibition.
2. Should tell the stories behind (the collection, building etc.); should give an experience of escapism (like going to another world); could immerse families in the stories of the Mauritshuis through movies, animations and augmented reality (AR).
3. Should make the family proceed through the museum together at the same speed; should evoke partnering / companionship and/or parental play; should engage parents too.
4. Should combine education and entertainment; should adapt to different visitor goals, interests and levels of prior knowledge of different users.
5. Should make users able to (proudly) share achievements of the visit with others or themselves; should make failing during the visit unlikely.
6. Should give the parent a secure / confident feeling about the behaviour of their children inside the museum and their (lack of) prior knowledge about the museum.
7. Should make the family visit the museum independently; should give children independence in taking the family with them through the museum.

4. Ideation

In order to get to ideas that fit to the vision and Programme of Requirements, two idea generation sessions are done:

For the sessions some ideation methods are used which can be found in the books:

- Delft Design Guide by Van Boeijen et. al. (2014);
- Productontwerpen, Structuur en Methoden by Roozenburg & Eekels (1998);
- and on the website: https://studiolab.ide.tudelft.nl/studiolab/codesignwithkids/.

Based on the results/conclusions of the sessions, five idea clusters are made and compared, resulting in an idea choice.

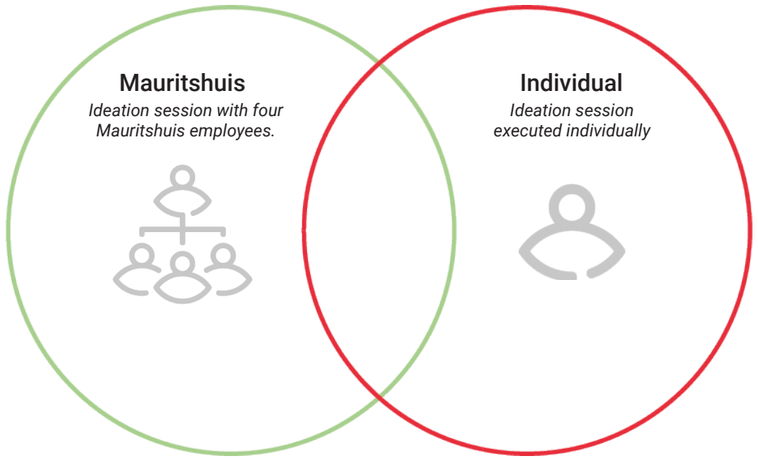


Figure 6. Creative session at the Mauritshuis.

4.1 Idea generation at the Mauritshuis.

A creative session with employees of the Mauritshuis is done, see Figure 6.

Approach
Before the ideation started, first the main outcomes of the research phase and the vision of the project were presented. Also some key rules of brainstorming were mentioned, as it was assumed that the participants were not familiar with brainstorm sessions (on a regular basis).

During the session the Inverse Brainstorm -and How To method are used for idea generation. The DOT voting technique is used to communicate the favourite ideas of the individual participants at the end of the session.

For the complete session plan, script and presentation slides, see Appendix A20.

Participants
Four employees of the departments Education and Development & Hospitality were asked to participate in the session. The session took place in a conference room in the Mauritshuis and the session took 1-1.5 hours. All participants were women with children.

Results and conclusion
For all results, see Appendix A21. The favourite ideas, as voted by the participants of the session, can be recognized through the dot-stickers in Appendix A21. The generated ideas are further explored and made into ideas 1-6 of Appendix A24.

At the end of the session some (new, important) criteria / wishes/ rules to keep into account in a new product were mentioned by the session members:

Requirements:

- **Should embrace the museum rules (like: not touching the collection, not screaming, no running, pass security first).**
- **Should be recognizable in use.**
- **Should not change the perception of space inside the museum.**
- **Should evoke using all senses.**

4.2 Individual idea generation.

Another creative session is done individually.

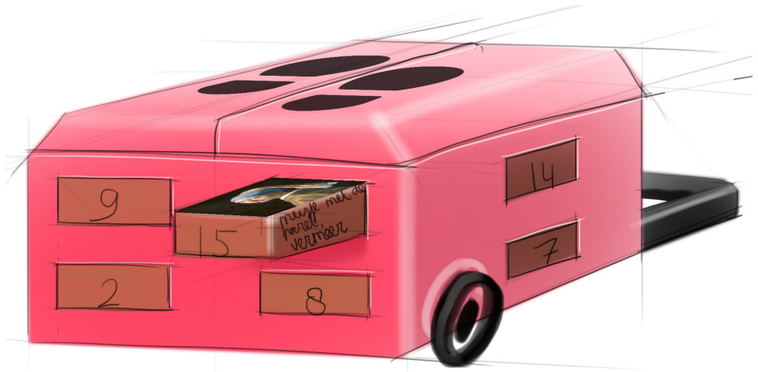
Approach
Some more How To's are done and a Morphological Chart is made based upon the How To's of both the group –and individual ideation session. Furthermore the Synectics method -and the Free Association method are used.

Results and conclusion
For all results, see Appendix A23. The ideas that came about during the individual sessions can be seen as ideas 7-20 in Appendix A25.

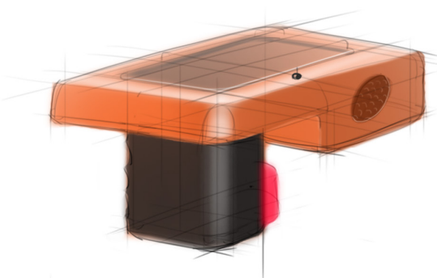
4.3 Idea clustering.

The generated ideas are clustered into five idea clusters:

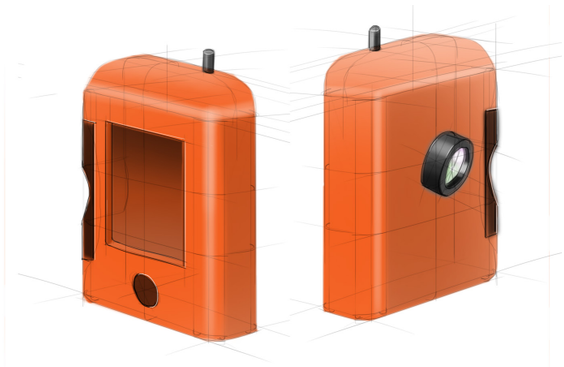
1. The Cart:
A trolley that can be used as step-up for children to better watch paintings. It has drawers that correspond to a room. Each drawer houses objects that enrich the art in the room (like a blue scarf for 'Het Meisje met de Parel').



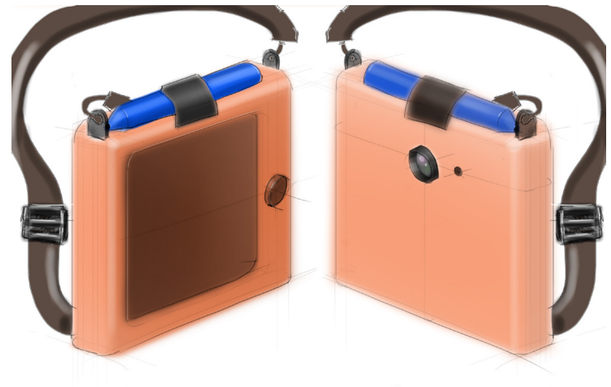
2. The Torch:
A device that can be held by one family member at a time. It guides the family through the museum and indicates potentially interesting places to discover. The location can be scanned and an assignment with information will occur.



3. The Mystery:
A device that guides families through a themed (fantastic) story of the museum. During the tour, modifications to the museum are shown on the device. In these fantastic, modified rooms mysteries need to be solved, for which hints can be obtained in the building, paintings or from security. Solving a mystery comes with a (part of a) price.

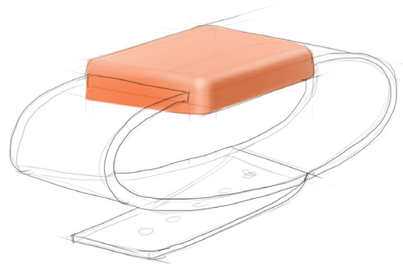


4. The Sieve:
A device then enables families to digitally explore paintings (techniques and the stories behind the paintings). It enables playing / experimenting with compositions, light, colour and layers of paint on the device, while seeing the actual painting in real life. At the end of the visit, the family can make a (3D printed) family portrait and use the techniques which they have learned during the experimentations.



5. The Rope:
A wearable that measures an individual's route and interests inside the museum (based on GPS and heart beat for example). The wearables of all family members are connected, making the statistics of each other visible as starting point for discussions / changes of route.

See Appendix A26 for a more detailed explanation of the idea clusters and their fit to the vision (Chapter 2.6).



4.4 Idea choice.

The idea clusters are tested on multiple wishes from the Programme of Requirements in a so called Harris Profile. The explanation of this tool can be seen in Appendix A27.

Even though the personal favourite idea cluster was the Mystery, this idea cluster initially did not fit best to the vision as can be seen in Figure 7. Therefore it is modified into a suitable concept.

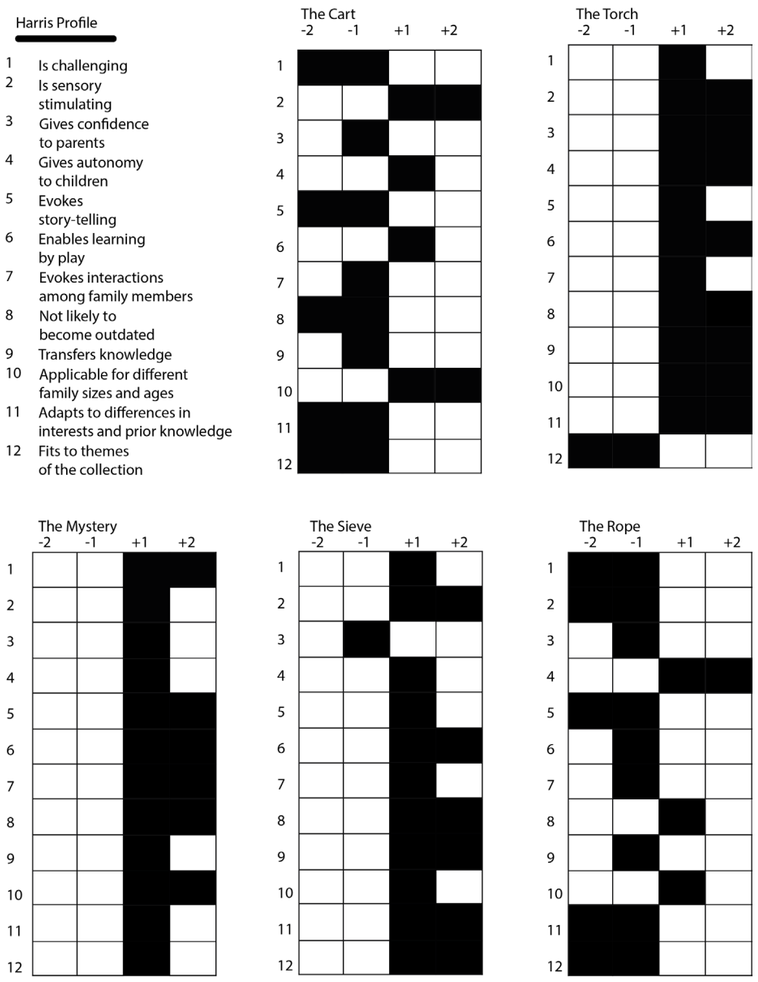
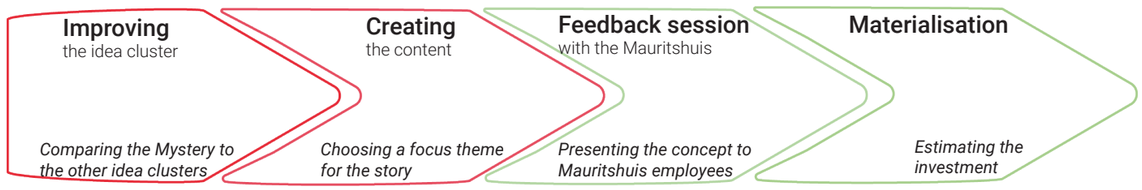


Figure 7. The Harris Profile.

5. Conceptualisation

The Mystery idea cluster is developed into the Mystery Game concept. This is done in several stages:



5.1 Improving the idea cluster.

In Appendix A28 the comparison between the Mystery idea cluster and the other idea clusters can be found. Some improvements are mentioned. In short:

- More sensory stimuli: The Mystery Game gets different kinds of interactions during its use, like group –and individual interactions, draw -, search -, listen -, make -and discuss assignments.
- More autonomy/confidence for the family: The Mystery Game directs families to locations of a mystery (GPS points) and sensory hints are given when the family is nearby a solution (vibrations of the device for example). Also, failing a mystery is (nearly) impossible, as there are multiple ways to get to the right solution of a mystery.
- Improved knowledge transfer about the Mauritshuis: The Mystery Game lets people do assignments that have a focus on one theme (not necessarily the collection). Hints can be received through consulting the collection.
- Adapt to differences in age, knowledge and interests: One overarching theme should be chosen by the family beforehand. Families can decide if they want to solve a specific mystery or not. The kind of mystery that could be done can be seen beforehand (individual / group, drawing / searching / discussing etc.). The family can have an own interpretation of educative themes.
- Adapt to differences in energy level: The family could indicate how much time they like to spend on the Mysteries, or can quit the game whenever they want.
- Maintenance friendliness: The Mystery Game can be linked to paintings and the rooms through sensors, to keep its content updated. Also, only the highlights (paintings) are used for the contents of the concept, as these are less likely to move places or leave the permanent exhibition.

5.2 Creating the content.

The different idea clusters had different possible focusses of contents:

- The collection (mostly the Cart and the Torch);
- The building (the Mystery);
- Painting techniques (the Sieve);
- The visitor itself (the Rope).

Based on the research outcomes it is decided to make a family choose one of the themes to continue with during one visit.

5.2.1. The building

The chosen focus theme for the development of the concept is based on the research outcomes that directed towards an interest in the building:

- From the generative session it was found that the building is seen as one of the most important artefacts of a museum besides the collection of the museum (many children noted that the Mauritshuis is partly underground and other memories about the building were mentioned);
- From the interview with a parent it was found that the Mauritshuis building looks chic, which makes parents hesitant to go to the Mauritshuis with children;
- From interviews with Mauritshuis employees it was found that they are proud of 'their' building.

The stories behind the building are researched to get a base for the storyline of the concept. The complete research can be found in Appendix A29. Some stories are emphasized in Appendix A30.

5.2.2. Room 12

For the development of the concept it is chosen to only focus on the stories of room 12 of the Mauritshuis, as these stories seemed to both fit well and completely resonate with the 'chic' Mauritshuis of current time:

- The big room on the upper floor used to have a dome that could not be seen from outside. The dome provided southern light to enter the big room. The light enabled to see the Brazilian exhibition that was shipped from Brazil by Johan Maurits. This story indicates that, although the Mauritshuis was originally a house to live in, it was also once used as museum like nowadays.
- Johan Maurits hosted parties in the big room. The dome was thereby used to let musicians play music. During some parties dance shows were given by (scantily dressed) Indians. Johan Maurits shipped these Indians from Brazil.

Based on the stories and knowledge about past contents of the Mauritshuis, a reconstruction of before it burned down in 1704 can be made. This reconstruction helps to make families with children immerse in the 'goldmine', as appointed in the vision (Chapter 2.6).

5.2.3. The Mystery Game narrator

In order to take families through the stories of the building, a central narrator is chosen.
The narrator of the Mystery game is chosen to be a parrot. The parrot was part of the exhibition in 1644 as mentioned by an eyewitness (Appendix A29) and generally the nature of parrots is to talk and get old. This matches the aim of the concept to tell the stories of a long time ago. Additionally, the parrot has the mouse as natural predator. This fact can be mingled with the story of Maurits Muis, the mouse that the museum already uses to tell stories to (young) children (see Appendix A31). Lastly: the parrot can be seen in some paintings inside the Mauritshuis (like "Het Aardse Paradijs" or "Soo voer gesongen, soo na gepepen") and this enables connecting the historic Mauritshuis story to the current exhibition too.

Appendix A32 shows a first version of the storyline of the Mystery Game. An overview can be seen in Figure 8.

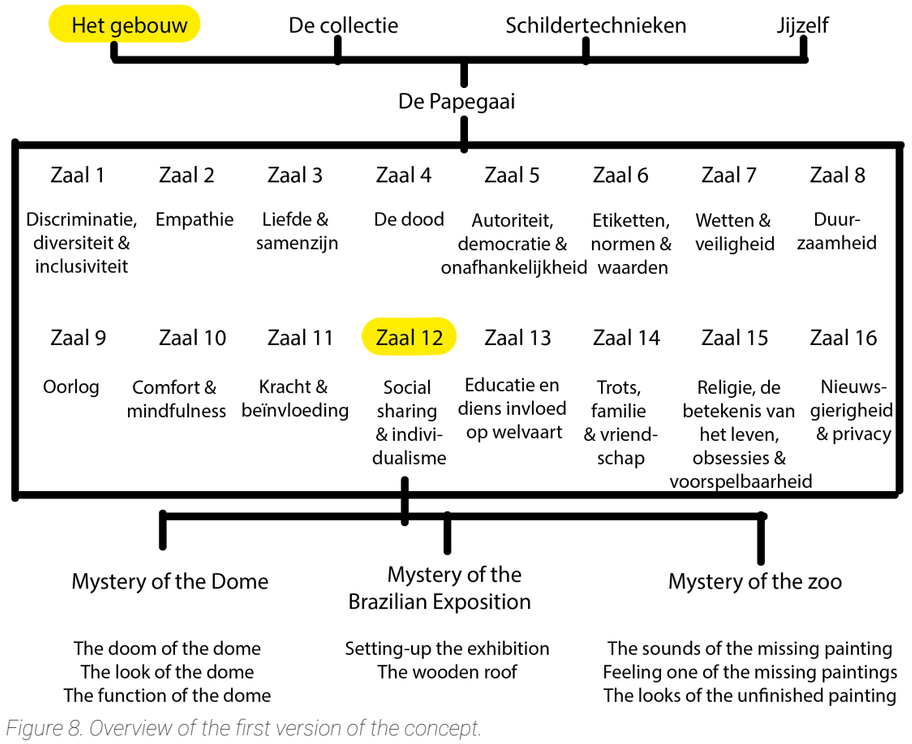


Figure 8. Overview of the first version of the concept.

5.3 Feedback session with the Mauritshuis.

A meeting with three Mauritshuis employees (of whom two participated in the idea generation session too (Chapter 4.1)) was organised in which the first version of the Mystery Game storyline (Appendix A32 and Figure 8) was discussed.

The presentation slides, the presented overview of the concept and the feedback results can be seen in Appendix A33.

5.3.1. Conclusions

The concept was seen as valuable because of its focus on the building instead of on the collection only. The employees foresee an improved and more comfortable visitor flow in the museum through the use of the concept. Also, the concept would be lower in maintenance compared to the current Family-do-Package, as it does not depend on the collection and could be picked up from a locker that automatically recharges it.

An addition to the concept is to rotate between family members to be in charge of the device, to give everyone a role and keep the family together. Also, the parrot got a name: Peter Parrot (Pieter Papegaai), to make it more personal.

The learning themes are left out, as the concept already is quite educative. Moreover, only one mystery is kept per room to keep a focus. The division of the three developed mysteries with eight assignments of room 12, spread over other rooms, can be seen in Appendix A34.

'The Mystery of the Dome' with the assignment 'The Function of the Dome' is chosen for room 12. The reconstruction for this room will be in augmented reality, to make the disappeared dome visible and tangible again. The other rooms will be reconstructed through videos, animations and drawings to keep the WOW effect of the use of AR in room 12. The assignments will be layered in difficulty, to be suitable for different ages. The painting collection will be included in the story of the assignment, as the collection remains an important part of the museum. Main curator Quentin Buvelot mentions that a small link can be found in that the paintings of room 12 (Appendix A35) are important landscape paintings, while in 1704 the room was stuffed with big Tiergarten paintings.

5.4 Materialisation.

5.4.1. The iPad and a child proof cover
It is chosen to let the Mystery Game be an application on a modern iPad Pro 11" with child proof cover (see Figure 9). Though iPads are not given to 'individual' visiting families in the Mauritshuis yet, iPads are already being used in the Maurits Muis program, making it a known medium to use for the museum. During the session with employees of the Mauritshuis (Chapter 5.3) it was found that the size and the weight of an 11" inch iPad (with cover) are no problem to use for young children aged 4-8 year. This is validated in Chapter 7 (Testing).

5.4.1.1. Security
In order to prevent the iPad to be stolen, the issuing of the iPad can be done like how the museum currently deals with theft prevention: lists with data of people that make use of the iPad.

Employees of the Mauritshuis noted that, due to the two entrances of the museum (one main entrance in the foyer and one through the Brasserie restaurant on the first floor), it is hard to catch leaving visitors in the act of taking an iPad with the use of the cameras and sensors. But it should be noted that visitors have to drop off large bags and jackets upon entering the museum, making it hard to smuggle away the iPad. Also, iPads have a built-in GPS tracking system that can help to find back a stolen iPad.

5.4.1.2. Functionality
The iPad is chosen as device, because it has all functionalities required for the concept: it can tell a story, make families connect with each other and can be connected to the museum building.

Storytelling
The iPad enables showing videos / animations and using augmented reality (AR). It can also make family pictures to eventually share online. During the mysteries the iPad can give (sensory) feedback, like vibrations or on-screen effects.

Connecting family members for family togetherness
The Mystery Game will only be usable on the iPads of / in the Mauritshuis and cannot be bought via the App Store on mobile phones. This is to ensure family members will not be tempted to continue the visit individually on their own device. One iPad can be shared among 2-4 family members and as mentioned earlier, in order to make them all engage in the mysteries, the individuals have to enter their names beforehand and the iPad will indicate who should be in charge of it at different moments in time. Not only for that, but also to be able to see the mysteries explained in the movies, animations and AR and to solve the mysteries the family needs to stay together.

Figure 9. An iPad 11" Pro with child proof cover.

Connecting to the building
The iPad can be connected to sensors in the building, enabling live location tracking of the family and giving them orientation. This also enables that a mystery can be started (automatically) when a family is in a specific room. Likewise, the information about location could be used to navigate the family to (quiet) rooms based on crowd sensing.

5.4.2. Sensors
Besides the iPad, which carries the application that tells / shows the story of the Mystery Game and enables families to participate in it, some sensors need to be used to support the functionality of indoor navigation based on crowd sensing.
The exploration of sensors for location tracking and / or crowd measurement can be found in Appendix A36.

5.4.2.1. Indoor location
It can be concluded that the potentially most feasible and accurate technology for indoor navigation is Apple's ARKit. The iPad could either make use of recognizing markers inside the building with its camera (like a sticker of Peter Parrot once every 50 meter, or a specific painting in each room, like The Bull), or use the existing Wi-Fi infrastructure of the Mauritshuis. Together with radio frequency (RF) signals between the iPad and the Wi-Fi access point the position of the iPad can be determined. Through connecting the received data to a map of the building on the Cloud, the location can be rendered and send back to the iPad to make families view their live location.

5.4.2.2. Navigation based on crowd detection
For crowd detection the CCTV security camera in each room of the Mauritshuis could be used. If the camera images are updated in real time and connected to a Cloud, an algorithm can be designed to measure the amount of people on the camera images and determine the crowd in a room. Through connecting the live location of the iPad to this algorithm, a nearby quiet location can be searched to make the family navigate to it.

5.4.3. Cost price and investment
The concept requires some investments in hardware, software and labour, but the investment requires little maintenance costs / work: the application does not become outdated after each use or changes to the exhibition (in contrast to the Family-do-Package). Also, it should be noted that the investments will not only be for the good of the proposed concept, but also for the functioning of the museum as a whole (think of crowd management and potentially navigation for all visitors).

For the overall concept an important factor to keep in mind is time: the implementation of the proposed concept is estimated to take about 2 years from finding a project team, developing the content, waiting for the technology to be feasible, testing it and finally implementing / using it.

For the exploration of costs for development of the concept, see Appendix A37.

5.4.3.1. Hardware
For the concept, fifteen new iPads 11" Pro with Apple guarantee and child proof cover are needed. Also, a new (smart) CCTV security camera might be needed in each room of the Mauritshuis for crowd sensing. Altogether this will cost about **23370 euro**, but can be used for about 5 years.

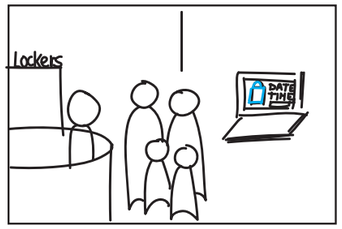
5.4.3.2. Software and labour
A project team should be composed, existing of an (internal) expert on the Mauritshuis building, a content writer, CAD model maker, illustrator, an application developer, UI designer and a software developer. This team will cost **about 100.000** euro for half a year, excluding the internal expert and eventual software licenses like Apple Developer, a CAD program and Adobe Creative Cloud.

In total the concept version 1 is estimated to cost **about 125.000 euro.** This estimation resembles the estimation of a version 1 app by Savvy Apps (2020), but they state that developing a professional tablet application is more likely cost **about 230.000 euro.**

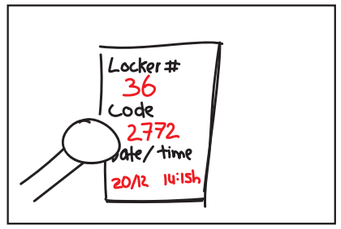
5.5 The concept from A to Z.

The content of the concept from A to Z can be seen on Pages 51-53.

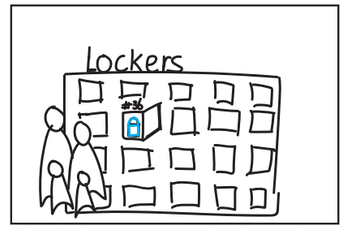
Note that the concept changed in content during the prototyping and testing stages of the project.



Either online or at the desk inside the Mauritshuis, a family can buy access to the Mystery game



When the Mystery game is bought, the family receives a code and locker number to pick-up the Mystery device



The iPad is automatically charged inside the locker

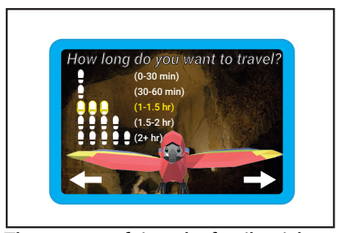
The Mystery device shows a screensaver (the painting: 'Resting Travellers' by Rembrandt)


When continuing, a movie starts in which Pieter Parrot enters the screen

Pieter Parrot introduces himself and asks for the names of the travellers that will help him to solve the mysteries

The family can fill in the names and add extra family members

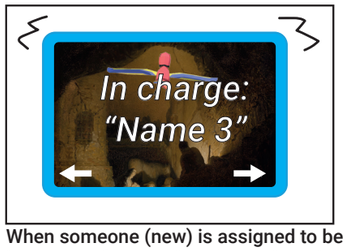
Per person the age is asked in order to automatically match assignment levels



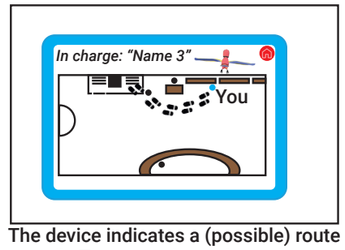
The amount of time the family wishes to spend on solving the mystery is asked

The overarching theme of the visit needs to be chosen by the family

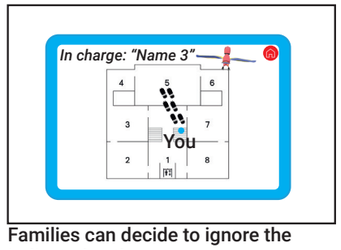
Pieter Parrot mentions that the device will indicate once in a while who should be in charge of the device during the visit



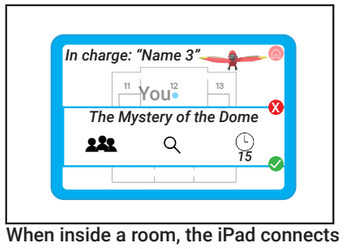
When someone (new) is assigned to be in charge of the device, the device will vibrate and the name will be shown



The device indicates a (possible) route to walk. The route depends on the time the family wants to spend on the Mystery game and crowds inside the museum rooms (measured by IR sensors)

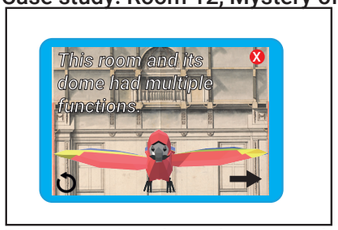


Families can decide to ignore the indicated path

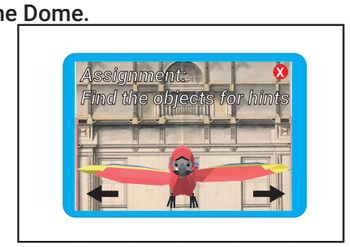


When inside a room, the iPad connects to iBeacons and the family gets the choice to solve a Mystery in that room

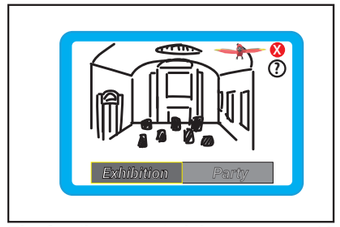
Case study: Room 12, Mystery of the Dome.



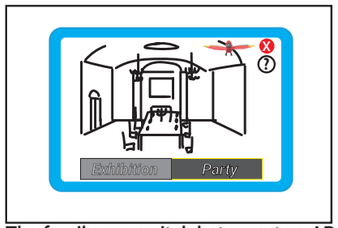
Pieter Parrot introduces the room and asks to solve the mystery: “What were two important functions of the dome?”



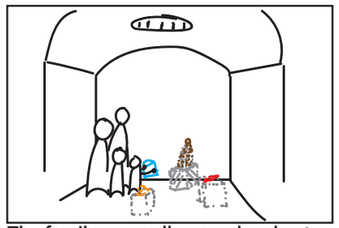
Pieter Parrot introduces the assignment: “In each AR mode objects can be found that hint about the function of the dome”



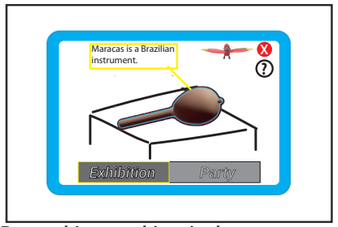
The family can switch between two AR modes. In each mode hints about the function of the dome are given



The family can switch between two AR modes. In each mode hints about the function of the dome are given

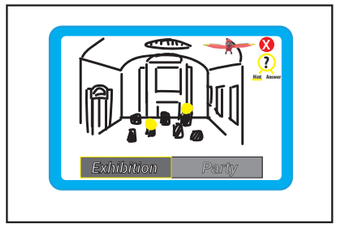


The family can walk around and get closer to the objects in the AR mode

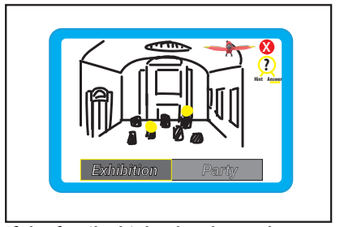


By touching an object in the screen, more information about the object will pop-up or a sound (hint) will be given

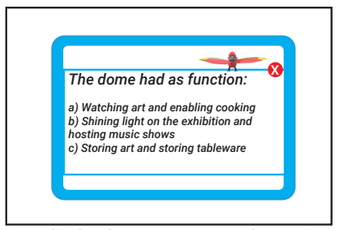
In some information texts hints are given (through asking a question that corresponds to the function of the dome)



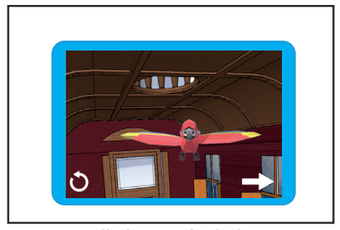
The family can ask hints about what objects they should explore. These objects will light up on the screen



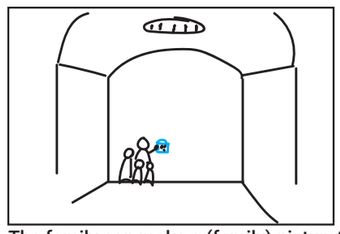
If the family thinks they know the answer or if they just want to get to know the answer, the answer can be asked



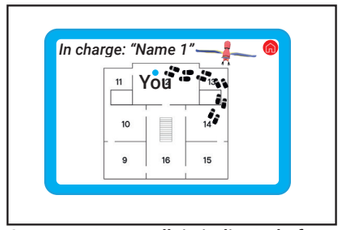
A multiple choice screen is shown in which the family can indicate what they expect the answer to be



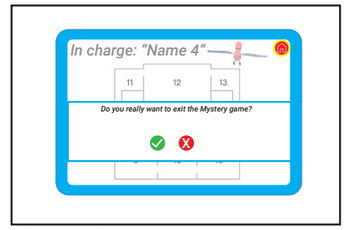
A movie will play in which the answer on the mystery will become clear through the memories of Pieter Parrot about the dome during exhibitions and at parties



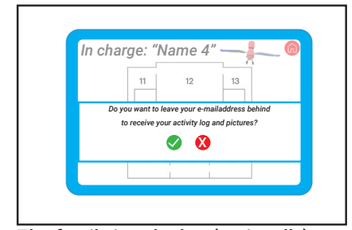
The family can make a (family) picture(s) in the room to indicate that they helped solving the Mystery of the Dome



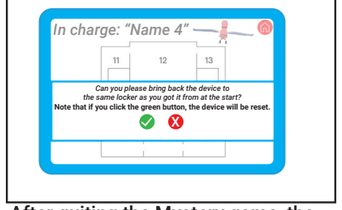
A new route to walk is indicated after a mystery is solved and the family can continue to solve other mysteries



When the family wants to quit the Mystery game, they can push exit



The family is asked to (optionally) give their e-mailaddress to receive the pictures that they made on

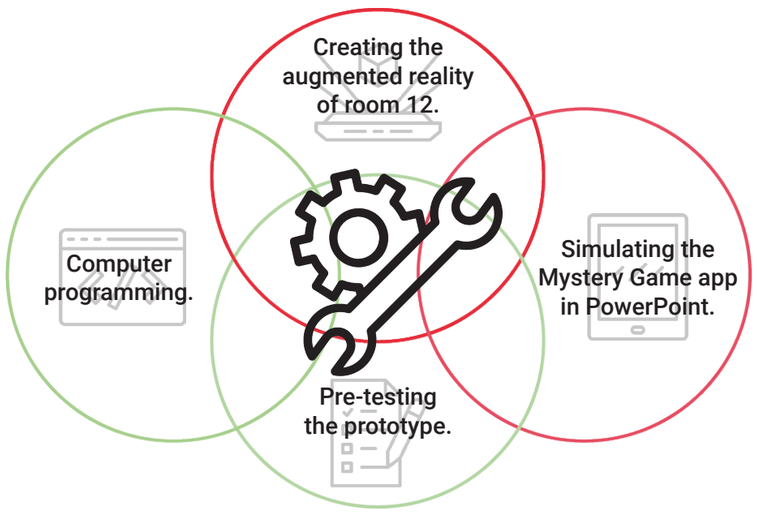


After quiting the Mystery game, the family is asked to bring back the device to the same locker

The Mystery device sends the family log to the e-mailaddress and resets itself to be ready for the next use

6. Prototyping

In order to be able to test the main functionalities of the concept (immersing in the story of the Mauritshuis building of the past and being guided through the museum) a prototype / proof of concept is made. The prototyping existed of several stages:



6.1 Creating the AR of room 12.

To be able to test if families will immerse in the story of the Mauritshuis of the past, and as a proof of concept, the AR environment of room 12 (of the year 1644-1704) is made. First a model of the historic room is made in SolidWorks. After that, the outlines of the room decorations (as seen in the drawings of Pieter Post, Figure 10) are copied and all parts are exported to Maya to be given a realistic material finish. The materialised parts are imported into Reality Composer and objects are added to complete the room. The final model(s) of the AR can be found in Appendix C.

6.1.1. SolidWorks modelling

First the outer sizes of the actual room 12 are taken and reconstructed in SolidWorks. After this the set of drawings by Pieter Post, see Figure 10, are attached to the walls in the model with a ratio close to 1:1 and taken as base for the reconstruction of the interior. See Figure 11 for the SolidWorks model.

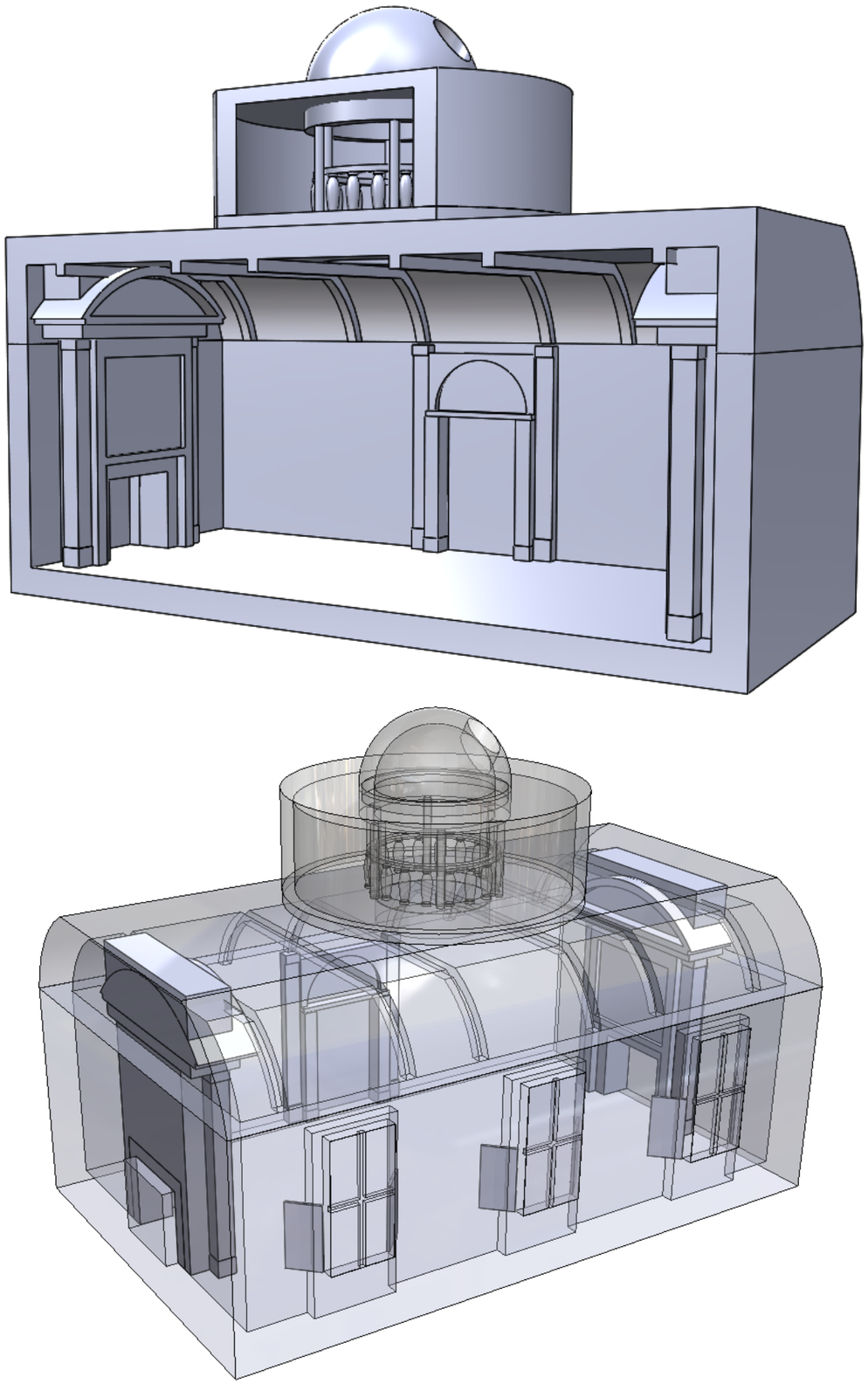


Figure 11. SolidWorks model.

6.1.2. Creating decoration outlines in Photoshop

The decorations of the interior (on the chimneys, door, ceiling and dome) as seen in the drawings of Post (Figure 10), are redrawn in Photoshop, see Figure 12. As the dome is curved, its decoration outlines are an estimation of how they would look like flat, before being 'pasted' on the curved surface of the 3D model of the dome.

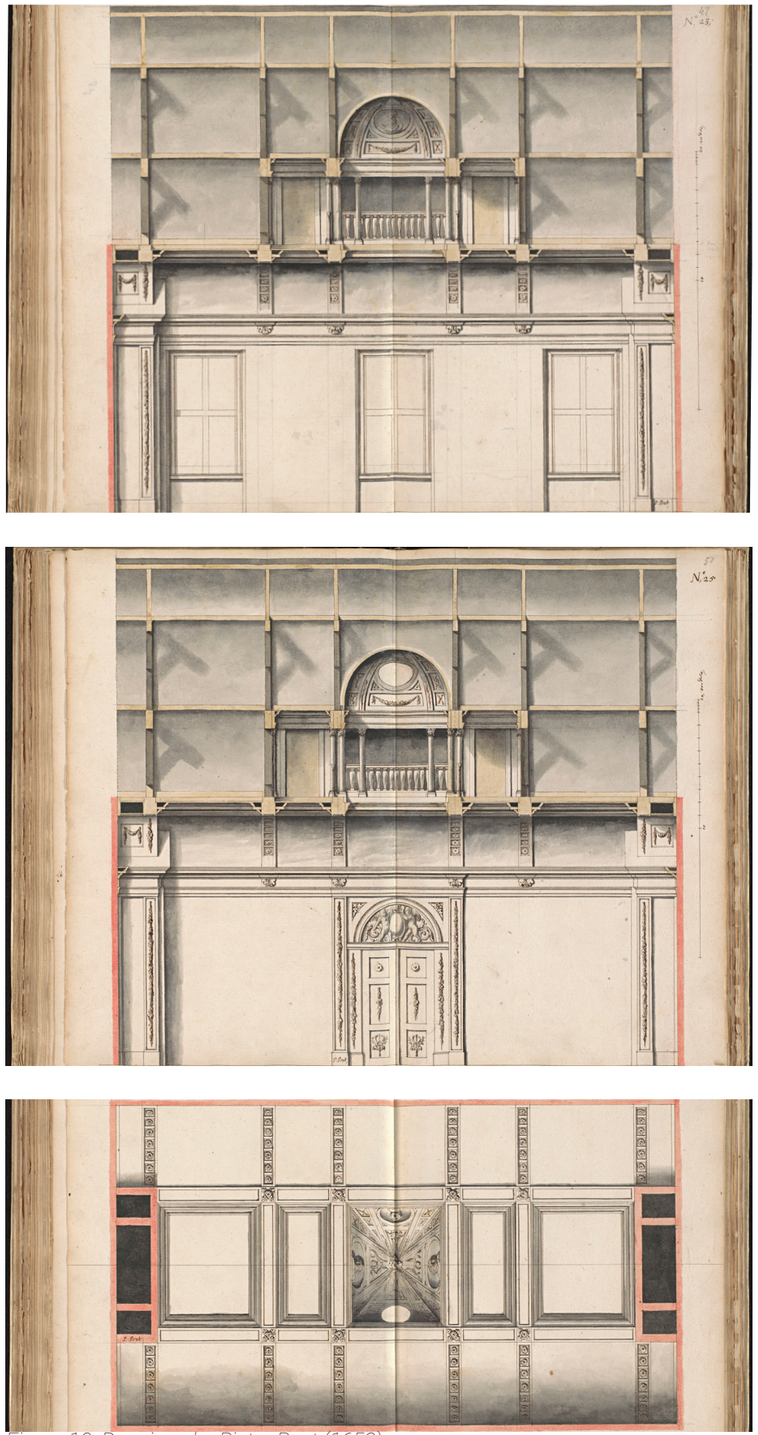


Figure 10. Drawings by Pieter Post (1652).

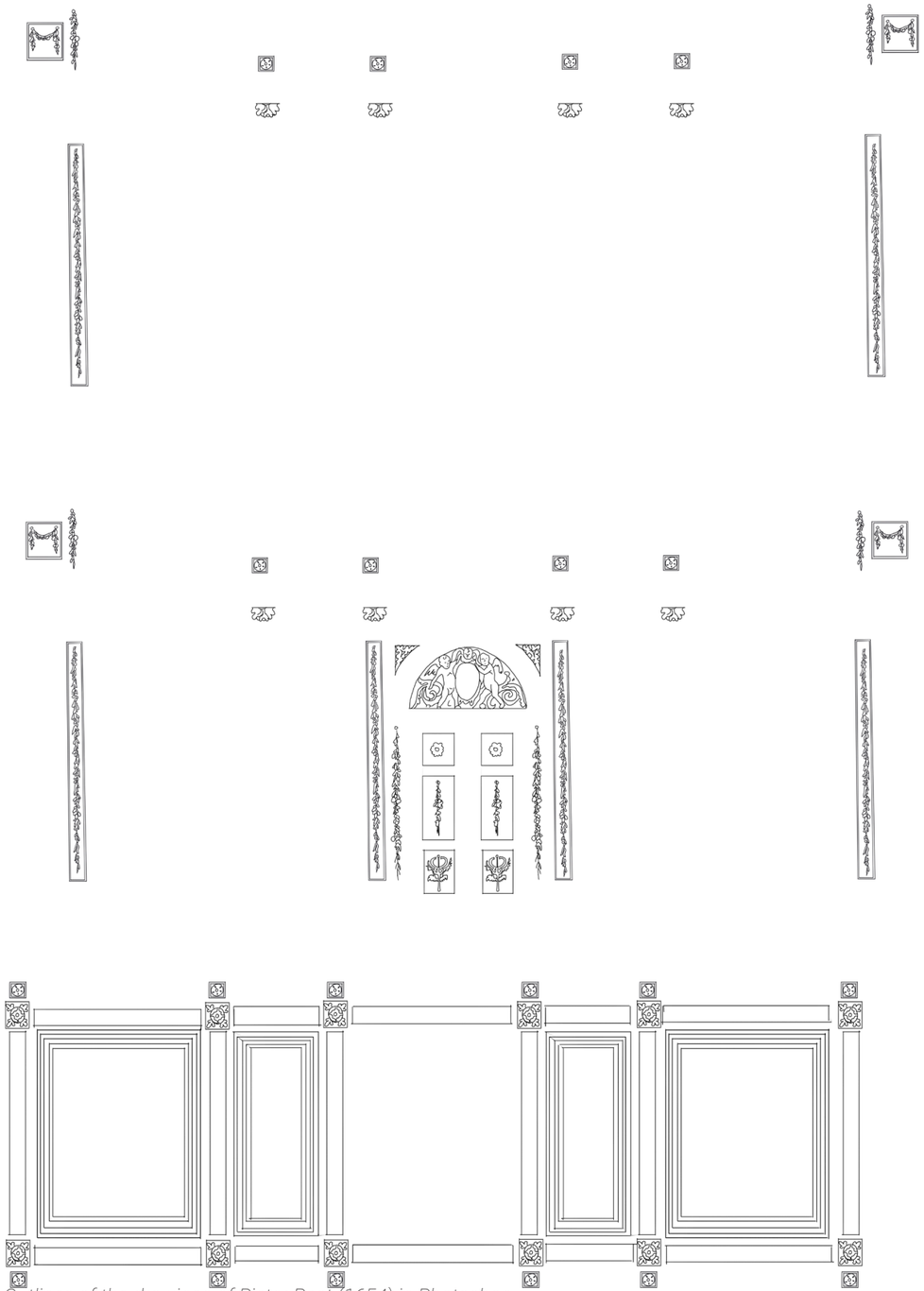


Figure 12. Outlines of the drawings of Pieter Post (1654) in Photoshop.

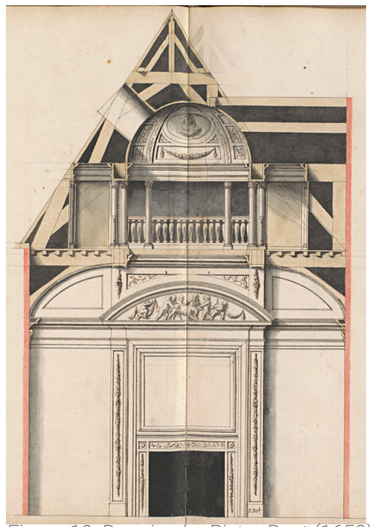


Figure 10. Drawing by Pieter Post (1652).

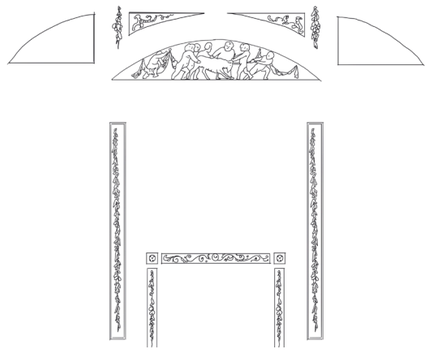


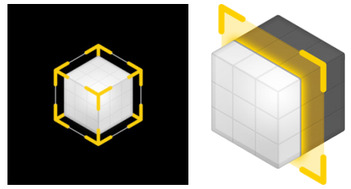
Figure 12. Outlines of the drawings of Pieter Post (1652) in Photoshop.

6.1.3. Creating material appearances in Maya

Arno Freeke, head of the VR zone in the TU Delft Library, is asked to materialise the SolidWorks models in Maya. Maya software enables giving models a realistic material appearance. Maya has a material and texture database, but own images can be imported, adjusted in colour, roughness, metalness, normal map etc. and put onto the models too.

6.1.3.1. Surface selection
From the imported SolidWorks models, Arno selected only the visible inner surfaces in Maya. By deleting all surfaces that will be invisible for the user of the AR (like the outer walls and backsides of the chimneys, door and columns) the file size is optimised for export.

6.1.3.2. Individual surface control
Maya copies all surfaces of a model part individually and eventually flattens curved surfaces, as of which an example is the dome (see Figure 13). By having all surfaces of one model individually, they could be orientated on a material surface in the right direction. For example: both the dome and the ceiling beams had wood as material, but the wood nerves follow a circular direction for the dome and a straight direction for the ceiling beams. Also, the lighting on -and roughness of the materials are made to fit logically to the surfaces.



6.1.4. Converting models to Reality Composer

The output of Maya were .fbx files of the models, with .png images of the corresponding material maps. See Appendix A38 for the explanation about the conversion of the models into .USDZ files for Reality Composer.

The .USDZ files are imported and located in Apple's Reality Composer software, see Figure 14. As the narrative of the concept tells the story of two functions of room 12 (an exhibition –and party room), some models to put in the rooms are searched via SketchFab (a free model platform) and from the Reality Composer model library. The two versions of the room with the models can be seen in Figures 15 and 16.

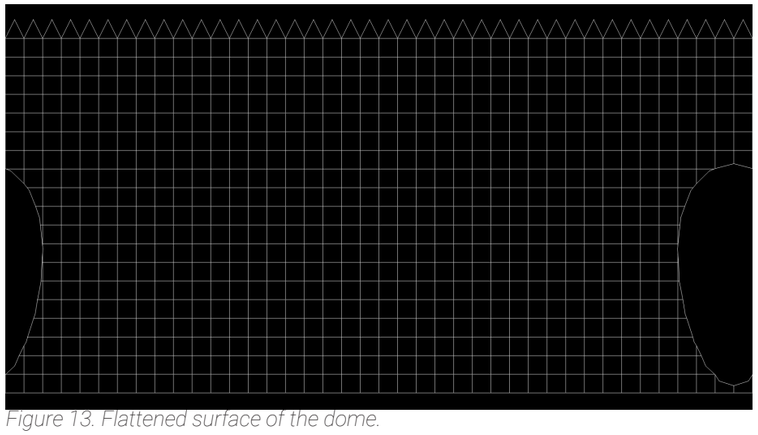


Figure 13. Flattened surface of the dome.

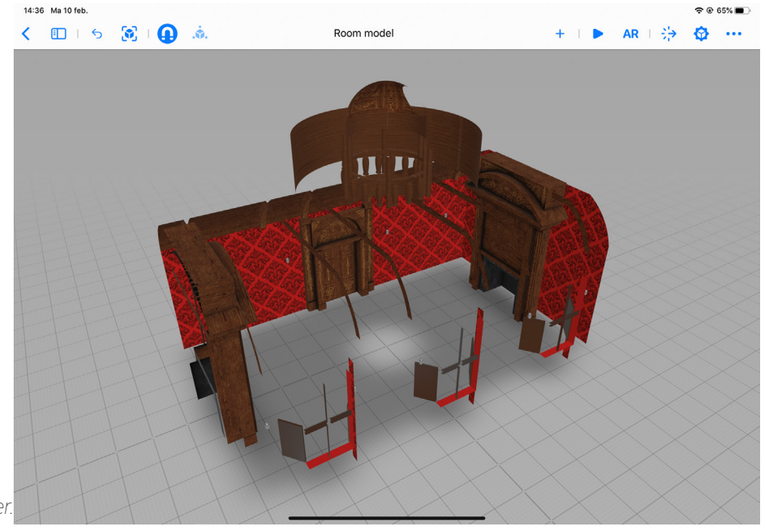


Figure 14. .USDZ files in Reality Composer.

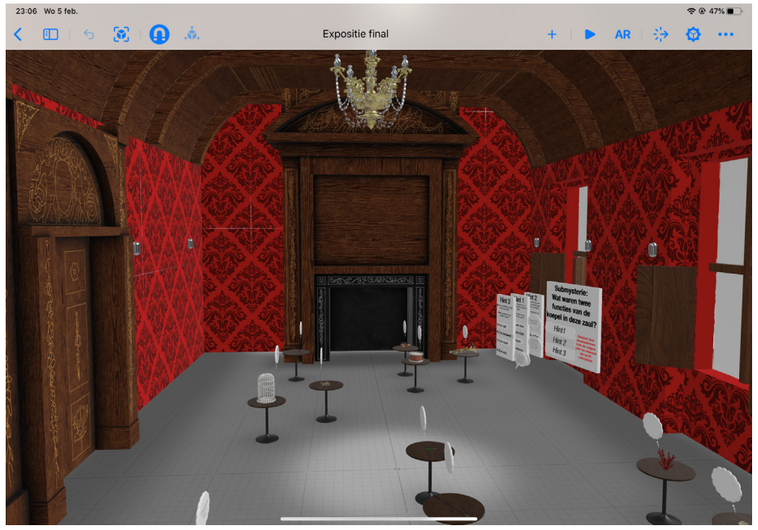


Figure 15. The exhibition room in AR.

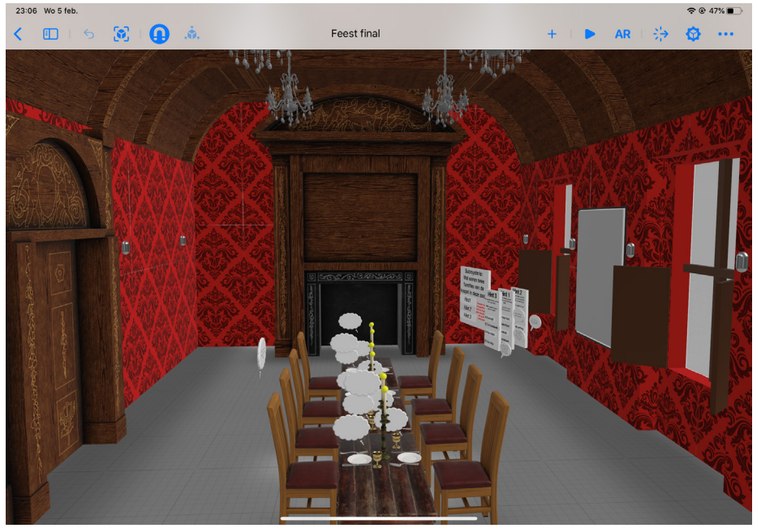


Figure 16. The partyroom in AR.

6.2 Simulating the Mystery Game app.

To be able to test the perceived relevance of the storytelling guidance the concept provides and to make the family (who will test the concept) understand the context of the use of the AR environment, a part of the application is simulated in PowerPoint.

The application prototype is a simplified version of the final app and misses some functionalities. For example: videos / animations, sensory effects like vibrations and the live AR navigation are left out and only simulated by still screens. Also, the family will not be able to identify themselves in the application (through filling in their name and ages) and do not have a freedom of choice (only the Mystery of the Lost Building and a use of the Mystery Game of 30 minutes can be chosen).

Some screens of the final application can be seen in Figure 17. The complete final version of the simulated application can be seen in Appendix C ("mh app V3").

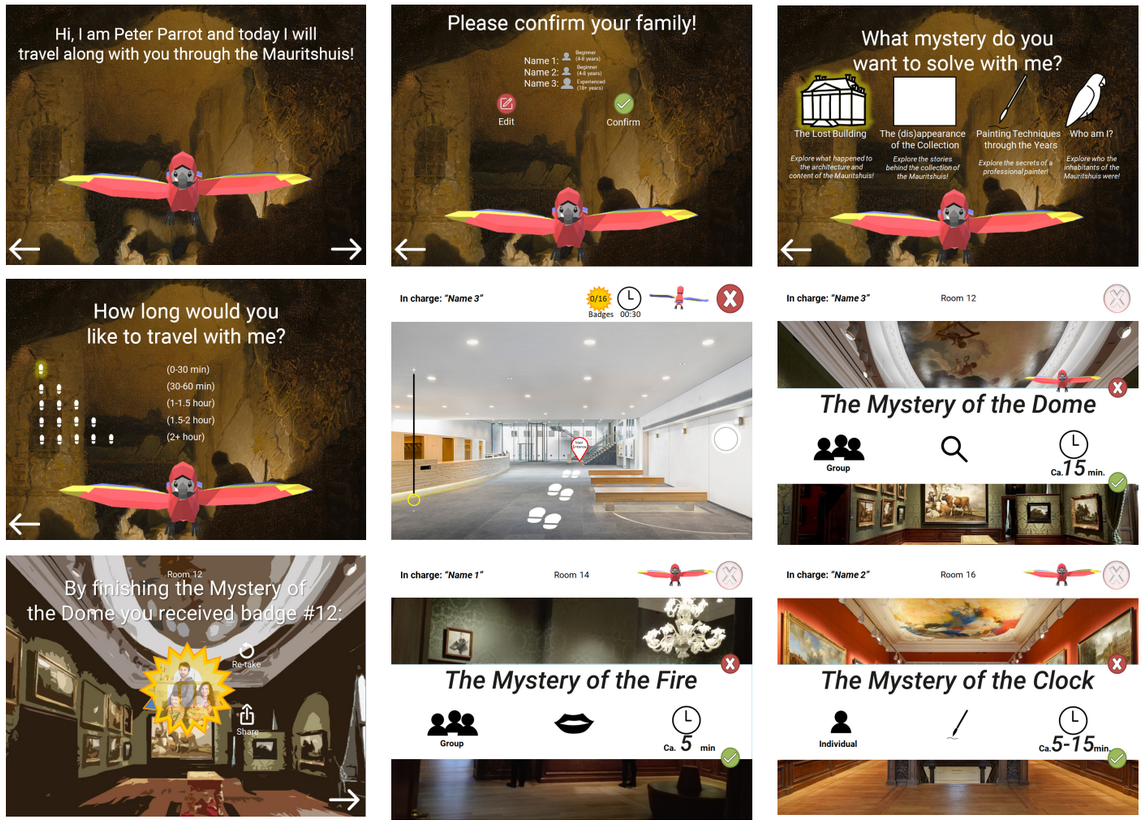


Figure 17. Some screens of the final application.

6.3 Pre-testing the prototype.

Before the aforementioned final application –and AR prototype came about, the prototype was tested by myself and (temporary) employees of the Mauritshuis. On both the application and AR some iterations took place based on the results of the tests. See Appendix A39 for the explanation of the pre-tests and the results.

Based on the tests the main iterations on the AR were:

- The floor is left out of the model and the walls are made somewhat transparent in order to see the current room 12 and its paintings through the model. This makes the user experience the AR model more as a layer over the real world than completely losing the real world.
- More animations are added as feedback and enrichment of the story.
- Instead of taking the floor of room 12 as calibration target for the AR model it is chosen to take the painting 'The Bull' of Paulus Potter. The painting is always clearly visible through lighting, which is important for the technology to work. The painting does not move places often (due to its size and because it is a highlight of the museum), making it a clear target to instruct families about where to start calibrating the AR and enabling fixing the AR model based on the coordinates of the painting.

Scanning the painting will be less effort for family members than having to scan all corners of the room and risking that it will not work due to technology issues. Besides, including The Bull in the Mystery Game ensures the collection is included in the concept too.

For the development of calibrating the AR model upon scanning the Bull painting, see the next chapter.

The main iterations on the application were:

- AR indoor navigation is chosen as guiding tool through the interior of the museum, as it gives families more security about their location, orientation and direction then when using a(n offline) map.
- As a prize of solving a (sub-) mystery a personalised family badge will be received that can be (proudly) shared with other people. This is also like a proof for others and can potentially attract them to visit the Mauritshuis too.
- The permanent painting collection is included in the hints and/or answering of the (sub-)mysteries, to make families live in both the real –and augmented world at the same time. By answering questions about the collection, the family has to look at the paintings. Sharing knowledge about the collection was seen as an important part of the mission of the museum.

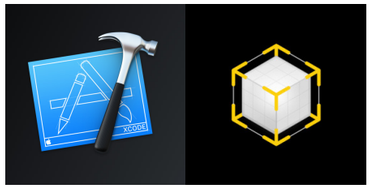
See Appendix A42 for the new hints for the sub-mysteries in the three rooms which were developed in the prototype of the application.

6.4 Computer programming.

The AR development program (Reality Composer) recognizes two types of AR display:

- Placing an AR model in the existing world: the user can scan a floor and based on that the model will display. Changes to the floor, like movements, or a change in orientation do not affect the scene (thus the model stays the same on a sailor ship that changes directions and fluctuates due to waves).
- Coupling the AR model to an image: the user can scan an image. The image should remain in camera sight of the iPad, or it will disappear. Changes to the image (like moving it) make the model follow.

For the concept a combination between the two types of AR were needed: scanning an image (painting) to automatically orientate the model in a room (room 12) and keeping it anchored even though the image is not seen by the iPad camera anymore. To enable this functionality, the computer programming language Xcode needed to be used.



6.4.1. Xcode and Reality Composer

Both the software (Reality Composer) and the computer programming language (Xcode) are new: the release date of Reality Composer is June 3, 2019 and the release date of the most recent / stable version of Xcode is April 19, 2019. Also, both are not commonly used in professions yet (compared to JavaScript, PHP, C++, Python etc.), but Luuk Goossen of the VR Zone at the TU Delft was found and asked to help with writing the code. As for him the software and coding language were also quite new, the focus was on anchoring the placement/ orientation of one AR model after scanning and not the functionality to switch between the exhibition –and party room model.

6.4.2. Result

For the programming code, see Appendix C ("Xcode").

The code worked as can be seen in Figure 18 and the attached video (Appendix C, "Proof A"). However, the code only run when the iPad was wired to the iMac computer of the VR Zone at the TU Delft and thus could not be tested in the Mauritshuis (Appendix C, "Proof B" shows that it did not work without a wire).

6.4.3. Conclusion

The issues with the code were beyond control and it was a matter of time and updates to make the code work. Therefore it is chosen for go back one AR version and calibrate the model based on the floor. During the test with the family this had to be done by me and hope was settled that the AR model would not 'walk' away after being calibrated, due to issues with lighting inside the room.

Figure 18. The programmed code to project AR after scanning The Bull painting.

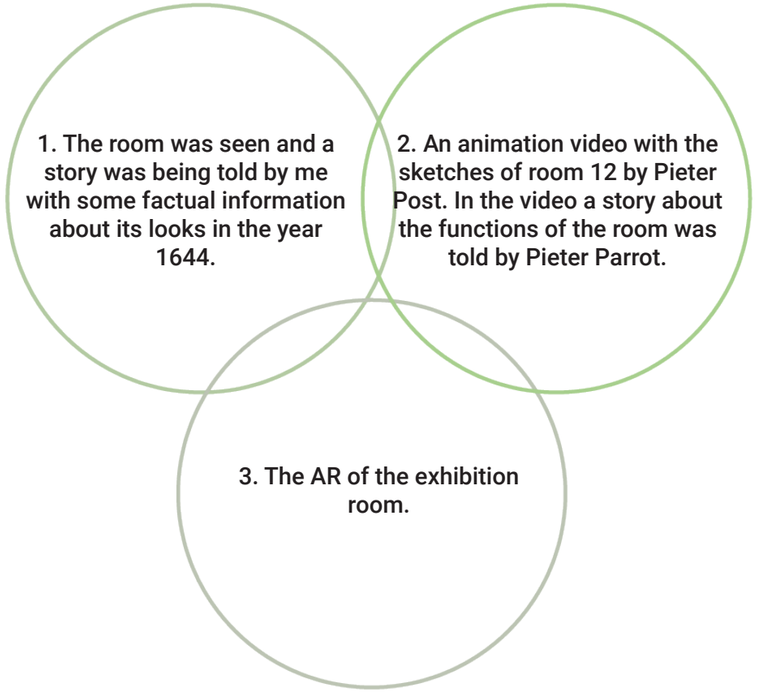
7. Testing

The final prototype version of the application (Appendix C, "mh app V3") and AR (Appendix C, .rcproject / .reality files) are tested with a family inside the Mauritshuis in order to evaluate the relevance of the concept. Note that the final application was translated to Dutch, as the tested family was Dutch.

The test existed of an individual part and a group part.

7.1 Individual test.

During the individual test each individual was taken to room 12 separately and was shown three versions of the room:



Per version a 7-point likert scale was used to ask the participant in three ways if the version was found to be exciting and vivacious.

The aim of the individual test was to get an indication on if the Mystery Game concept, which tells the story behind the building and makes families immerse in / explore room 12, overall would improve the museum experience of visiting families.

7.2 Group test.

During the group test the family was given the iPad and guided through three rooms (12, 14 and 16) to solve some mysteries. Observations were done during the test and an interview was held afterwards. The aim of this test was to get an indication on if the Mystery Game concept provided a relevant visit to the Mauritshuis and increased the perceived relevance of the Mauritshuis for families with children.

7.3 Results.

See Appendix A43 for the approach and results of the individual test and Appendix A44 for the approach and results of the group test.

7.3.1. Participants
The family that participated was Dutch and existed of one mother and two children (a girl aged 7 and a boy aged 9). The family participated on a Tuesday afternoon, after school time.

7.3.2. Individual test
7.3.2.1. Mean scores
The mean scores for the different variables for the three versions of room 12 can be seen in Table 1.

7.3.2.2. Notes
A selection of notes on why each version was exciting:
V1: as you get to hear something, but not everything (yet);
V2: because I did not know about the fire and what the parrot did in this room;
V3: because it is just fun to do.

A selection of notes on why each version was vivacious:
V1: because I think it is clever that so much information and details about ornaments is known;
V2: as it is more like watching a film than reading a book and thus there is less you have to think about yourself;
V3: as it is fun to move around [in the virtual space].

Table 1. Mean scores on three versions of room 12.

	Version 1 (story)	Version 2 (movie)	Version 3 (AR)
Stimulating	4.33	4.33	4.67
Activating	4.33	4.67	6.33
Exciting	3.67	5.00	5.00
Challenging	3.67	4.00	6.67
Renewing	4.00	4.67	6.67
Vivacious	4.00	4.00	4.00

7.3.3. Group test

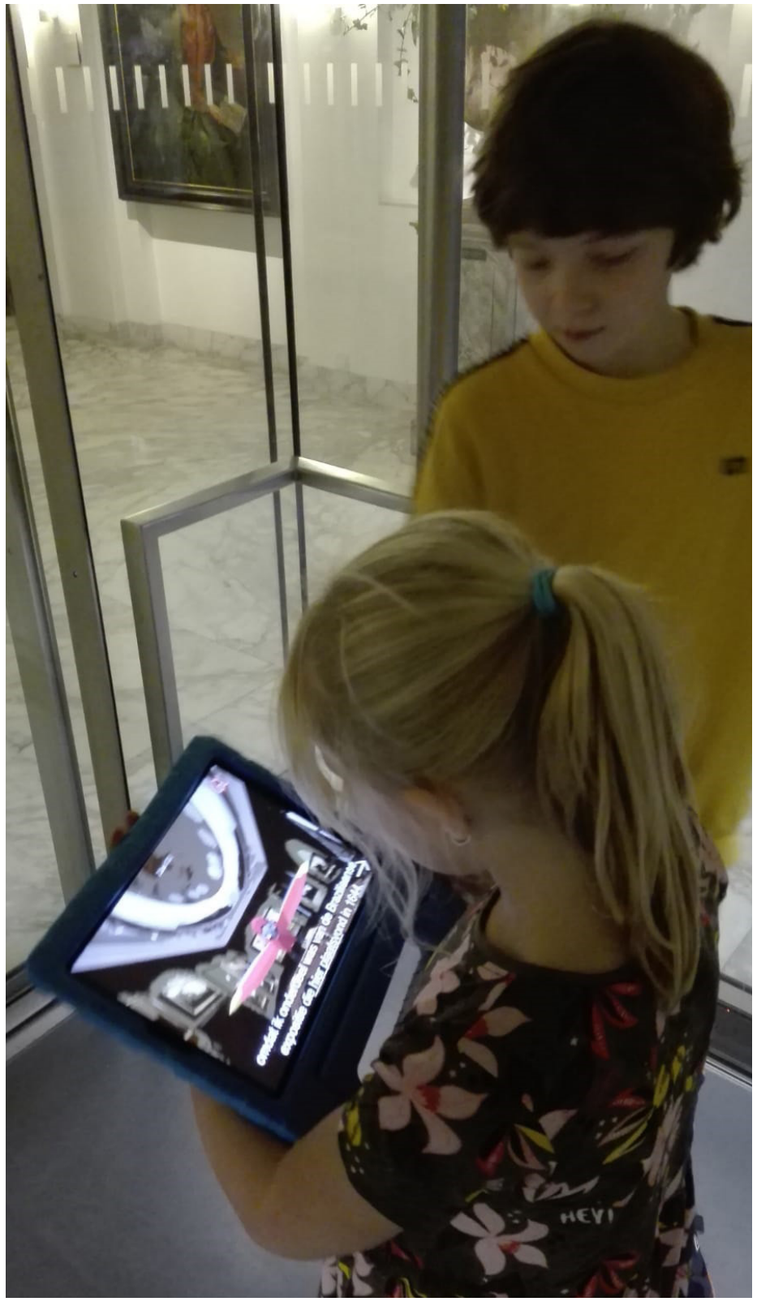
7.3.3.1. Observations

A selection of interesting observations are:

- Participant M is surprised / confused that 16 mysteries can be solved in either 30 minutes, or 2 hours.
- Even though participant M should be in charge at the start, participants D and K take the charge together. Later on, when participant D is to be in charge, participant K decides that now participant M can hold the iPad instead.
- The family pushes the first hint of the Sub-mystery of the Dome. Participants D and M walk around the room to look for a paintings with Haarlem on it. In the meantime participant K explores the AR environment.

- Participant K notices an object occurred in the AR of the dome. He figures out it is a pie. The family thinks they solved the mystery, but they are not sure what the answer was.
- Participants K and D sit down where they entered room 16 and read the story, to start drawing.

- Participant M asks if a family would be able to choose where to go themselves.
- At the end participant D restarted the application. With participant K she hopes to go into AR again.



A selection of quotes from the interview, that show the relevance of the Mystery Game concept, are as follows:

- **Wat vond jij van met de kinderen samen spelen?**

M: *"Het is wel leuk dat je zelf ook iets mag doen. En dat ze zeggen: nu ben jij aan de beurt. Want normaal bij zo'n speurtocht op papier is het altijd zo: de kinderen hebben iets en je loopt alleen te zoeken zeg maar, voor hun."*

- **Wat was voor jullie de beloning van het doen van het mysterie spel?**

D: *"Ik vond het leuk."*
K: *"Dat je uiteindelijk wel leert hoe je moet samenwerken als je normaal niet veel samenwerkt. En plezier. En ook een klein beetje meer informatie over welk mysterie je deed, van het gebouw bijvoorbeeld."*
M: *"Gewoon iets samen, gewoon even gezellig iets anders. Gewoon even erop uit. En dat ze bezig zijn in een museum. Dat je ze niet hoeft mee te slepen."*

- **Wat vind je van het Mysterie Spel?**

M: *"Dat is wel leuk, dat je dingen moet zoeken die er zijn. En dan, ik ben hier vaker geweest, hoor je weer andere dingen die je eigenlijk nog niet wist. En normaal ga je: oh ik wil dat schilderij zien, maar dan heb je er geen geschiedenis eromheen. Dus dat is nu je met hun meeloopt wel leuk om te horen."*

- **Wat vonden jullie van de keuzes die jullie konden maken tijdens het gebruik? Dat jullie bijvoorbeeld de routes niet zelf bepaalden?**

K: *"Dat vond ik eigenlijk wel fijn, want dan hoefde je geen ruzie te maken over welke we als eerste gingen doen. Er gaat dan ook niet veel tijd af van je eigen tijd. Het is ook wel iets fijner want dan krijg je eerder een eerste hint en badge en dan krijg je meer zelfvertrouwen."*

- **Wat vonden jullie het interessants van het bezoek?**

K: *"De belangrijke info en dat je moest rondlopen en uiteindelijk iets niet te doen had en dan naar de schilderijen kon kijken. En dat je uiteindelijk zelf een idee moest bedenken van hoe die klok er vroeger uit zag."*
D: *"De opdrachten vond ik interessant en de klok."*
M: *"Dat je stiekem allemaal dingen eromheen, die je normaal als je rondloopt niet hoort of ziet of leest, dat je stiekem meer info hoort dan je eigenlijk zou denken."*

7.4 Conclusions.

Since only one family was being tested, the test results are an indication and not an answer on the research questions. Still, the results helped giving a view on how the concept possibly improves the museum experience and make it more relevant to families with children. Furthermore the test resulted in some recommendations for improving the Mystery Game concept, see Chapter 8.

7.4.1. Improved museum experience

The main finding from the individual test is that the mean average scores on excitedness (stimulating, activating, exciting) and vivaciousness (challenging, renewing, vivacious) are overall higher for room 12 version 3 (the AR) than for version 1 (the factual story). Together with some of the notes that show emotional values of the participants about version 3 ('It is fun') it can be concluded that version 3 is a positive improvement compared to the current situation of the museum (no emotional response).
Also, since the mean scores of room 12 version 2 (the storytelling movie) were either the same or higher than the mean scores of version 1 (the factual story), it can be concluded that telling the story behind the museum is overall received more positively than hearing the facts about the museum.

7.4.2. Increased perceived relevance

The group test with interview helped to get an answer on if the visit was relevant for families through the use of the Mystery Concept and on if the perceived relevance of the Mauritshuis improved through the use of the Mystery Game concept.

Sub-question 1:
To what extend does the concept allow families with children to play (together) inside the museum?
From the observations it was found that from the start of the visit each family member took a role during the use of the Mystery Game and got involved by doing so. These roles shifted during the visit, with the help of the iPad: at the start when no one was in charge of the iPad yet, the mother took the role of giving the children each a fair turn or input (who should read, what mystery theme should we do). But later, when the iPad indicated who was in charge, the family members switched roles regularly. Also during the assignments the iPad was passed along. The hierarchy eventually even switched towards the children giving the mother 'a fair turn' and choice during the visit. During the interview the mother emphasized that she liked to play herself too and hearing her children tell her that it was her turn.
One of the children indicated that he learned more about how to collaborate. In the interview the mother indicated that the Mystery Game really kept the family together.
At the end the children wanted to do the Mystery Game again. This shows that the Mystery Game is liked by the children and would repeatedly make them play inside the museum

Sub-question 2:
To what extend does the family perceive the concept as being an acceptable visitor effort?
During the interview the mother mentioned that the Mystery Game helped keeping them busy. While the family normally would leave a museum like the Mauritshuis (which is not a children museum) after about 30 minutes, she would now stay longer or even come back more often because she notices the children are amused. She also mentioned that she herself did not think about time (anymore).
The children indicated that they liked the time spend and one child even mentioned it was challenging to try to do everything in the only 30 minutes they got.
During the observation it was seen that the children wanted to continue the Mystery Game, even though this was not possible (due to prototype constraints); they restarted the prototype and asked me to re-start the AR of room 12. The children did not seem exhausted, even though they visited the museum directly after school time.

During the interview the mother mentioned that, since they have a museum card, she likes skipping the lines at the ticket desks. Therefore she would not like to have to wait in line at the ticket desk to get the Mystery Game. Working with codes, that can be received online, to get access to a locker with an iPad when inside the museum would be a convenient option.

Sub-question 3:
To what extend does the concept enhance meaning-making?
During the observations it was seen that the Mystery Game made the family members gather around –and come closer to each other; the family started collaborating in finding hints, holding the device, reading texts and giving answers etc. The Mystery Game also made the children feel at home, as they started sitting on the floor to do the Sub-Mystery of the Clock.

During the interview the mother indicated to be happy to participate in the Mystery Game together with the children. She liked being cosily together with the children and not having to put effort in pulling the children with her. The visit enriched her knowledge about the museum history; she saw, read and heard new things that she normally did not see / read / hear (even though she visits the museum more often).
The children indicated that the Mystery Game was a mission; they had to remember things, investigate and they could see and do things. At the same time one child indicated that he liked the guiding aspect of the Mystery Game, as it ensured the family did not lose time with fighting where to go and what to do.
Also: receiving hints and a badge quickly gave more confidence.

At the end of the visit the mother asked if the results of the visit (eventual pictures / drawings) could potentially be send to the family (as a reminder).

Main Question:

What effect does the Mystery Game have on the perceived relevance of the museum for the family?

The concept made the Mauritshuis more relevant in terms of engaging all family members during the visit, resulting in family togetherness and collaborations.

The concept made families learn in a fun way while losing track of time. The concept even triggered the family to re-visit the Mauritshuis and spend more time at the museum: they wanted to tell others about it in a school presentation or invite other families to visit the museum together with them.

The Mystery Game gave confidence to both the children and the mother and made them feel welcome / at home. The experience was a lasting memory, of which the family wanted pictures as visual memory.

8. Recommendations

In this chapter some recommendations for further development of the concept are given.

Further researches

Due to limited time, the design is only tested thrice and only one of these tests was with the actual user group. Further testing with the user group and following itterations are recommended to better improve the usability and relevance of the product. Two more specific topics for testing would be:

- The impact on the usability of the concept with family sizes of four or more people.
- The effect of the concept on the perceived comfort of visiting families (due to the crowd dependent indoor navigation) and how families experience the product when using it in their full museum visit.

The app and AR

Based on the test with the family, some changes to the content of the concept were advised to make:

- Show beforehand how many mysteries could be solved in a chosen time;
- Explore how to incorporate that a family could decide upon some rooms or paintings they do not want to miss during the use of the Mystery Game in the given time;
- Ensure the standard museum rules are repeated at the start of the Mystery Game;
- In order to keep into account different levels of prior knowledge of individual family members, the Mystery Game could make someone in charge who potentially is most capable of solving the sub-mystery where the family is heading to;
- To make the Mystery Game more challenging / exciting, more effects could be incorporated in the videos / animation / AR. Also, a timer could be added to some of the sub-mysteries;
- To ensure a family will not automatically visit the same rooms at a re-visit to the Mauritshuis, the 'login travel code' could work. However, it should be noted that in order to make this work properly, the family should also have a password to prevent other families to continue with their personal code. Having a combination of log-in name (e-mail address) and password might also be easier to remember for a next visit (instead of the 'travel code' which has many numbers). To assure the family can still decide to visit a certain room, even though they visited it the previous visit, they should be enabled to indicate they would like to visit that room the current visit too;
- It could be interesting to alternate between reality and sur-reality through involving the actual physical building more in the Mystery of the Lost Building. For example through making the family look for a certain decoration in the architecture. Or hiding an object somewhere. It should be noted that the relevance of this is not tested;
- If all sixteen sub-mysteries of one main mystery are solved, the museum could think of some sort of prize to attract families to solve another main mystery, each of which have their own 16 sub-mysteries. (The main mysteries are: the Lost Building, the (Dis) appearance of the Collection, Painting Techniques through the Years and Who am I?)

Technology implementation

Automatic logging

In order to keep the Mystery Game updated with the content of the museum, mainly for the theme 'The Mystery of the Collection' that can be chosen by a family, it might be interesting to research the possibilities of automatically locating the collection in the museum. Potentially this could be done by using the CCTV cameras (which are also used for detecting the amount of people in a museum room) and writing an algorithm that recognizes the paintings in the room and feedback that to an online painting database. This would not only be functional for the Mystery Game concept or functioning of the museum, but also for the multimedia tour of the museum.

Collaboration with the TU Delft

Since the concept involves quite some new technologies, it is estimated that the implementation could take about two years before technology errors are solved and the technology becomes (more) feasible. It might be interesting to connect the Mauritshuis and the TU Delft to start scientific researches on the domain of relevance and the use of new immersive technologies in museum environments. This would save costs for the Mauritshuis for the development of the concept and at the same time help the TU Delft to develop technologies that improve museum experiences.

Simplified Mystery Game

If the technology does not work yet but the Mauritshuis wants to launch the Mystery Game concept, a simplified Mystery Game could be developed that likewise tells the mysteries / secrets / stories behind the museum (building, collection etc.) but only in videos / animations per room and without crowd dependent navigation. It should be noted that by simplifying the concept some values as found during the (user) research might get lost (like the demand for comfort and orientation inside a building).

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