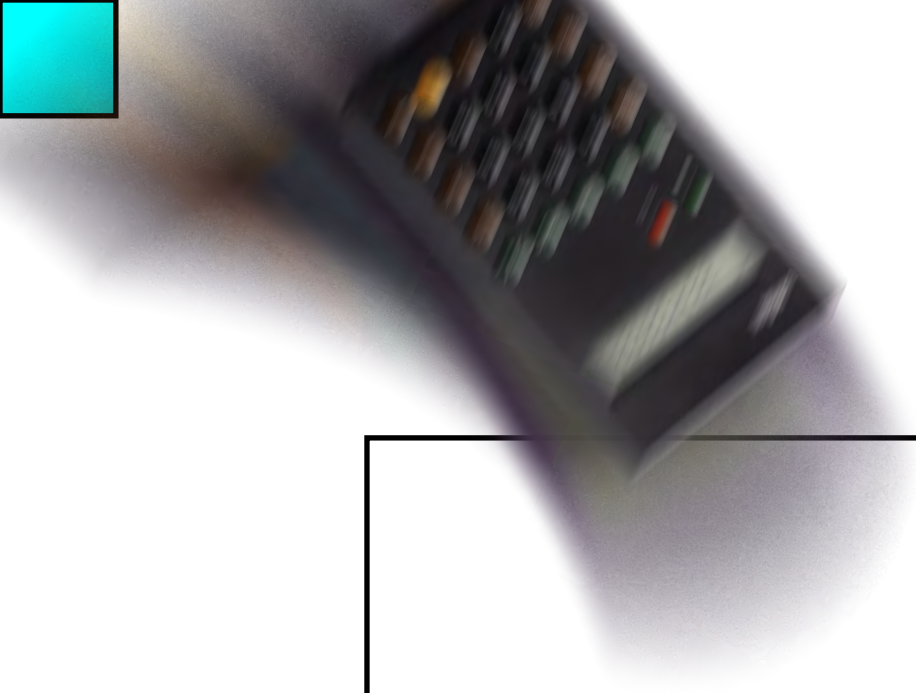
ARchive



by Mohamed Chajid

Delft University of Technology
Industrial Design Engineering
Msc. Design for Interaction

Graduation Master Thesis
July 2022

Supervisory Team
chair - Dr. ir. Elkhuizen, W.S.
mentor - Dr. ir. Vermeeren, A.P.O.S.

TU Delft Museum Futures Lab

Preface

This document is the report of my graduation project for the Design for Interaction Msc. at TU Delft, which concludes the two-year programme.
The graduation project started in mid-February and ended in mid-July of 2022. During this time I worked on exploring and researching ways to inspire and educate on Design Heritage students/museum visitors through AR.
The Industrial Design Engineering faculty and its students formed the context for the project.
This project was in collaboration with the faculty's Henri Baudet Institute, which manages a collection of Design Heritage products.

This project marks the end of my 5-year journey at the faculty, of learning about design and myself, towards becoming a designer.

This project was not performed in a vacuum, the people involved were crucial and I would like to thank everyone who helped directly or indirectly.

First off, I want to thank my supervisory team, for their consistent help, the open atmosphere and the great dialogue over this 20-week period.

Thank you to Arnold, for sharing your expertise on museum visits and sharpness in pushing the interactions to the next level.
Thank you to Willemijn, for your enthusiasm for technology during the project which was ever inspiring. Also for your critical eye, especially when it comes to research and novel technologies.

Secondly, I would like to thank the Henri Baudet Institue, for opening its doors and entrusting me throughout the project with the valuable artefacts.

This project had quite a few user tests and sessions, thank you to all the people who gifted their valuable time, by participating, for the sake of the development of the project.

A special thank you to my parents, who have been ever-entrusting and supporting, like always. A special thanks to my friends, for sharing their thoughts and sharing their comfort during this project.

A final thank you to the reader, for taking a moment to fully go through this report or skim through it. Either way, your attention is very much appreciated

Thank you all :) !!

Executive summary

Museums are places where the objects displayed are on a pedestal, often quite literally. These objects are found to be of such importance to be selected and displayed for thousands of people, tourists or purists, to see.
This experience of visiting an institution, viewing an almost sacred object you cannot touch, and reading the supplementary text, only goes so far. It is a long shot for trying to communicate the artefacts' deep backstories, to the visitors.
Could it be possible for this to still be achieved? By appreciating the institute's wants, respecting the artefact, but not sacrificing depth and interaction with the artefacts. What if a novel technology, Augmented Reality, was implemented, could that create that change?
This train of thought formed the conception of this project.

The Henri Baudet Institute(HBI) holds an archive of classic industrial design products, which it safe keeps for students at the Industrial Design Engineering(IDE) faculty, at the TU Delft, to learn from. The collection is quite vast, however, there is little to no interaction between students and the artefacts.
For this project, the IDE faculty and students formed the scope and target group. Herein the Henri Baudet Institute was a collaborative party.

The objective of this project is to explore Augmented Reality and in which ways it can deepen stories told about the HBI's artefacts, for the students to be inspired and learn.

First learning was delved into, to gain a better understanding of the activity and how it can be promoted(Chapter 2). Afterwards, Augmented Reality(AR) was explored, getting a better sense of how the technology works, including its strengths and weaknesses. Furthermore, existing AR projects were consulted to get a grasp of what has been done previously (Chapter 3).
The context, IDE faculty, was explored through user studies to discover how students interact with the artefacts currently and obtain insight into what they would like (Chapter 4).
More user research was performed in order to understand the nuances of the target group's wants, needs and dreams(Chapter 5).
The insights from these chapters were subsequently used to converge and create a solid frame and direction for ideation (Chapter 6).

Ideation and conceptualisation activities were performed to get a wide spectrum of ideas and try to push what is currently possible, with a focus on the interactions(Chapter 7).
Prototyping also played an important role in this process, together with iteratively testing with users to create a tight iteration loop.

These activities bore a fruit in the form of the final concept, which is presented in the form of a storyboard and visualisations (Chapter 8).
A prototype was built to evaluate the concept in context with the target group. Based on the results final recommendations were given(Chapter 9)

Index

INDEX

CH1: Introduction

In this chapter the background of the project is given, including the assignment and project approach.

Chapter spine
1.1 Background
1.2 Assignment
1.3 Augmented Reality
1.4 Context - HBI TU Delft
1.5 Target group
1.6 Project Approach

1.1 Background

Lots of us have a fascination for aesthetics and love to visit a place to discover art and design, a museum visit!
Imagine visiting an exhibition on product design classics, walking and seeing different products in different spaces. All of them are classic designs and had significance today. Each artefact has a small text label next to it, with the object's name, date and a few supplementary sentences.
Usually, you really like visiting musea and trying to interpret what the creative did, however this time you are not satisfied, you want more.
Why is this object so significant, what is its backstory and why is it relevant now?
These questions formed the conception of this graduation project.

Museums typically are seen as places where design and art are exhibited, changing throughout the year. This is true, however, there is a richer definition given by the International Council of Musea;

'' A museum is a non-profit, permanent institution in the service of society and its development, open to the public, which acquires,conserves,researches,communicates and exhibits the tangible and intangible heritage of humanity and its environment for the purposes of education, study and enjoyment. ''
(ICOM, 2022)

1.2 Assignment

The questions posed above acted as a catalyst for the project assignment.
The assignment set out to explore the dynamic between institutes, their archive, and visitors. how could we add depth to these stories told about these artefacts?

Early in the project, a vision was made, on how more depth can be added. Figure 2shows the current visitor-artefact interaction on the left, and envisioned on the right. Currently, it often is a one-way street, where visitors mostly solely consume information. The early vision proposes interactions to take place between artefacts and visitors, some sort of dialogue.

A key element in this explanation, and (part-) means on how to achieve such is Augmented Reality(AR). This technology was chosen based on its potential, personal interest and the posed future vision. More on AR in the upcoming section.

Figure 1: Young adults in Museum (MET museum, 2022)

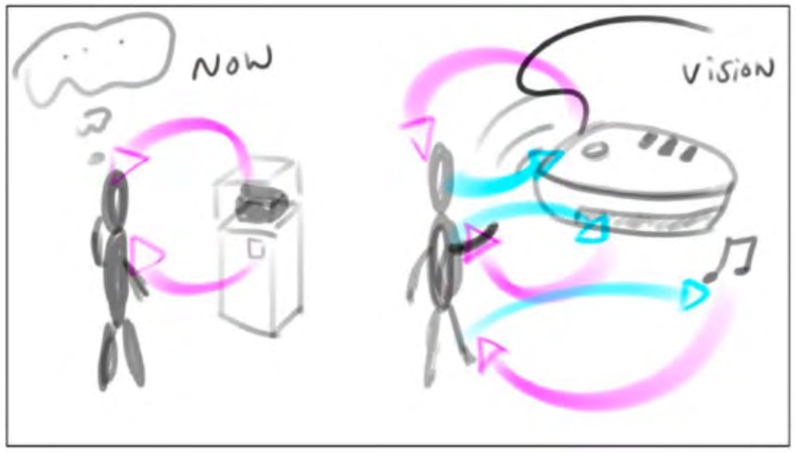


Figure 2: initial interaction vision

1.3 Augmented reality

Over the past few years, Augmented Reality, has been and remains a hot topic. People view it as the future and the next step in how we interact with our environment (Marr, 2021).
Most of us, however, already had casual experiences with AR. If you have ever played Pokémon Go or tried an Instagram or Snapchat filter before, you fit this category.
A simplified definition of Augmented Reality is the overlay of digital elements(e.g. images, audio, video, 3D animations) over the real world (Gartner, 2022).

Why Augmented Reality?
Aside from personal interest and prior experience creating small AR experiences, there are a few reasons why specifically this technology was chosen as a key element in the solution space;

1. **Balance**: Through AR a balance could be struck between the physical object and these overlayed digital elements. The technology has the potential to be implemented in a way that balances on the one hand appreciating the physical object, whilst having the freedom of digital interactions. Essentially having partial digital immersion. Virtual Reality experiences, for example, are fully immersive.
This experience can still be engaging, however, especially through the use of multi-sensory components.

2. **Adding interactions**: For this project, and institutes, the artefacts play an important role. As per the definition, conserving is part of an institute's set of tasks, which practically often means visitors cannot physically touch the objects on display. AR technology could fill this gap, by adding digital interactions without damaging the objects.

3. **Freedom**: With this digital technology there is a lot possible. In digital space, there are no laws of gravity, meaning virtually anything is possible, with a relatively low cost.

Everything comes with a price, however, aside from the great potential there are possible caviats which are explored during the project.

1.4 Context - HBI TU delft

For this project, the overarching context and target group are museums and their visitors. In order to create a more tangible assignment and problem definition, a specific context was set:
The Industrial Design Engineering(IDE) faculty and its students. The faculty has a considerable collection of classic design products, stored and on display throughout the faculty. This archive is part of the Henri Baudet Institute(HBI), which conserves and expands the collection.

The HBI was founded in 2004, named after lecturer Henri Baudet, who was a professor of design history at the TU Delft and professor of social-economic history at Rijksuniversiteit Groningen.
The ethos of the HBI is for students to learn more about the past of design, so they can, à la the faculty's mantra, design for our future.
The institute however finds there is little connection with the students currently, whilst the archive is quite vast.

Figure 3: Well known example of Augmented Reality, Pokémon Go (Cisco, 2016)

Figure 4: Images of the HBI archive

1.5 Target group

Part of the case of the project context is the target group.
The context-specific target group for this project are Industrial Design students from the TU Delft, from every academic level(year).
Characteristics of the target group are;
18-28 years old
Digitally literate
Interested in design

The zoomed-out target group are museum visitors as a whole. A categorisation of different museum visitors was made by Falk and Dierking. There are 5 types of museum visitors, see Figure 6.
This project focuses on the explorers and hobbyists groups specifically.
Visitors(students) who have an interest in design are open to learning, having a general curiosity, and fit the explorer category.

The expert category is for visitors who want to know the nitty-gritty regarding a subject. They usually are critical and seek in-depth information during a museum experience. Think of a material designer, who with a specific interest in production methods and materials when visiting a design museum.

1.6 Project approach

After the project essentials were composed, the approach to this graduation project was formed. Different phases were managed to cover the different research areas, come up with a novel design and evaluate the concept in context.
Figure 7 shows the overarching project process with the corresponding phases and main activities.
The project process is based on the double-diamond framework(Design Council, 2019).

Figure 5: Industrial Design Engineering main hall in faculty (van Huystee, 2022)

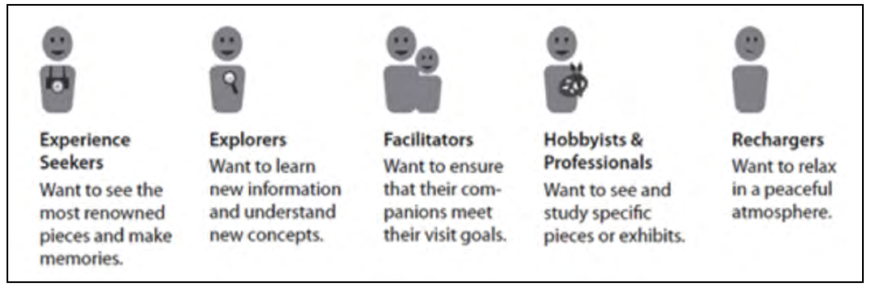


Figure 6: Museum visitor types (Falk & Dierking, 2004)

The project starts with the discovery of the assignment components. The main tasks of this phase are context and user study, and literature research concerning learning and AR.
From these research methods, insights were formulated, which in turn resulted in a sharpened design goal and interaction vision. These are part of the definition phase.
Hereafter development was started, with iterative ideation, prototyping and conceptualisation. Also, small-scale user tests were performed in context.
From here the final stage is reached of delivery. Part of this stage is detailing the concept, the final concept proposal, a final prototype and use evaluation in context.

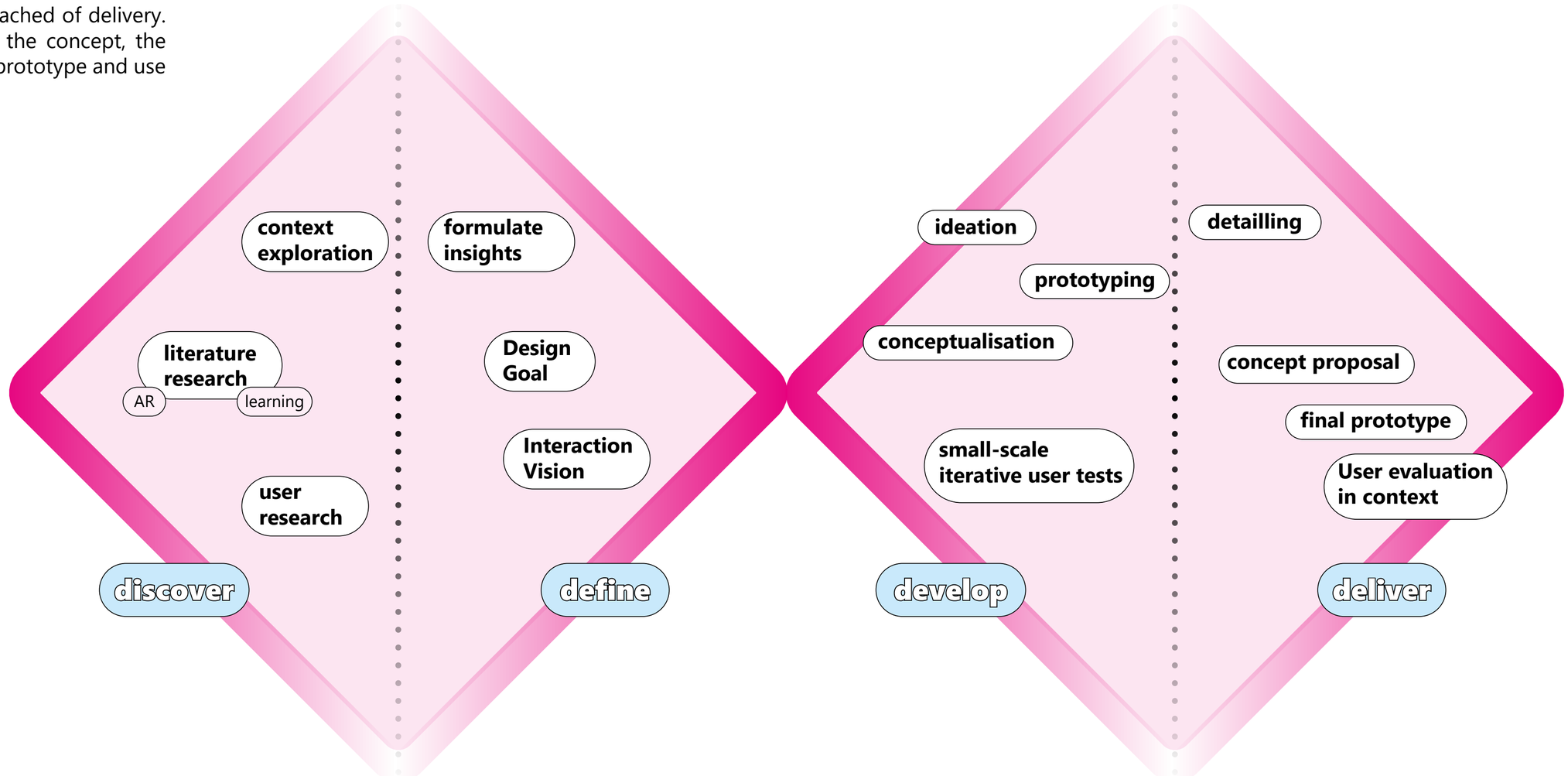


Figure 7: Project approach based on double-diamond framework (Design Council, 2019)

CH2:
Exploring Learning

In this chapter learning is explored in relation to the project. The main research question to be answered here is the following:

How can learning be promoted?

To gain proper understanding on this subject, literature research and expert interviews were performed.
The first section of this chapter dives into existing learning frameworks and the process of learning.
Afterwards, ways to boost learning, and finally the IDE faculty's stance regarding learning are discussed.

Chapter spine
2.1 Defining Learning
2.2 Learning Frameworks
2.3 Kolb's Learning Cycle
2.4 Learning Scaffolds
2.5 Learning at IDE
2.6 Conclusion

2.1 Defining Learning

An integral part of the set design challenge is adding depth to the stories told about design artefacts, specifically for students to learn and be inspired by these products.
How can we promote learning? What are the learning frameworks and how can we implement these for the to come design intervention? The upcoming sections dive into the above.

Before discussing existing learning frameworks, what is '*learning*' ?
According to Kelly(2003) learning is generally defined as the following:

' a positive process, ongoing, everyday and lifelong, broadening horizons and taking an active interest in the world in many diverse ways such as talking to friends, reading books and watching television. It was described as a subliminal process rather than a conscious activity sought out by the individual.'' ***(p.4)***

From this we can draw that learning does not just happen when studying, reading a book or following a lecture. It is a much more holistic and continuous activity in a person's life. One could even be learning during their daily coffee break or playing a video game.
Education and learning still might feel inseparable, the IDE faculty being an educational institution in the end. What is the definition of 'education'?

Education was viewed as a formal process usually associated with school, something imposed and prescriptive, left behind when they finished.''
(Kelly, 2003, p.4)

There is an interesting and important nuance that can be made between the definition of learning and education.
Ecuation can bring up negative feelings, contrary to learning which is seen as something positive. Important to note here this contrast is due to one being imposed, education, and learning seen as unimposed. To an extent a diffference between external versus intrinsic motivation. With that, the design intervention should cater to, and capitalize on this intrinsic drive of the students.

2.2 Learning frameworks

As it comes to current frameworks there are two main paradigms regarding learning: positivism and constructivism.
Positivism posits that learning occurs exclusively through the senses, or logic. Constructivism, on the other hand, posits that learning is based on the learner's past experiences, intelligence and interactions with the world (Hasa, 2020).
Figure 8 on the right compares the two.

An important differentiator here is that the stance of positivism towards learning is that the external world contains information and it can be transferred to us through learning. From the constructivist view, knowledge is constructed rather than transferred, the learner making meaning based on their culture and upbringing for example, rather than absorbing it from the world.
As an effect the constructivist stance views students as active constructors, meaning participation is key. Again in contrast to positivism, which sees them as passive vessels (Tucker et al., 2014).

These frameworks are not mutually exclusive, however, the constructivist approach is more often used in creative fields, like Industrial Design (Fyfield, 2018).

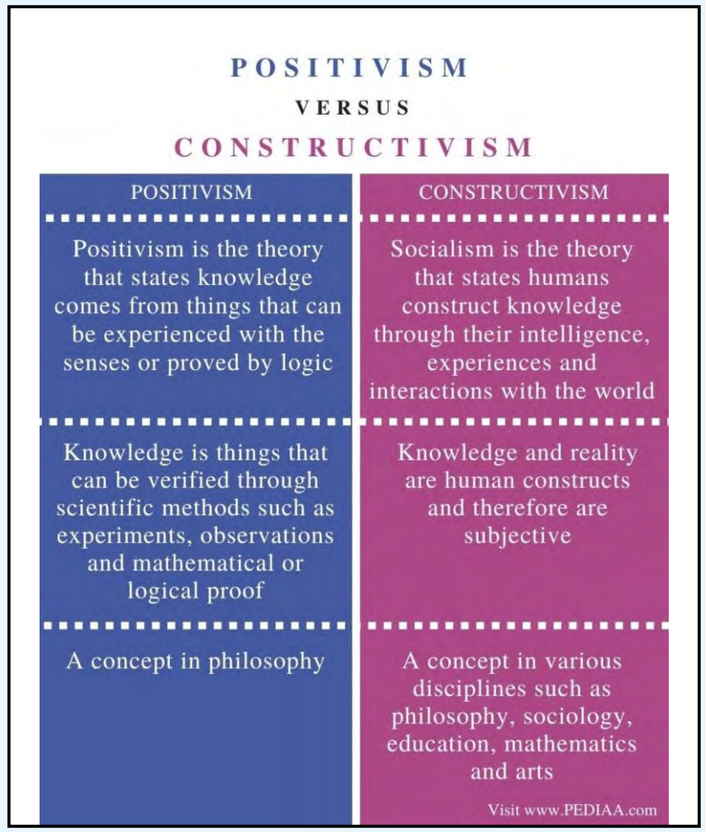


Figure 8: positivism vs. constructivsm (PEDIAA, 2020)

With this, from the constructivist lens, learning is seen as a **social activity**, where social interactions are key to the learning process (Dewey, 1938).
Secondly, learning is viewed as an **active process**,as mentioned earlier, where active engagement is key for learning to take place.
Finally learning is a **personal experience**, this means that even participating in the same activity could entail different learnings for people (Mcleod, 2019). This again is based on the notion of learners constructing knowledge based on their worldviews and past experiences.

Now knowing the definition learning, and the contemporary frameworks, how does the process of learning work? That question is explored in the upcoming section.

2.3 Kolb's Learning Cycle

David Kolb, an American psychologist, came up with the experiential learning cycle, representing the different stages and ways of learning. Figure 9 shows the cycle.

1. Concrete experience; Learning at this stage is done through a tangible task people are actively engaged in. For example talking to a classmate or reading a newspaper article.

2. Reflective observation; After having completed the concrete experience, the learner takes a step back and reflects on it. This can also be done socially, by discussing their experience with others.

3. Abstract conceptualization; In this step the learner tries to generalize and draw conclusions from the initial experience and reflection. Think of placing the experience in to their prior knowledge and past experiences.

4. Active experimentation;
At this stage, the acquired knowledge can be applied to reality. For the set context, design students during their design projects. Or creatives to their practice after having visited the institute.

Note that Kolb's cycle can be entered at any of the four stages. However, for learning to take place, all of these steps need to have been completed, especially for long-term learning (Kolb, 1984).

Translating this to the project and subsequently to come design; the experience should be built upon Kolb's framework, for long-standing learning to take place.
For example by engaging the users (stage 1), and giving the opportunity for them to reflect and discuss (2). In return relating this to contemporary or their existing knowledge (3) and finally, stage 4, the newly gained knowledge can be applied in the students' practice (Kolb, 1984).

Having gained insight into thelearning process and how this can be incorporated to the design, what are some concrete ways to promote learning? This is discussed in the upcoming section.

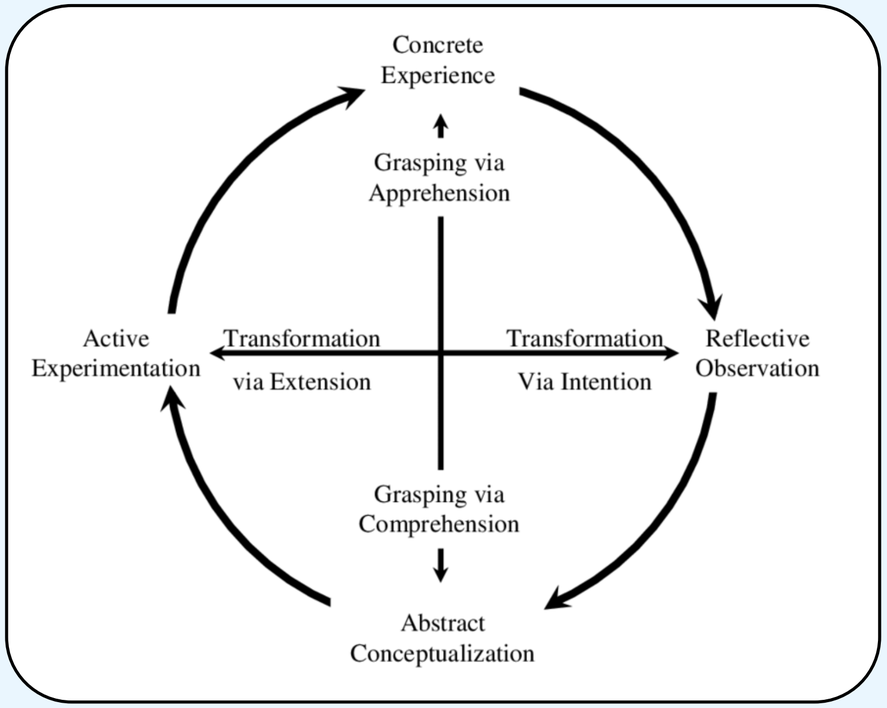


Figure 9: Kolb's Experintial Learning Cycle (Kolb, 1984) & (Roberts, 2006)

2.4 Learning Scaffolds

Scaffolding is the use of tools that help people learn something, these can occur in different forms and styles (EdGlossary Org., 2015). Think of them as side-wheels when starting to ride a bike, first you need them and after a while, you can easily cycle without them.

Similar to Kolb's learning cycle, scaffolding can be seen as a process, divided into four stages (Victoria University, 2022):

1. **Gauge foundation knowledge**: First the foundational knowledge of the user group needs to be measured. What do they already know about the subject, here on Design Heritage?

2. **Let them perform an activity**: Through having people perform a task they can actively learn and familiarize themselves with the topic.

3. **Scaffold stacking**: By providing multiple scaffolds, the learners are guided in the new topics and can learn more easily. Think of explanatory text, guiding audio or visual graphics. Essentially having multiple ways a concept is explained or a story is told.

4. **Apply new knowledge**: The final stage is the application of the newly gained knowledge independently. This stage is virtually identitical to Kolb's stage 4 (active experimentation).

This 4-step process can be valuable for the learning aspect of the design. Implying that a first step in futher research is to gauge the foundational knowledge of the target group.

Concrete examples of scaffolds to promote learning are the following (Prodigy, 2020):

1. Building upon existing knowledge; using the knowledge people have as a starting ground to add more, novel, information.
2. Repeating information (in different forms); think of describing an element sonically and highlighting it visually.
3. Encouraging participation; having institute visitors participate socially and discuss the contents for example.

Now for the set context, IDE, what framework does the faculty use and how is learning promoted towards students throughout its curriculum? These questions are discussed in the following section.

2.5 Learning at IDE

The target group is following a study, at the faculty, now what is the faculty's stance on learning? What kind of learning does it want to promote during the studies, and how does it do so?

To answer these questions an interview was performed with faculty's education advisor. She is an educationalist, playing a key role in the development of the new IDE bachelor that launched this school year. The advisor also manages the quality control of every course at the faculty, processing students' wants and requests for improval. For an overview of the asked questions and answers please see Appendix B. On the right is a concise overview of the insights gained from the conversation;

interview insights

•**Self-motivation** is important and essential when learning, it is the intrinsic drive to learn and gain knowledge. This also means actively engaging students to kick-start this.

•The faculty tries to engage learning through **promoting** the **social context** and interactions between students.

•Students in the past voiced that they **want to learn** more about **Design Heritage** and felt this was lacking in the Bsc.

•There is no single **framework** chosen, positivism vs. constructivism. The faculty uses a **combination** of each. However, the faculty is definitely more on the constructivist end of the spectrum.

•**Autonomous learning** is the didactic concept for the new IDE Bsc.
This means students are in the driver seat when it comes to their learning, they more often are given responsibility and freedom.

•The content of the courses are all serving to **prepare** students for the '**real-world**', post-studies. So the faculty tries to teach proactiveness and self-reliance to students.

•It is also important to **inspire** students. The main way the faculty currently does this is by inviting guest speakers.

The insights gained from the interview are quite well in line with the above-discussed parts, of the learning scaffolds and Kolb's cycle. Self-motivation and the social context are mentioned several times, meaning they play an integral part in the learning journey of people. They should be taken into account during the design process.
With that the conclusions of this chapter on learning are found on the following page.

2.6 Conclusion

Having gained the insights on what learning, now reflecting on the previously set research question:

How does one promote learning?

Self motivation
Learning is really only possible when one is willing to, is self-motivated. Thus the design needs to align with the users' wants and needs, this self-motivation is core.

Social
Having interactions in a social context promotes learning, also fitting IDE's learning ethos. Think of learning in duos, or other group acitivities.

Engagement
Having active engagement of the students, in turn, promotes learning. For example them initiating or participating in the activity, instead of 'just' absorbing information, active learning essentially.

Kolb's Learning Cycle
Promote learning using Kolb's cycle: Learning is done through Kolb's 4-stage experiential learning cycle. The design needs to take this into account.

Scaffolds
Promote learning through scaffolds: Learning scaffolds offer ways for learners to gain new knowledge and apply them. The to come design should offer learning scaffolds to the users during use.

CH3:
Understanding AR

Augmented Reality is viewed as an important and promising medium for the future.
In this chapter, the technology itself, its risks, opportunities and affordances are explored.

First the definition of AR, the technological possibilities and its relation to education are discussed.
Followed by a case study analysis of existing AR experiences (in museum settings). The chapter closes with an overview of AR's relevant affordances, potential risks and opportunities.

All of the above is to answer the overarching research question;

How to use AR in the most fitting way for the set design challenge?

Chapter spine

3.1 Defining AR

Augmented Reality is a term widely used, especially in the past few years. From tv-commercials, tech websites and even social media networks. Before diving into the technical definition of AR. How does it relate to other immersive technologies?

Any blending of real-world and digital components fits under the Mixed Reality(MR) umbrella, mixing real-world and digital environments. This suggests that there are two extremes, the physical world and the digital. With that, Milgram & Kishino (1995) created the Reality-Virtuality(RV) spectrum seen on the right.

A nuance can be picked up from the spectrum, between Augmented Reality and Augmented Virtuality(AV). When there is real-world content overlayed with digital components this is considered AR. When the majority of the content is virtual, with still some experience of the real world, this is considered AV (Skarbez et al., 2021). The most extreme right on the spectrum is where VR is placed, total digital immersion. This could, next to visually also be sonically(using headphones) and haptically(by using gloves).
Previously mentioned in the original project brief(Appendix A), this project is set to explore the left side of the spectrum. Looking to strike a balance between the physical and digital world.
Having discussed the relative definition of AR in the RV spectrum, the technical definition of AR is discussed in the next paragraph.
Now, what does 'AR' really mean, specifically regarding this project?

Cianciarulo (2015) defined it as the following:

''The Augmented Reality (often called AR) is used to enhance reality with virtual content: Augmented Reality is in fact the overlapping of layers with information (of different types such as video and graphics 2D, 3D, audio) to the real environment." (p.140)

Essentially AR is adding a digital layer to the real world with virtual content, say overlaying information.
Think of holding a transparent A4 in front of your cup of coffee and drawing smoke on it, in a way this is a form of analogue AR.

Going from a theoretical, or abstract, lens to a more practical one, what can we do with AR? What are its technological capabilities? These questions are discussed in the upcoming section.

Now, what does 'AR' really mean, specifically regarding this project?

Cianciarulo (2015) defined it as the following:

''The Augmented Reality (often called AR) is used to enhance reality with virtual content: augmented reality is in fact the overlapping of layers with information (of different types such as video and graphics 2D, 3D, audio) to the real environment." (p.140)

Essentially AR is adding a digital layer to the real world with virtual content, say overlaying information. Think of holding a transparent A4 in front of your cup of coffee and drawing smoke on it, in a way this is a form of analogue AR.

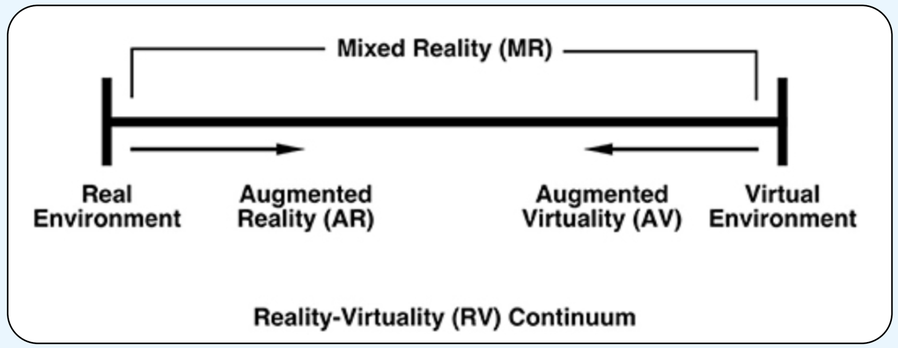


Figure 10: Reality-Virtuality Contuinuum (Milgram et al., 1995)

Figure 11: example of analogue AR - "hmmm AR Coffee"

3.2 AR as a technology

From a more pragmatic point of view, what could one do with AR? And what are the current technological possibilities?

3.2.1 AR Building blocks

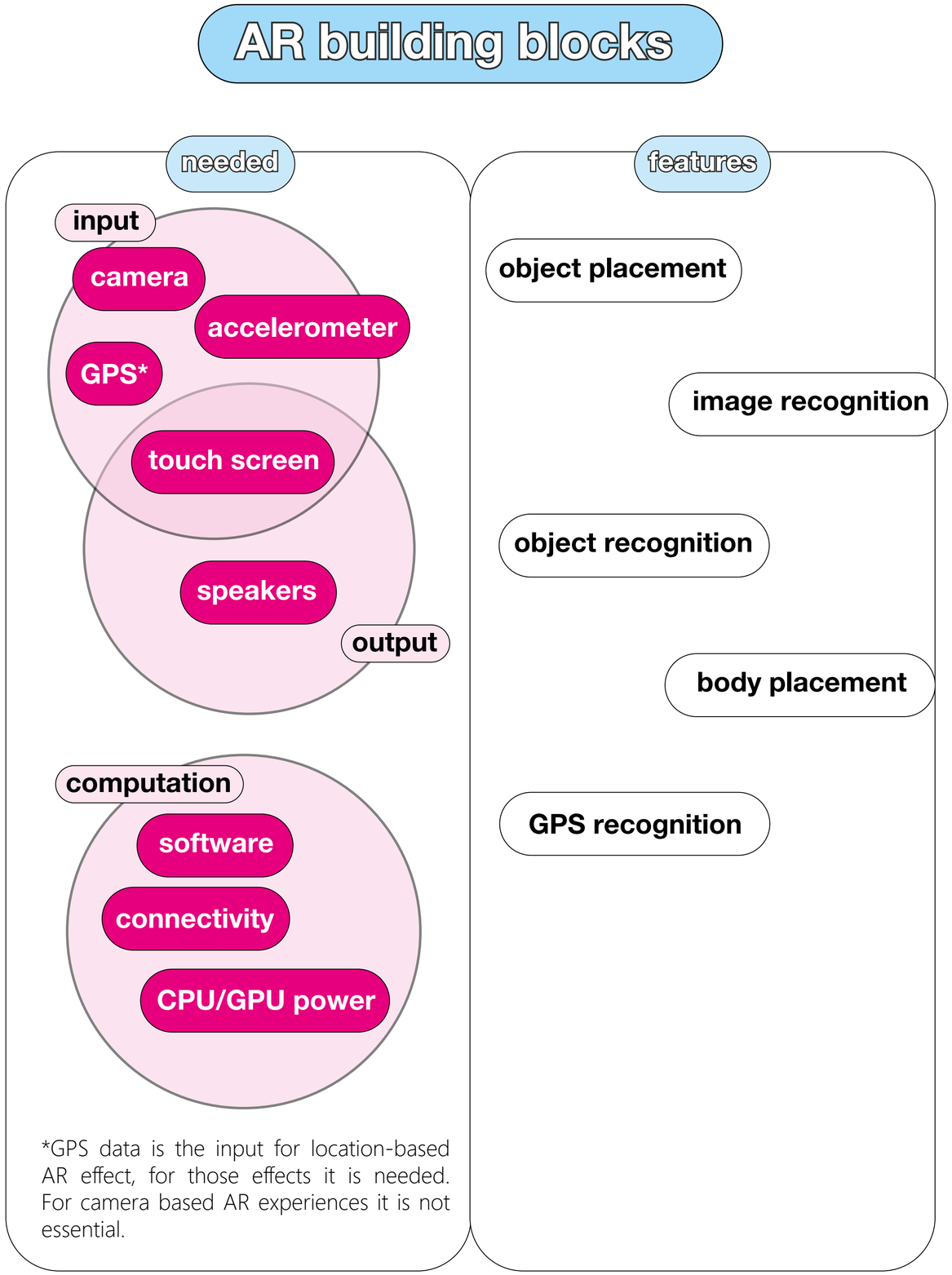
Augmented Reality is a technology that allows for the digital overlay on reality. One might ask, what is needed for this to be brought about? And what are the features, and possibilities within the technology?
On the right a list of needs and technological features of Augmented Reality (8thwall,2022).

The left column shows what is needed for an AR experience. In terms of device input that is a camera, accelerometer and possibly GPS.
The output of most AR experiences is sound and visually, via the speakers and screen. The touchscreen on a device can be seen as both an input and output element.
There also is computation needed, the AR engine interpreting the input data. Furthermore the device needs to be connected to the internet, especially for WebAR experiences. Finally enough processing is required for the devices.

The right column shows current AR features. More explanation on those coming up.

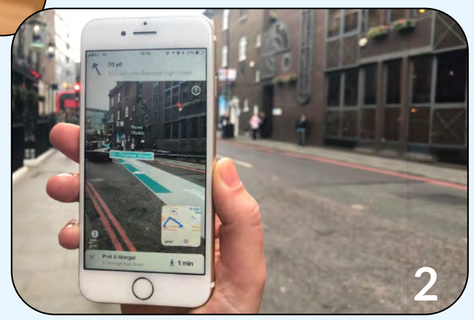
Edwards-Stewart et al. (2016) found that there are two main categories in AR; triggered AR experiences and view-based ones.
An AR experience can get 'triggered' on a device by the external world, say a certain image, sound or GPS location. This can entail different effects occurring, say a message popping up, 3D-model loading or sound playing.

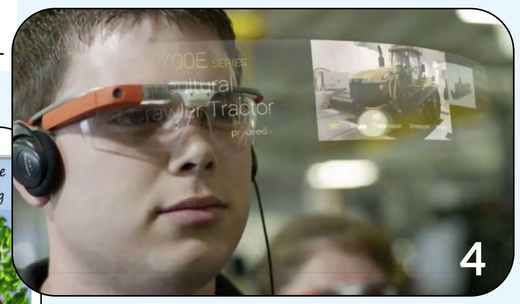
View-based AR on the other hand, simply uses the device's viewport(camera) to superimpose something, this can also be one of the mentioned effects.
Figure 12 is based on the categorization of AR by Edwards-Stewart et al. (2016), showing the different categories and types of Augmented Reality with each an example image.

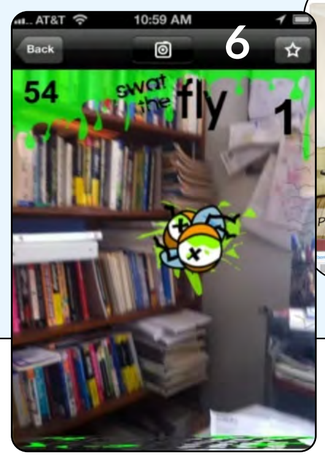


*GPS data is the input for location-based AR effect, for those effects it is needed. For camera based AR experiences it is not essential.

Category	Type	Examples	Characteristics
Triggered	1a. Marker-based: Paper	String (string.co) Blippar (blippar.com)	Paper marker activates stimuli.
	1b. Marker-based: Object	Aurasma (aurasma.com)	Most objects can be made into markers.
	2. Location-based	Yelp (yelp.com) PAJ (t2health.dcoe.mil/positiveactivityjackpot) Instagram (instagram.com)	Overlay of digital information on a map or live camera view. GPS may activate stimuli.
	3. Dynamic Augmentation	Video Painter (itunes.apple.com/us/app/video-painter/id581539953?mt=8) Swivel (Motion; facecake.com)	Meaningful, interactive augmentation with possible object recognition and/or motion tracking.
	4. Complex Augmentation	Google Glass (google.com/glass)	Augment dynamic view and pull internet information based on location, markers, or object recognition.
View-Based	5. Indirect Augmentation	Wall Painter (itunes.apple.com/us/app/wall-painter/id396799182?my=8)	Image of the real world augmented intelligently.
	6. Non-specific Digital Augmentation	Swat the Fly (inengy.com/swatthefly) Bubbles (virtualpopgames.com)	Augmentation of any camera view regardless of location.







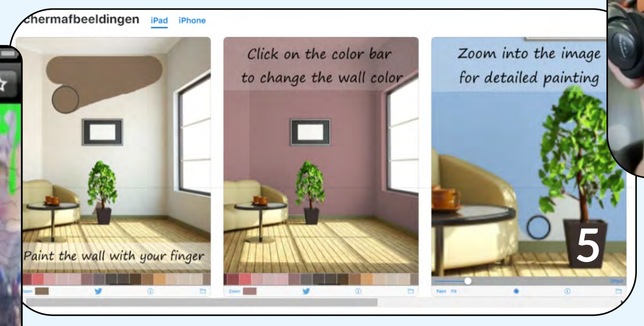


Figure 12: AR types figure (Edwards-Stewart et al., 2016) with contemporary examples

3.2.2 AR Types

1a. Marker based paper: The use of a physical marker for the AR engine to recognize and superimpose something, on the image a 3D house. This is also known as image tracking or image recognition.

1b. Marker based object: The same concept as above, instead of a 2D object functioning as the marker a 3D object is. In the example a Bosch tool is recognized and elements are superimposed on screen.

2. Location based AR: AR effects based on the geographical location of a person. The example shows an AR version of routefinding app.

3. Dynamic augmentation: Augmentation that is performed on a dynamic, moving, object. A common example of this is body recognition, the example a gucci watch overlaying the user's wrist. Other well known examples are facefilters (e.g. found on Snapchat).

4. Complex Augmentation: This is a combination of all the above mentioned types. An example of that is Google Glass.

5. Indirect Augmentation: Utilizing the objects camera to superimpose and recognize objects. For example a wall painter app that shows how your wall could look in another color.

6. Non-specific Augmentation: Essentially the most primitive form of AR, solely using the camera's view as a background and overlaying a digital object. The paper mentioned a game called 'swat-the-fly', doing exactly that.

3.3 AR and Learning

Another application of AR is in education and learning. What are its strengths as it comes to learning specifically, and what are its disadvantages?
An interesting point was made by Wu et al. (2013), specifically on the relation between AR and learning. Where it is said that viewing AR as a concept rather than a technology is more beneficial;
''AR exploits the affordances of the real world by providing additional and contextual information that augments learners' experience of reality'' (p. 42)

Multiple scienitific articles were consulted to get research AR and the link to learning. On the right is an overview of the main found benefits, risks and recommendations as it comes to AR and learning.

Augmented Reality technology can be helpful to learning, enhancing collaboration and long-term memory retention for example. There are some potential risks, however, the main one being cognitive overload. This risk can be mainly mitigated by keeping the experience simple.

3.4 Multisensory AR

Aside from traditional AR, augmenting visual elements, there has been research and implementation of multisensory AR, think of the use of sound and smell. How can this multi-dimensionality(layeredness) change people's AR experience for the better? Below is an overview of insights gained from the literary study:

Sound

1. The combination of visual and audio in AR enhances the enjoyment of users compared to traditional AR (Marto et al., 2020).
2. The implementation of sound can create realistic and more immersive experiences
3. Sound can alter perceptions, e.g. how a space is perceived.
4. A multisensory experience can contribute to increased user involvement (Marto et al., 2020).

Smell

5. Depending on the experience, adding smell does not substantially enrich the AR experience (Marto et al., 2020).

Haptic

6. AR is a good substitute for people with a high urge for haptic experiences, e.g. when online shopping, making it more enjoyable via an AR component (Gatter et al., 2021).
7. Through haptic AR, real-life touch can be simulated quite close to reality (Jeon et al., 2012). Think of dialling a phone number on the buttons of a rotary dial phone and feeling the simulated resistance.

From the above, it can be stated that the use of AR solely as a tool to superimpose visual elements is limiting its potential. Incorporating other senses, especially sound, can have a great positive impact on the experience. With that, the sonic aspect of the AR experience should be taken into consideration when ideating and designing the experience.

Smell and taste have not been implemented in AR experiences broadly in the past, however, it can be valuable depending on the project, say in the food industry. For this specific project, there is no direct link, thus they will not be explored any further.

The addition of haptic elements could enhance the experience, especially since the artefacts are physical products. Sound being the most promising sense as part of the AR, and due to the limited time of this project, touch will not have a priority in the exploration. Also Augmented touch virtually is currently not possible without an external device, e.g. glove or similar tools, making the project more diluted and complex.

Learning Benefits

1. AR helps people explore the real world in an authentic manner, through virtual overlays. Authenticity here meaning staying true to the physical world.
   E.g. overlayed videos or texts as supplementary material (Wu et al., 2013).
2. It can facilitate the combinination of real-world and virtual learning materials.
   E.g. visualize the process of photosynthesis (Wu et al., 2013).
3. AR activates users to interact and manipulate materials. These interactions can help learners to understand subjects more thoroughly (Wu et al., 2013).
4. AR is believed to increase long-term memory retention (Vincenzi et al., 2003).
5. AR can create immersive hybrid learning environments (Vincenzi et al., 2003).
6. Improved student collaboration: especially when using a shared device has been found (Radu, 2014).
7. An increase in student motivation and enthusiasm (Radu, 2014).

Learning Risks

1. **Cognitive overload**: Students could become cognitively overloaded in a learning environment, especially when performing difficult tasks (Radu, 2014).
2. The experience is **device-dependent**, device failure, e.g. due to lack of computing power, would entail no experience at all (Radu, 2014).
3. **Attention tunnelling**: AR demands extra attention from students, this can lead to increased difficulty in fulfilling team tasks (Morrison et al., 2009).
The AR material and experience are set in advance; teachers and users cannot change something impromptu if they would like to (Dunleavy & Dede, 2013).

Learning Recommendations

1. **Simplify the experience**; start off simple and increase complexity over time (Perry et al., 2008).
2. **Scaffolding**; building each experience up, offering ways to more easily learn at every step. (Perry et al., 2008). An example of scaffolding; giving students a dictionary when reading a difficult text (Edglossary Org., 2015).
3. **Limit features**; limit the number of elements encountered per timeframe (O'Shea et al., 2009).
4. **Minimize text**; minimising text, replacing this with audio (O'Shea et al., 2009).

3.5 AR engines & tools

AR experiences can be developed using existing tools and engines. These exist in varying levels of accessibility, coding skills needed and AR features. Through past experience, the consultancy of TU Delft's VR Zone experts and desktop research, Figure 13 keynotes contemporary AR tools and their abilities:

The table shows well known AR tools currently available. Now, these can be ranked based on different parameters, as seen on the table. For this project, there are two important ones: feasibility of the concept, which tool fits the concept best & which tool allows to prototype parts of these experiences.
A review was made of the tools for this project which one would be best for prototyping and which AR tools has the most freedom for the to come concept.

From this, ZapWorks, Adobe Aero and SparkAR are the most promising when it comes to simple and quick prototyping . They offer the essential AR features needed(plane tracking and image recognition) and have a relatively low learning curve. ZapWorks takes the throne here, being a webAR tool. Aero currently being limited to Apple devices. For SparkAR there is a limitation in project size and the AR effect needs to run via the Instagram or Facebook app.

Without taking prototyping and my coding skills into account, another tool seems te most qualified, 8thWall. It is a web-based engine, supporting different AR features, making it compatible with both Apple and Android devices. The AR functionalities are built upon three frameworks; A-Frame, three.js and babylon.js. This allows for a high degree of freedom, especially for a webAR application.
It also has a relatively lower fee, 99$ a month, at least for short-term and non-commercial projects. Coding expertise is needed however to build the experiences since they are built on JavaScript and WebGL.

3.6 Analysing AR reference projects

To get a better sense of existing AR experiences in practice, select AR projects have been analysed. From generic (Snapchat and Pokemon Go) to Augmented Reality in museums, education settings and a wild card. Each project is briefly described, and partnered with a short analysis relating to this specific design challenge: anything we can learn from these existing AR projects?

	expertise level	AR features	device comp.	web vs. app	dev. vs. proto first	paid vs. free
three.js	high-coding	ALL-IMG-BODY	BOTH	WEB	DEV	free
SparkAR	low-medium	ALL	BOTH	IG/FB ONLY	PROTO-DEV	free
ARkit by Apple	high-medium	ALL	APPLE	APP	DEV	free (Mac & iPhone/iPad needed!)
ARCore by Google	high	ALL-BODY	ANDROID	APP	DEV	free
Unity w/ Vuforia	medium-high	ALL-BODY	BOTH	APP	DEV	free
Adobe Aero	low	ALL-BODY	APPLE	APP/WEB	PROTO	Adobe subscription
8th wall	medium-high	ALL	BOTH	WEB	DEV	$99/month
Wikitude	high	ALL-BODY	BOTH	APP	DEV	€2490+ one time fee
ZapWorks (Web)	medium	IMG & OBJ.	BOTH	WEB	PROTO	free
		AR FEATURES				
		ALL				
		IMG RECOG.				
		OBJ. PLC.				
		GEO				
		BODY				

Figure 13: Overview of contemporary AR engines and their capabilities.

Generic

Figure 14: Snapchat AR face effects (Techpulse, 2017)

Figure 15: Pokémon GO players in the streets (WSJ, 2016).

Figure 16: Pokémon GO (Pokémon GO app, 2018)

Generic
Lots of people have already interacted with AR, not in museums, but in more casual manners, such as through Snapchat, Instagram or Pokémon Go. Below is an analysis of Snapchat and Pokémon Go, which many students might have used in the past.

Snapchat
Snapchat is a social media platform with a focus on sharing photos and videos. One of its unique features are the face filters, where people can change and alter their appearance. For example wear the features of a cute puppy(Fig. 14), all through the help of AR. The app recognizes the user's face and overlays the filter, say a 3D model of sunglasses.

Snapchat is targeted toward teens and young adults. Its main use of its AR features is to entertain and engage users. One could say this case strays quite far from the set design challenge, however, the social element, seeing what others do and share, and the vastness of different AR effects are inspiring.

Snapchat

Well known social media platform, which was one of the first to popularize AR face filters.

- entertainment
- social
- visual
- sound
- dedicated application
- face recog.

Pokémon Go
Pokémon Go superimposes Pokémons onto your environment using your smartphone. Different monsters can be found and captured based on a combination of your GPS location, the algorithm and luck. Using the back-facing camera, an animated 3d model is augmented onto the real world and can be interacted with, see Figure 7.

Like Snapchat, the target group is fairly similar. The difference however is that playing Pokémon Go, a priori, is a physical activity. The user needs to roam the streets of their town, and beyond, to catch pokémon.

The element of luck, unpredictability(randomness) and regular updates keep the user coming back, longing for more. Here also the social element plays a key role, friends can play together and compete to see who has the more rare Pokémons.

Pokémon GO

Popular phone AR game. Using GPS and object placement users can catch new Pokémons in this blended world.

- entertainment
- (social) game
- visual
- sound
- dedicated application
- object place.
- GPS

Museum

ReBlink - Art Gallery of Ontario (2017-2018)
The Art gallery of Ontario made its exhibition come to life through AR. In a collaboration with digital artist Alex Mayhew. Multiple paintings were augmented with quirky animated overlays, giving a contemporary twist to old 'boring' paintings in the gallery's permanent collection. Visitors could download the ReBlink app via the App Store or Google Play Store.

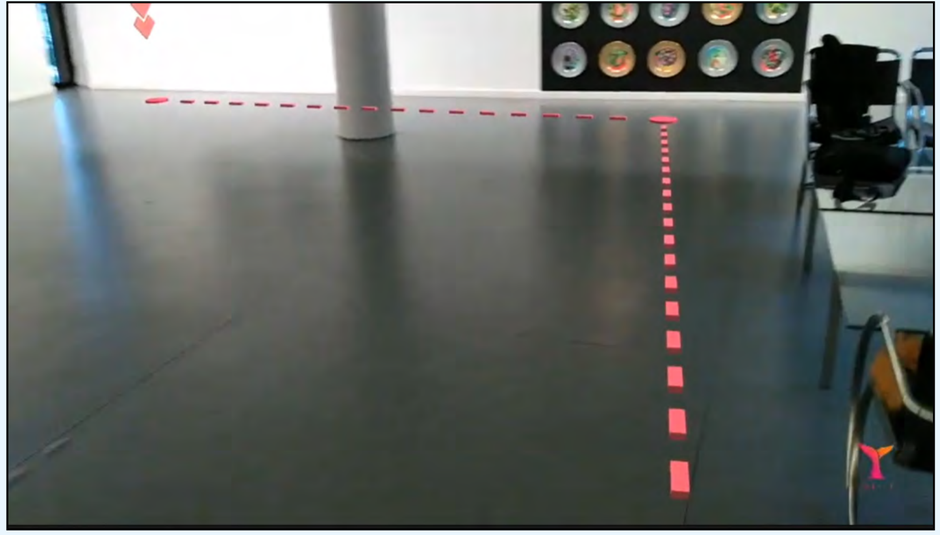
It was not much more than the mentioned above, no extra depth or insights were given here to the user. This is fine, the primary goal seemed to entertain visitors, and create an experience, not necessarily educate them. The contemporary lens overlaying the paintings, through AR, is inspiring nevertheless. For example a figure of a Rembrandt painting taking selfies, or another figure working behind their Macbook with Starbucks coffee on their table. This contrast between 'old' and contemporary is an intriguing one. They achieved this using a custom app, where the device recognizes the painting and in turn an AR effect loaded on screen.

ReBlink

Playful AR remixes of old painting, giving them a contemporary twist.

- informing
- visual
- sound
- dedicated application
- image recog.

Figure 17: Examples of the ReBlink AR overlay on the paintings (Mayhew, 2017)



''Cinco Sentidos'' (2017-2018)
The Barjola Museum of Gijón held an exhibition in 2017 with the use of an Augmented Reality application. Visitors could go through the spaces with their device and be:
guided via AR wayfinding
informed via augmented text labels next to the artworks

For this experience a standalone app needed to be downloaded. The application uses image recognition and GPS for the experience.
It could be seen as a plus for this museum to be able to leave out text labels next to the artworks, focusing on the pieces themselves. With that however it is difficult to know which artwork is by whom, hence the AR way-finding. The AR wayfinding however I do not reckon as a good overall contributor to the experience. This could guide the user too much, on where to go and when instead of facilitating free exploration. An AR floor plan might have solved the latter.

Cinco Sentidos

AR wayfinding in gallery space and AR textlabels next to artworks

- informing
- visual
- dedicated application
- image recog.
- location based

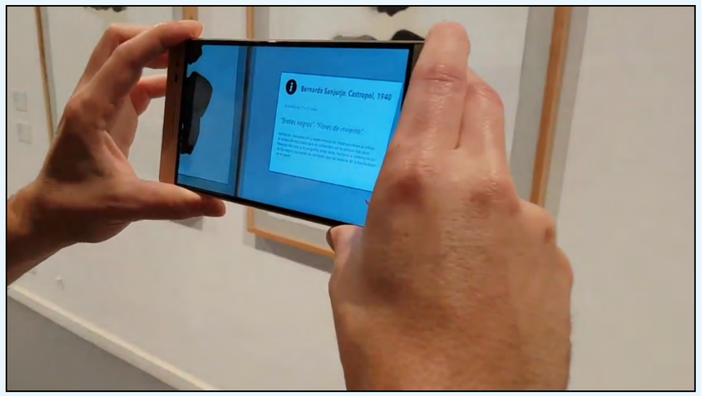
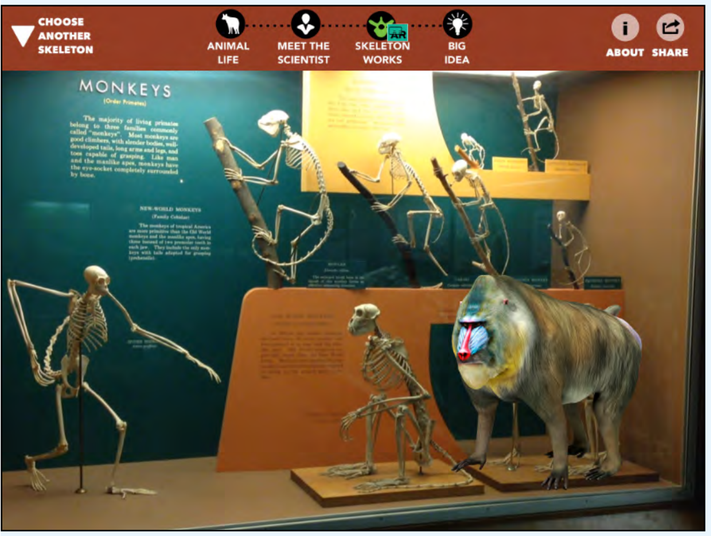


Figure 18: The AR text label and route guide (Onirix, 2018)



Smithsonian

The Smithsonian is an institution dedicated to ''preserving heritage, discovering new knowledge, and sharing our resources with the world''.
They have had multiple exhibits with the integration of AR, and are rather forward-thinking as it comes to digital. Two projects are highlighted below, the Skin & Bones AR app from 2013 and, a more recent, Coral Reef experience from 2021.

Skin & Bones

Skin & Bones is an application where AR is used to augment animals onto physical animal bones. The bones are inside the displays and through an iPhone or iPad, one can see how the animal looked while alive. These are overlayed 3d models and some of them are animated as well.

Here the objects digitally come to life, which adds to the experience, since it can be quite difficult to recognize an animal just by its bones. Here the augmentation helps make it easier to grasp and imagine, especially since the app is targeted toward kids.

Skin & Bones

3D (pre-historic) animals augmented over their real life skeleton. Also more info is accesible

informing

visual | sound

dedicated application

plane track.

image recog.

Figure 19: Examples of the Skin & Bones AR app in use(Smithsonian, 2015)

Coral Reef(2021)

In a more recent exhibition, the institute collaborated with the Hydrous, a non-profit leveraging connection to the ocean, and Adobe, using their Aero platform. Unique to this exhibition is that some of the AR experiences did not overlay over physical viewable work, rather showing archived coral pieces, since most of them were not able to be displayed due to the vastness of the collection. The institute 3d-scanned the coral reef objects from their archive, for them to be processed and (partly) retextured using another adobe tool, Substance3D.

Through the AR app the user could;
A. view the coral reef with animated animals as 3D models
B. Learn more via annotations on the display by pressing

Interesting here is that the experience is mainly digital, since the coral reefs are still in the archive and not viewable in real life. Also, the level of visual fidelity of the digital assets is quite high. Next to annotations and 3d-models the team also implemented sound, and narration, for a more immersive experience.

Coral Reef

placing 3D scanned coral plants in AR, with annotation & sound effects.

informing

visual | sound

dedicated application

plane track.

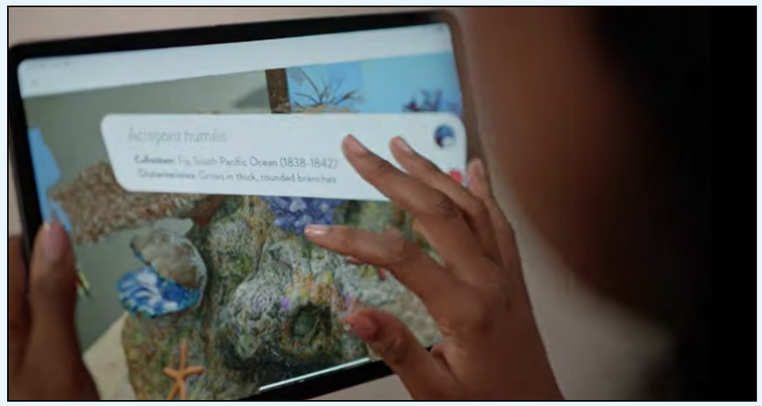
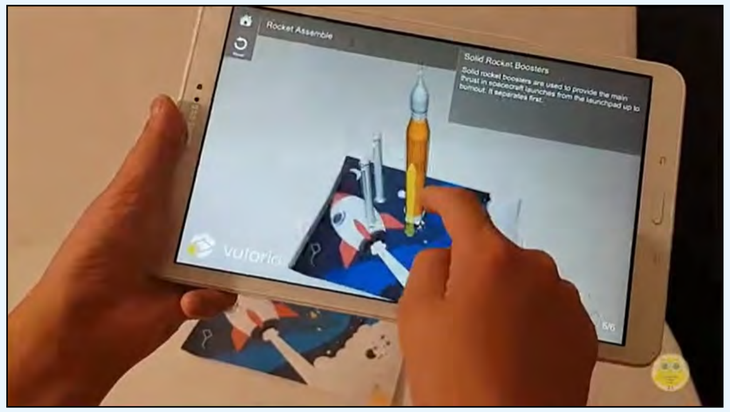


Figure 20: The Coral Reef AR app in action (Adobe et al., 2021)

Education

Figure 21: An educational AR effect based on a target image (CleverBooks, 2021)



LEARNING
AR has recently been more and more implemented in the domain of learning, especially for STEM subjects in primary and secondary school.

Cleverbooks & ARloopa
These examples all have in common that they use image recognition of, say a textbook image, and superimpose something on it digitally. For example the process of light travelling through glass fibre is visualized in the german textbook.

I have noticed that most of these 'AR books' are specifically for STEM subjects. This makes sense since it can be quite difficult to imagine abstract physical processes, especially for kids and young adults. The crux here is showing what cannot be shown in the textbook, utilizing the dynamic element of animation and 3D. I reckon this is a good example of leveraging that specific strength of AR.

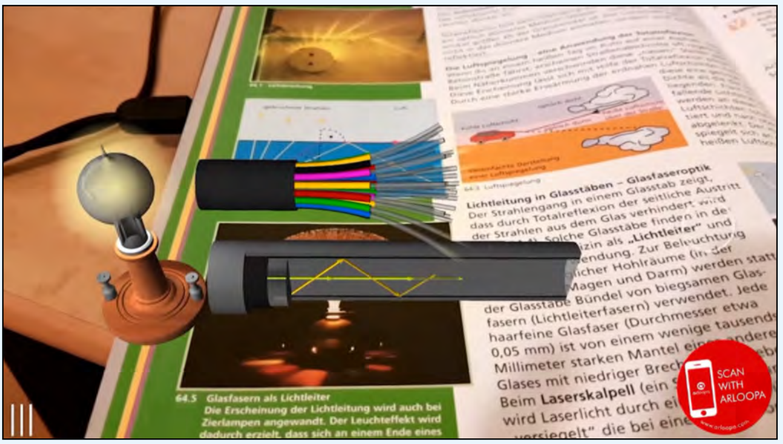


Figure 22: AR effect based on a text book image (ARLoopa, 2016)

Cleverbooks & ARloopa

viewing 3D AR effects based on a (text book) marker

- informing
- visual
- sound
- dedicated application
- image recog.

Hyper Reality(2016)
Finally, Hyper Reality is an example of a possible future with AR, by artist and critical designer Keiichi Matsuda. In the short film, he sketched a possible future where the world is fully augmented, creating a cocktail of vibrant coloured, dopamine rushing sceneries and even a few eery moments (Hyper Reality, 2018).
Even though this is not an existing applied design, it reminds me of where not to go. An overload of stimuli, sounds and objects. All asking for your attention, at the same time, all the time. AR can be a strong medium, but too much of anything just is too much...

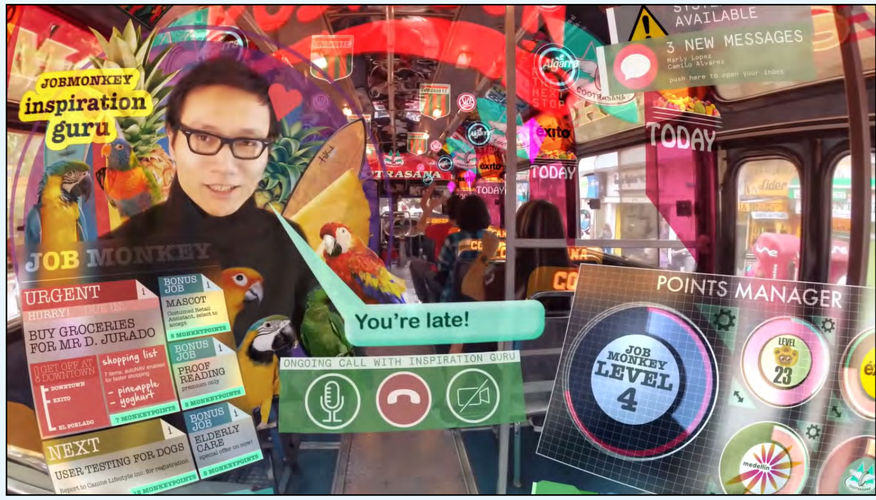


Figure 23: Stills from the Hyper-Reality short film (Matsuda, 2015)

Hyper Reality

speculative film on an potential extreme future with AR used everywhere.

- reflect
- visual
- sound
- lens integration
- all AR types
- + new ones??

Now having seen different applications of AR for divfferent use cases, are there any common affordances, risks and opportunities AR offers? This question is explored in upcoming section

3.7 AR Affordances, Risks and Opportunities

As discussed in the previous sections, Augmented Reality is a promising technology with different affordances and strengths. However, there are some potential pitfalls the use of the medium has, and certain opportunities too. In this section, an overview is given of each.

Studying different literature an overview is shown, on the next page, of the most prominent affordances of the technology.

Affordances, Risks & Opportunities

AR can create immersive hybrid learning experiences, facilitate a deeper level of perception in regards to historical objects and transform and educate visitors' perceptions. Notably, AR's affordances are also characterised to be intuitive(#9), increase the degree of flow(#7) and increase revenue for museums through re-visits(#10).

Aside from strengths AR also has certain risks or pitfalls. The most important risks are cognitive overload, the need for a functioning device, and the feeling of isolation can occur especially when groups use an AR experience. Finally, AR experiences often are time-consuming to develop, particularly the creation of the assets. is needed for example, and attention needs to be split between the digital and physical world.
Below is an overview of these risks:

Aside from strengths and risks, there are opportunities regarding AR:
Notably using AR to augment visual assets, works well in conjunction with sound, creating a more immersive and educative experience. Furthermore including 3D animation and avatar in the AR experience is found to be intriguing by visitors. Intertwining storytelling with AR creates a more compelling experience.

Affordances

1. **Create immersive hybrid learning experiences** (Dunleavy et al., 2008)
2. Facilitate a **deeper level of perception** in regards to (historical) objects (MAMUR et al., 2020)
3. **Educate** and transform visitor's perception (Tillon et al., 2011).
4. Reconstruct a museum visit from **contemplative to interactive** (Fenu & Pittarello, 2018).
5. AR can lead to **higher** degrees of **learning,** due to transforming visitors from passive to active ones(engagement) (Wojciechowski et al., 2004)
6. **Increase motivation** in learning of students (Moorhouse et al., 2019)
7. Increase the degree of '**Flow**' felt (Ma, 2021)
8. **Guide** easy focus switch between Real-Life and digital space (Jung et al., 2016)
9. AR is relatively **intuitive** and has a **fast learning curve** (Jung et al., 2016)
10. Revenue; Due to the high engagement of AR experiences, this could potentially lead to **higher** institute **revenue** (effect from affordance) (He et al., 2018)

Risks

1. **Cognitive overload** (Dunleavy & Dede, 2013)
2. **Technology depandance,** AR technology can only be used by devices from a certain generation and software version (Neuburger & Egger, 2017).
3. Can **isolate visitors** (Keil et al., 2013)
4. Good tracking is essential, **3D target tracking** still is a **challenge** (Keil et al., 2013)
5. AR is **time-consuming** in the development of media and assets. (Neuburger & Egger, 2017)
6. **Sound**; the use of sound and speakers might **disturb** other (Neuburger & Egger, 2017)
7. **Device-dependant**; The AR experience is quite device-dependent, especially when the users' devices are used. Think of the difference in screen size and processing power. (Neuburger & Egger, 2017)
8. **Less digital literate** users can have extra difficulty using AR experience, especially in combination with point 1 (Wu et al., 2013).
9. **More devices** used, entails a **higher risk of device failure** (Wu et al., 2013).
10. In a dynamic setting, the **experience is limited to a certain number of people,** blocking the view of others (Neuburger & Egger, 2017)

Opportunities

1. **AR visual + sound more immersive & educative experience** (Fenu & Pittarello, 2018)
2. **3D animation & avatars** are intruiging for visitors (Jung et al., 2016)
3. **AR & storytelling**; works well (Fenu & Pittarello, 2018)
4. **Mobile platforms** are **ideal** for AR (Venkatasubramanian et al., 2012)
5. The **aesthetic experience** is **important** for re-visits (He et al., 2018)
6. **Dynamic verbal cues** > dynamic visual (He et al., 2018)
7. The combination of **visual and audio** seem to work better than AR text (Fenu & Pittarello, 2018)
8. The **closer** you are **to the object** in the space, the **more you learn**; (Chen et al., 2021)
9. The use of **Web-AR** is **good** for **early prototypes** and testing high-fidelity prototypes (Keil et al., 2013)
10. **High-quality** visuals and audio creates a **more authentic experience** (Jung et al., 2016)

Risk Recommendations

From the literary study, certain recommendations for the development of an AR experience were found. Such as the experience should be designed context-specific, kept simple to prevent cognitive overload and balanced to divide attention between digital and physical objects. Below is an overview:

1. The use of AR should be **context-specific**: the museum's context and archive should have importance during the design process.

2. **Balance** descriptive information and storytelling:
•Minimize direct contact; contact with input devices should be minimized for a better experience. E.g. keyboards, mice etc.
•Be User Friendly; be intuitive and easy to use
•Be flexible
•Ready-made; The use of readily available materials instead of custom, to be cost-effective.
•KISS; Keep it simple! This minimizes the chance of failure

3.8 conclusion -->

3.8 Conclusion

Now we have explored learning, and AR from multiple perspectives, let's take a step back to the overarching research question;

How to use AR in the most fitting way to increase learning and inspire students?

Implementing AR in the most fitting way means again capitalizing on its strengths and minimising potential risks when designing. For this project, AR can be used in the most fitting way by;

Leveraging its strengths

Especially the ability to create deeper learning environments, in a casual and non-permanent manner is a noteworthy strength of AR. This is often done through the display of augmented text, 3D models, sound or a combination.
Furthermore, AR promotes user interactivity, turning users from passive to active, entailing longer memory retention (better learning).

Minimizing its risks

Specifically cognitive overload and attention tunnelling are common risks associated with the use of AR in museum/learning environments. Interpreting and trying to gain knowledge from both the real and digital world can be overwhelming, especially if the latter is requesting consistent attention.

From a technical lens,

the medium is very dependent on the set infrastructure, think of device compatibility and internet connection.

Context & user-specific

In order to create a proper experience, AR experiences need to be tailor-made to the specific context and users. Having elderly or tech-savvy teens as users, or the project being staged outside versus inside, has a major impact on the project's AR's design and subsequently its success.

Ultimately, AR is a means to an end, the end is to satisfy the users' needs within context and achieve the set design goal. This is explored in the upcoming chapter, by performing context and user research.

CH4:
Context Exploration

Chapter spine
4.1 interview HBI
4.2 Exploration Context Space
4.3 Context Observations
4.4 Interview in context
    4.4.1 interview in context setup
    4.4.2 interview insights
4.5 Conclusion

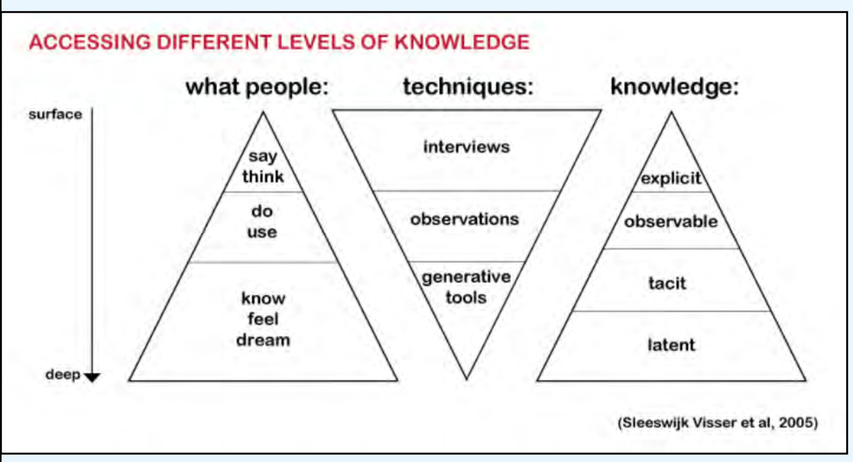


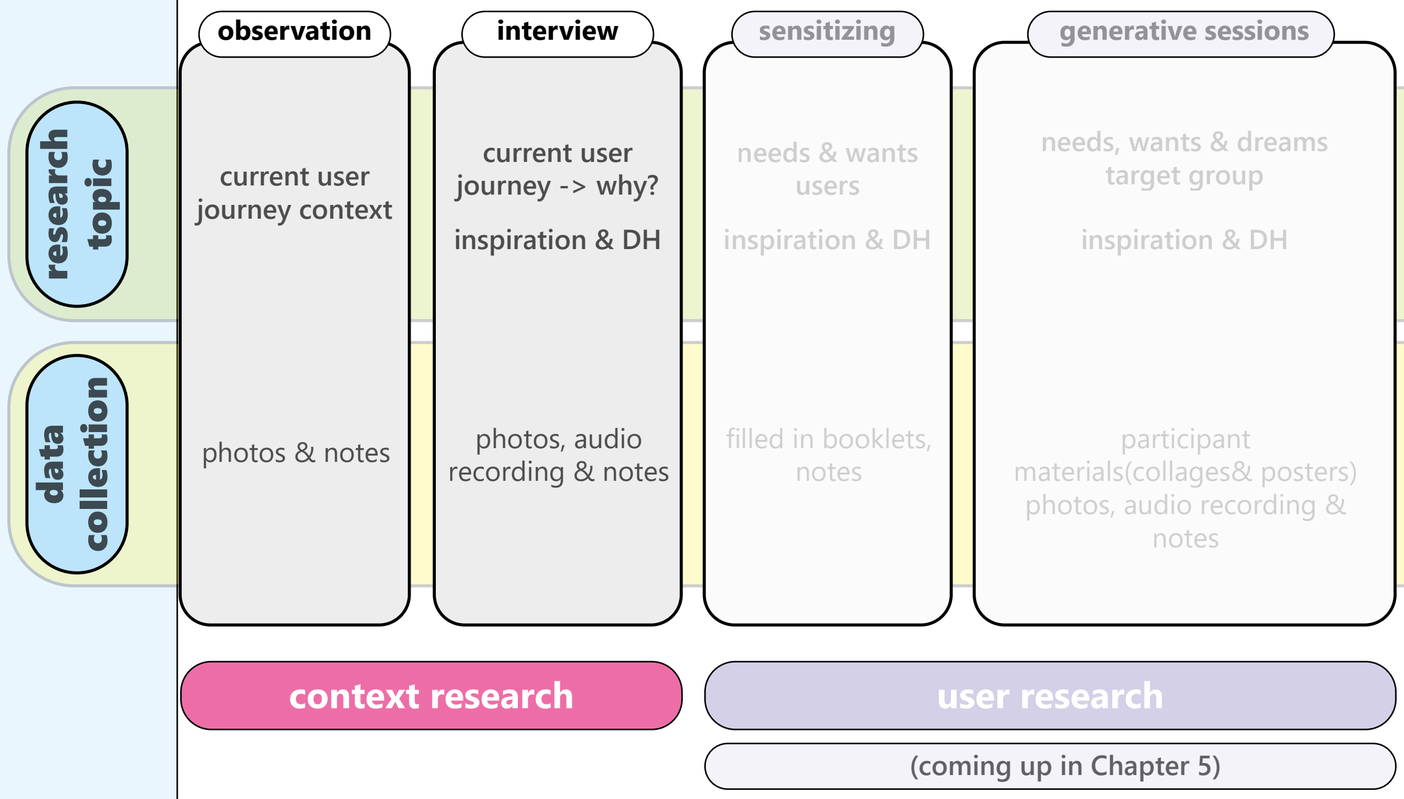
Figure 24: Context mapping knowledge pyramids (Sleeswijk Visser et al., 2005)

Institutions with collections often have exhibition spaces to display the different artefacts of their archive. Here at the IDE faculty, we have these displays too, located at different places inside the building.
In this chapter, the current physical context, where the design objects are displayed, is explored. These are the current touchpoints where students can have an interaction with the design heritage objects. The chapter answers the following research questions:

What is the current user journey, how do people interact with the objects and how does this make them feel & why?

The research phase is partly based on the context mapping framework by Sleeswijk Visser et al.(2005). To get knowledge on different levels, all of the techniques were used (Figure 24). In this chapter, interviews and observations are discussed.
On the right is a visual overview of the methods used and knowledge types gained per activity, when exploring the context. The context was observed to see how the target group acts around and with the artefacts.
Thereafter students were interviewed in the context, to get a better understanding of their thoughts on the display, the objects, inspiration & design heritage as a whole.
(Note here the students were not picked beforehand or prepared for the interview, intending to get the most intuitive and honest answers possible)

These findings are categorized into the rose, thorn, and bud overview of the context and the current user journey.



4.1 interview HBI

To get a better understanding of the archive and Henri Baudet Institute's goal, the head of the HBI, and archivist was interviewed. The Henri Baudet Institute was founded in 2004, named after the late Henri Baudet, whom was professor design history at the faculty (FS Redactie, 2004).
The overarching goal of the institute is to safekeep classic industrial design products, in order for the students to learn and gain insight from.

During the interview the head of the institute was firm to state there currently is no interaction between students and the products, which she finds a pity. She reckons students can learn a lot from the collection, and was quick to mention that students 'lit up' when entering the archive in the basement.
The archivist also thinks this could be improved by better vitrines, supplying more information and involving the students more.
Finally she is very open to the findings and result of the project and is willing to lend some products for experimantation.
Furthermore no hard requirements are set by the institute, except the artefacts not getting damaged of course. For the full interview, please consult Appendix C.

Having spoken to the HBI and seeing the wide array of objects in the archive was inspiring. Also it is great that products from the archive can be lend to experiment with in later stages.
It is time however to dive into the context, and see how students behave. This is discussed in the upcoming section.

4.2 Exploration context space

There are a few displays inside the faculty where the artefacts of the Henri Baudet Institute(HBI), are viewable. The HBI itself has an archive in the basement, where most pieces are stored safely. However this is a private section, inaccessible to students. Figure 25 shows an overview of the locations where students are able to interact with and see the heritage products currently.

There are multiple touchpoints where students can interact with HBI's archival pieces.
In the **basement** there are two big vitrines. There is a (permanent) display on the **ground floor**, and the biggest display are on the **first floor**. The ground floor display is hidden, since it is at the corner of the hall, next to the elevators.
The one on the first floor is the largest display, encircling the drawing studios with different product types on view.
Note that this one is technically managed by the drawing staff, however a collaboration between the HBI and the staff is on the way , according to the institute.

Also as seen on the figure are minor displays on the **second floor** and up, however students seldomly come to these spaces, since they are meant for the staff. For that reason those displays were disregarded for further observations.
Having mapped out all the current product display locations:
How do students behave surrounding the displays and object within? This is discussed in the upcoming section.

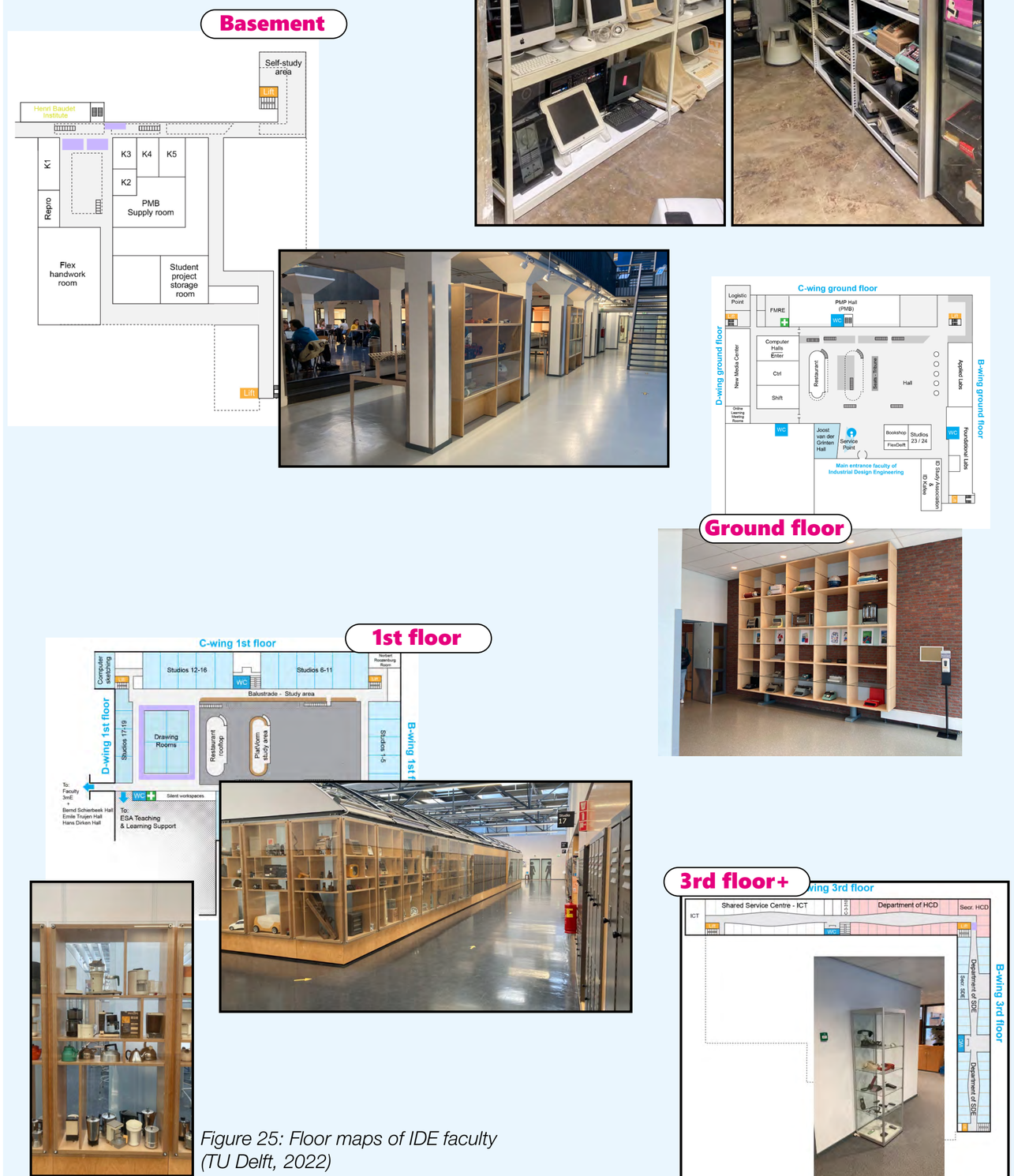


Figure 25: Floor maps of IDE faculty (TU Delft, 2022)

4.3 Context observation

Using the context mapping method, observations were made, to see how people act, what they do. This way relatively deeper knowledge can be achieved, than interviewing for example (Sleeswijk Visser et al., 2005).
To get an understanding of how the students act around and with the objects observations were carried out. This was done at different locations, during different moments of the day, on different days. The archival displays in the basement, ground and first floor were observed. On the right are photos of the observations and students interacting in-situ.

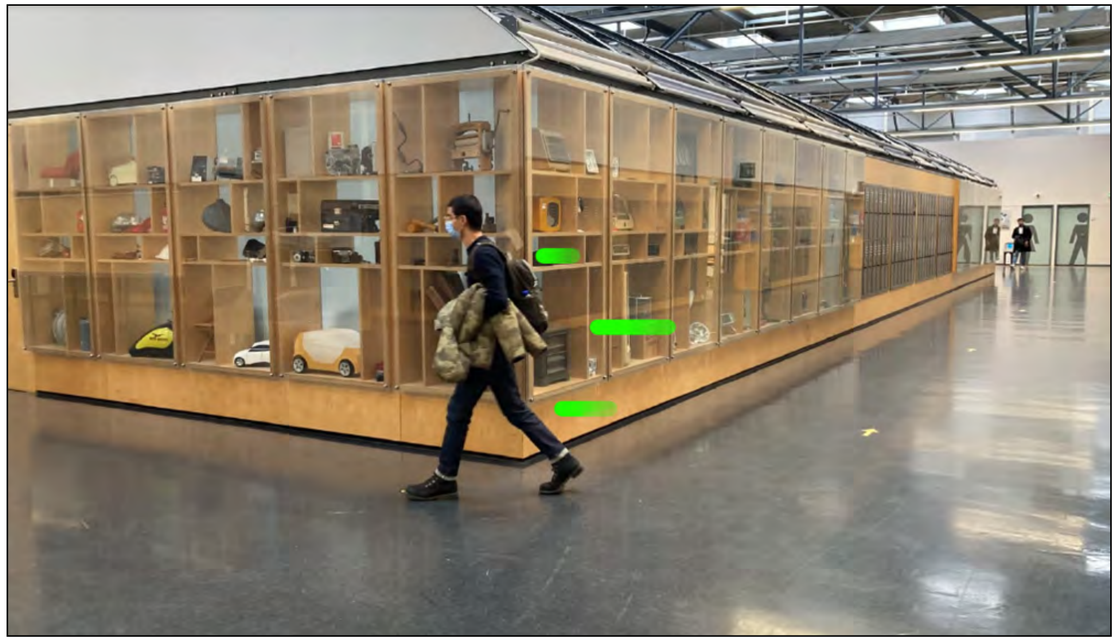
It quickly became clear that lots of students do not interact with the objects at all. The big majority are passersby, people going to a destination or coming from somewhere, e.g. going to their locker.
The second, smaller, group of passersby are having a break, walking around to take in the environment, yet still ignoring the displays.
The third group are people viewing the displays, this occurred just twice during the entire observation period, by non-IDE students actually.
These three main groups are further illustrated on the upcoming pages.

Very rarely do students stop to even glance at the objects, which makes sense when people have seen them before, over and over again. It is clear how people behave and having made the distinction between the three groups, mostly all ignoring the display and the artefacts inside.
Now knowing how the target group acts, it is needed to know why the students behave in such a way, this is explained in section 4.4.

Figure 26: selection of context observation photos

the Snipers

The snipers are the biggest group observed. They are in the corridor moving from point A to B, say from a lecture hall to a studio space.



the Sponges

Sponges are people who are moving more casually throughout the building, open to taking in and processing their environment. Often they are having a small break from work.

the Engagers

These are the people engaging with the archival products. Analyzing them, trying to draw links or studying the different forms.

4.4 Interviews in context

In this section the context itnerview setup and insights are discussed

4.4.1 Context interview setup

Interviews were conducted around the displays to understand why students behave in the way they do, and what their general opinion is on the display.
Also the students were asked how they typically get inspired, and what they know and would like to learn about Design Heritage. A total of 8 students were approached when passing by the displays and interviewed. Each interview was audio recorded (with permission) and key quotes have been distilled and processed. These are discussed in the interview insights(section 4.4.2).
The interviewees were a mix of different academic years, with equal male/female distribution.
The specific questions asked and user quotes can be seen in Appendix D.

Figure 27: selection of interviewees

4.4.2 interview insights

In this sub-section the interview insights are discussed and visualised. The visualisatinos show the main findings per topic drawn from the interviews. The participants were questioned about the display itself with objects inside, in relation to inspiration, design heritage and what they would like to learn.
Below is a concise summary per bubble topic:

1. Display and Products
The display and its products do not spark interest in the students anymore. Seeing them for the first time felt novel and interesting, however they get bored, and as an efffect ignored, after a while. With that the objects and display do not invoke a spark, they are non-inspiring to students in their current state.
Two students also mentioned that the products displayed felt 'passé', from the past, especially since the new bachelor is more service focused. They however explicitly mentioned this might be due to the presentation of the artefacts.
The objects in display were also framed as objects to draw during class.
Finally students mentioned a lack of information regarding the objects. Wanting to know more about a product and its story, but not having the information provided next to it.

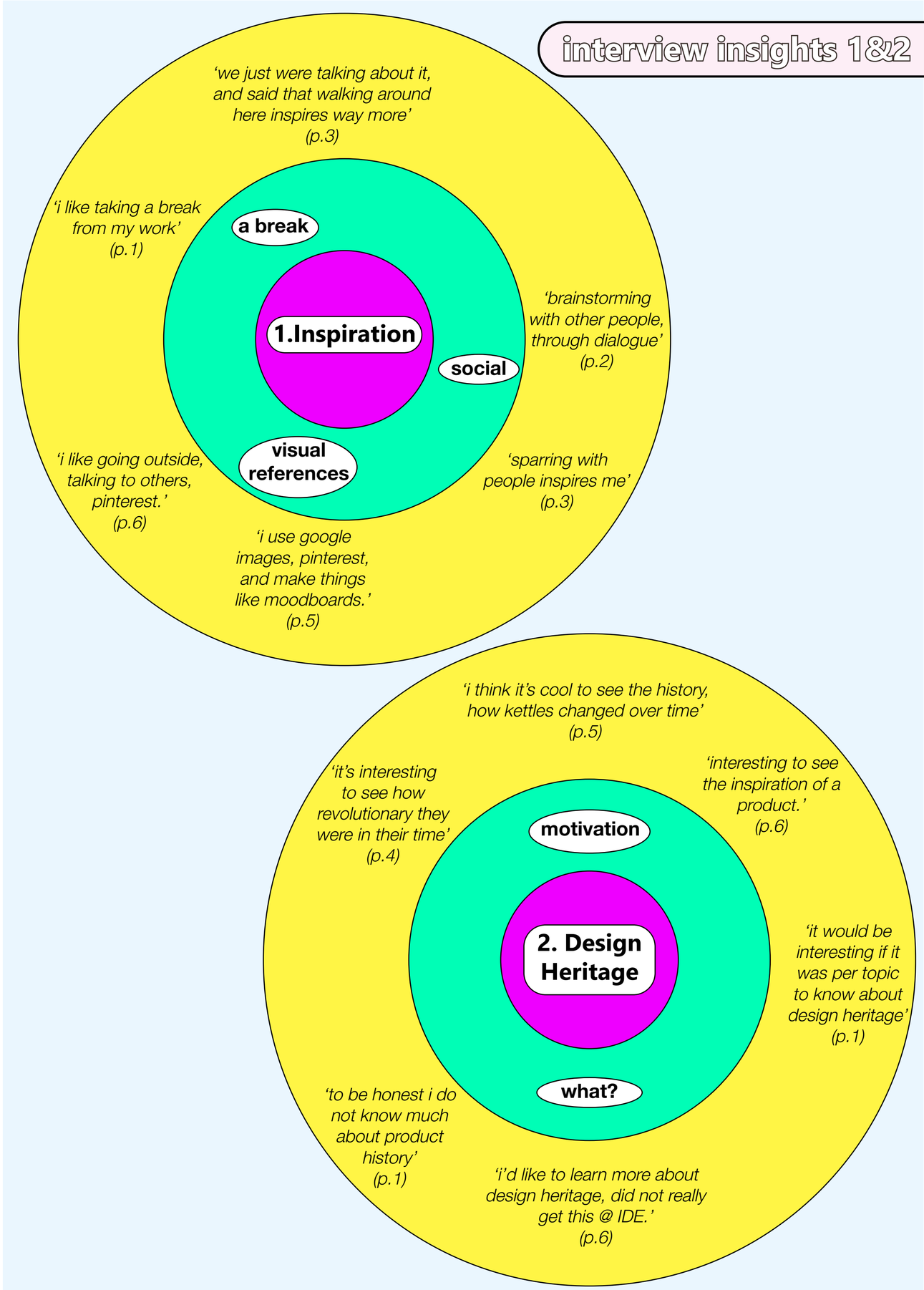
2. Inspiration
When looking to get inspired students look for visual references (e.g. Google images, Pinterest, make moodboards) or take a break from their environment (eg. go outside, go running, walk in the faculty). Unanimously students said they like to engage in social interactions, e.g. sparring with a partner about the topic or just talking.

3. the Context
The presentation of the display is not attractive in its current state. Students mentioned it feeling messy and 'not grabbing their attention'.
Also of course the vitrines are located in a corridor, where most people said they walk by to go from A to B.

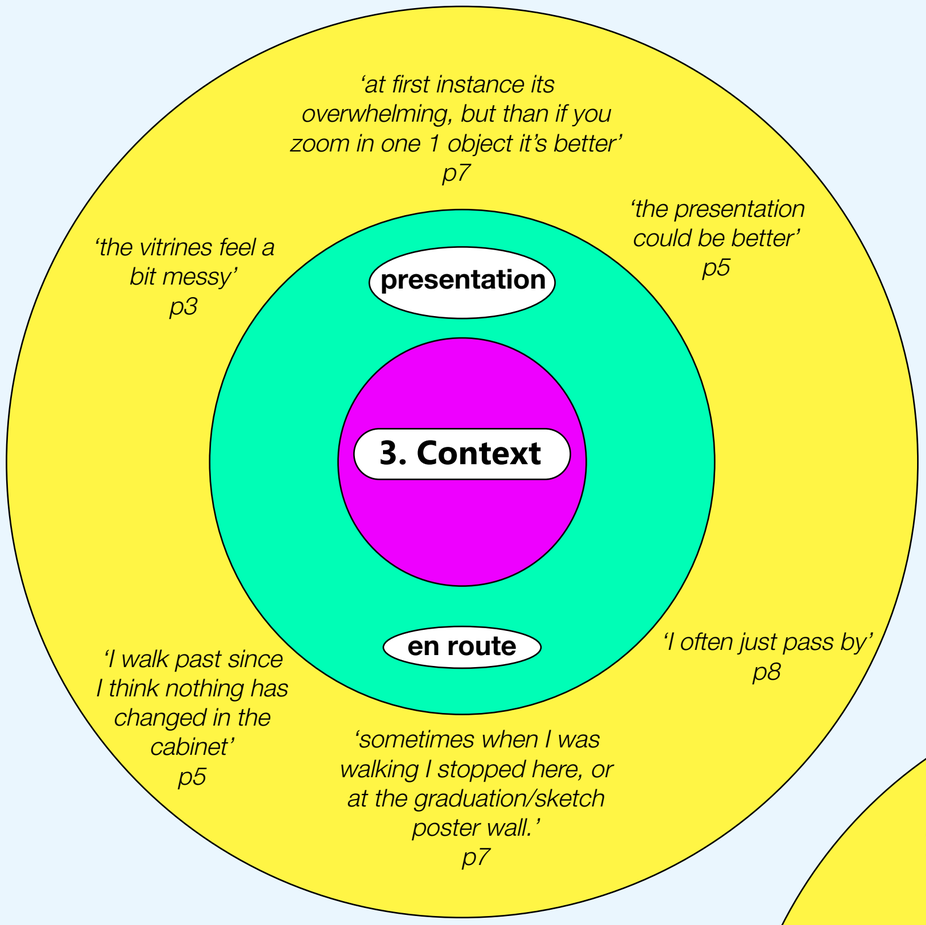
4. Design Heritage
Students feel they do not know much about design heritage, however are motivated and eager to learn more. Especially since this is not extensively taught in the bachelor's or master's curriculum they found.

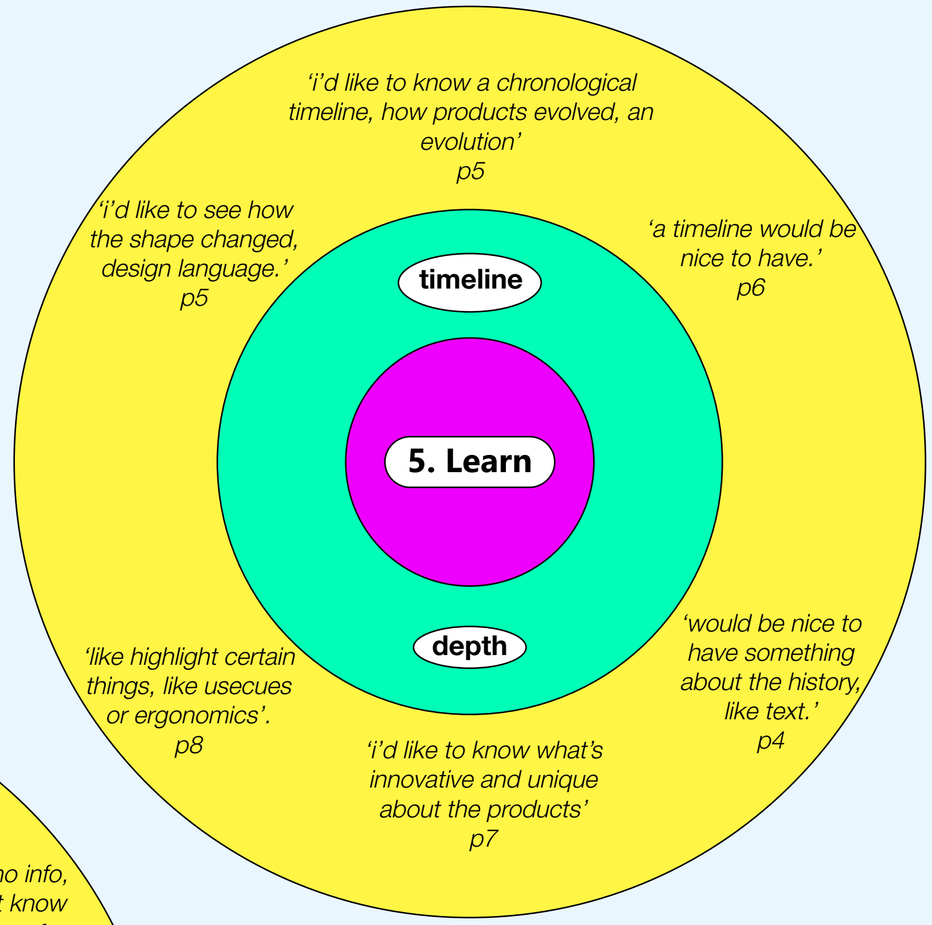
5. Learning
Students feel like they cannot learn much from the objects and presentation in their current state, except as drawing references. They want more depth and information about the collection.
Also a timeline of how a product(category) changed over time was mentioned multiple instances by students.

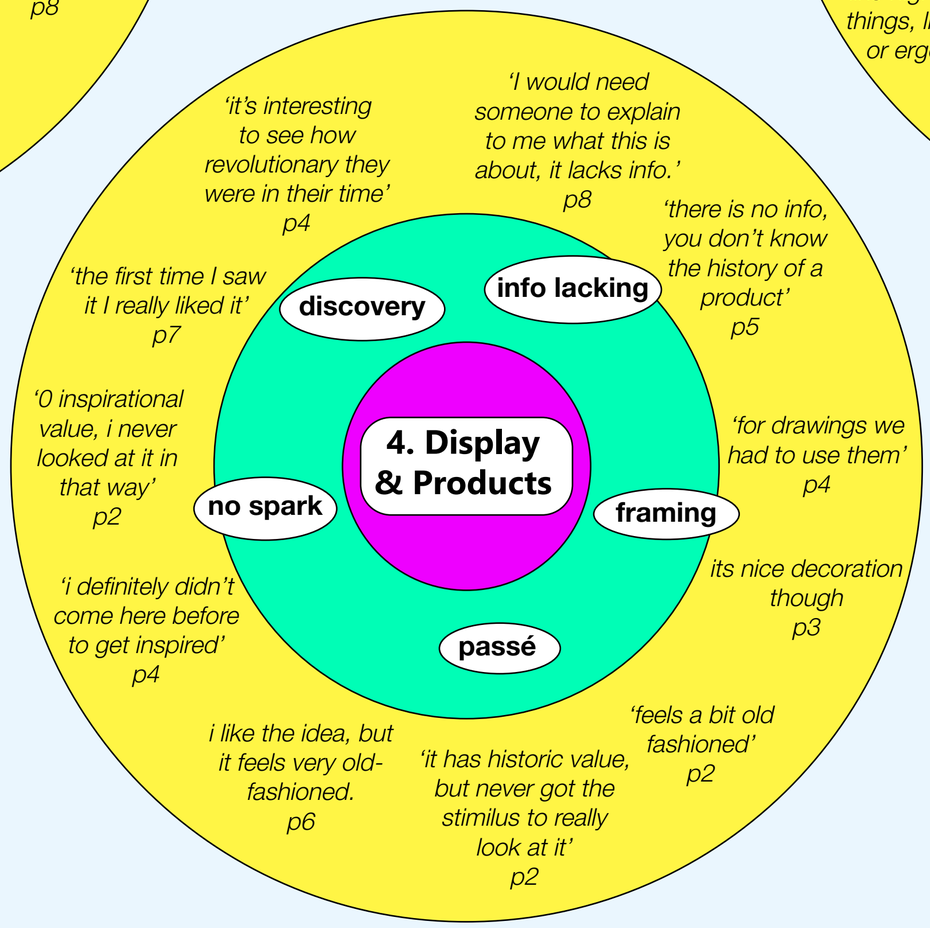
The upcoming pages show the insights per category, with quotes from interview participants and found themes.



interview insights 3-5







Rose, Thorn, Bud overview

Having performed the expert interview, observations and in-situ interviews, an insight overview was created. This in the form of; rose, thorns and buds. Positive points, negative points, and opportunities respectively. What are positive qualities of the objects and display, the challenges and what are the opportunities for the design project?
Also personas were made based on the insights.

Rose

1. Initially students found the objects inspiring, at first contact.

2. Students are motivated and willing to learn more about design heritage.
   a. They would like to have more information, content and depth
   b. Most students were interested in a timeline, the evolution of the artefacts. E.g. how a certain product (category) changed over time visually.

3. The Henri Baudet Institute has a wide array of classic design objects.

4. The HBI is open to a new experience, and is aware of the lack of student interaction.

5.The faculty has set displays to display the objects and is receptive to temporary exhibitions as seen in the past, e.g. in the hall.

Thorn

1. There is a lack of information linking to the products.

2. The display and objects do not spark students, they are not inspiring in their current state

3. Especially to some Bsc. students the products feel old-fashioned, passé.
initially the objects are exciting, after a while not anymore -> get ignored

4. The presentation of the object is not attractive. Students mentioned it feeling messy and just not grabbing their attention.

5. The biggest displays are situated in the corridors, however most people are on their way to a destination.

Bud

1. The object and space are framed in a certain manner, based on the past. E.g. used during drawing lessons & located at drawing studios.

2. Students often take a break from working, leaving their workplace/studio and e.g. going for a walk in the faculty.

3. Students often look for visual references when designing (inspiration).

4. Students like to engage socially when looking for inspiration (e.g. sparring).

5. The displays are situated in the corridor and are accessible.

6. Students are very much motivated and willing to learn more about design heritage.
   a. They would like to have more information, content and depth
   b. Most students were interested in a timeline, the evolution of the artefacts. E.g. how a certain product (category) changed over time visually.

Explorer

interested in **learning from past success**
gets inspired from **visual** references and **random** encounters/activities

sniper

Nienke, a 19-year old second year IDE student, needs good and accesible inspiration sources at the faculty, to be able to fulfill her design porjects in a proper manner. She likes browsing in books & pinterest and loves spontaneity

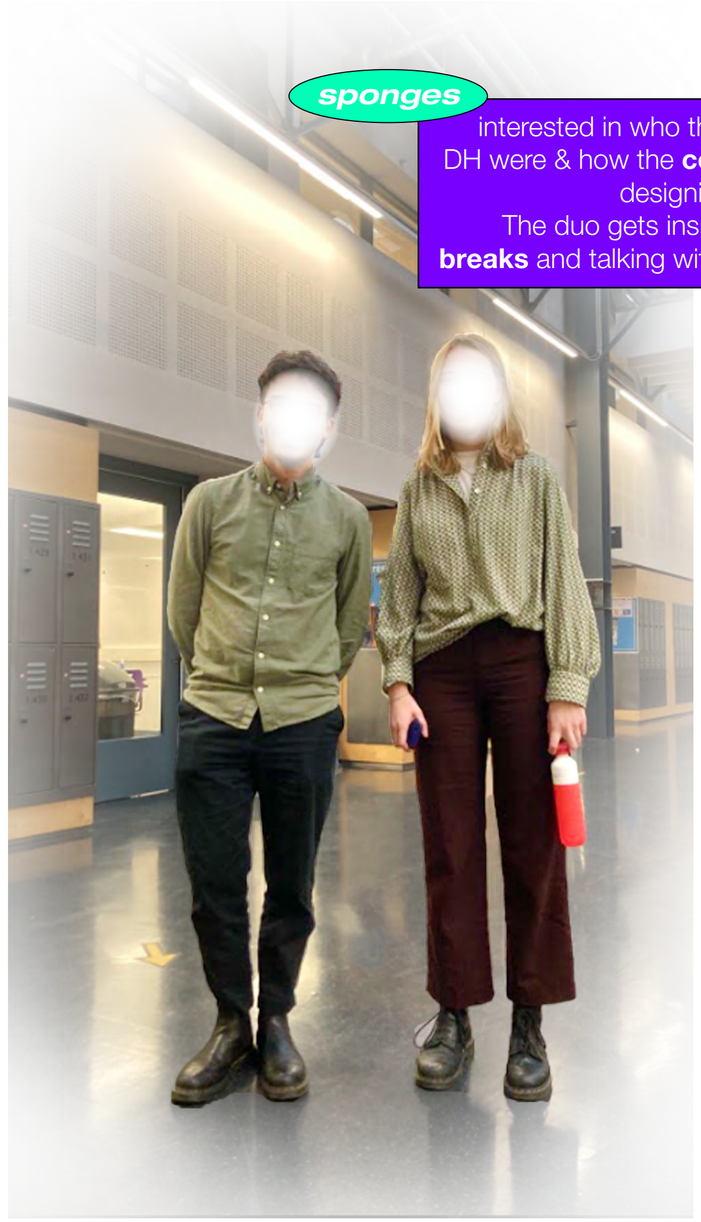
Expert

engager

interested in how products **evolved** over time & overall **design waves**
gets inspired from **history** and looking at the **process** of other design projects

Sep is a critical thinker with a passion for classical product design, as an IPD-er. He likes taking a step back, that is why his favorite question is; why?

Explorers



sponges

interested in who the **big names** of DH were & how the **context** impacted designing the products.
The duo gets inspired from taking **breaks** and talking with friends(**social**)

Khalid & Sietske take breaks together and go walking at the faculty during their design projects. As a break to chat and change scenery. Somehow they always return more inspired, since they can get inspired by the most random things.

4.5 Conclusion

Having performed the observation and interview study in context, the following can be concluded.

What is the current user journey and how do they currently interact with the objects?

Current interactions in context

Students can be categorized into three groups when interacting with the displays. The snipers, not engaging with the display, this formed the biggest group. The sponges, students who are casually walking around, eg. the faculty during a break. Finally the smallest group, engagers, people actually interacting with the design objects.

Currently, there is virtually no interaction between students and objects.

Why do students behave how they do and how does this make them feel?

Behaviour students in context

One of the main reasons why students ignore the objects in display are: they have seen them before, and there is no information provided. Also objects in current state are not inspiring to students. Finally however, students are motivated to learn more about Design Heritage.

CH5:
User Research

Chapter spine

5.1 Research Approach
- 5.1.1 Participants
- 5.1.2 Procedure

5.2 Sensitizing

5.3 Generative session
- 5.3.1 Session structure
- 5.3.2 Generative session insights per exercise

5.4 Conclusion

This chapter, of the Research phase, is dedicated to the exploration of the needs, wants and dreams of the target group, TU Delft IDE students. This concludes the context mapping trajectory, with a sensitizing exercise and generative session (Sleeswijk Visser et al., 2005).
The overarching question here is; Who are the users, and what are their needs, wants and dreams? How do they get inspired and what would they like to learn about design heritage, and why? These questions are essential to understand the current situation, to be able to achieve the desired situation (design goal).

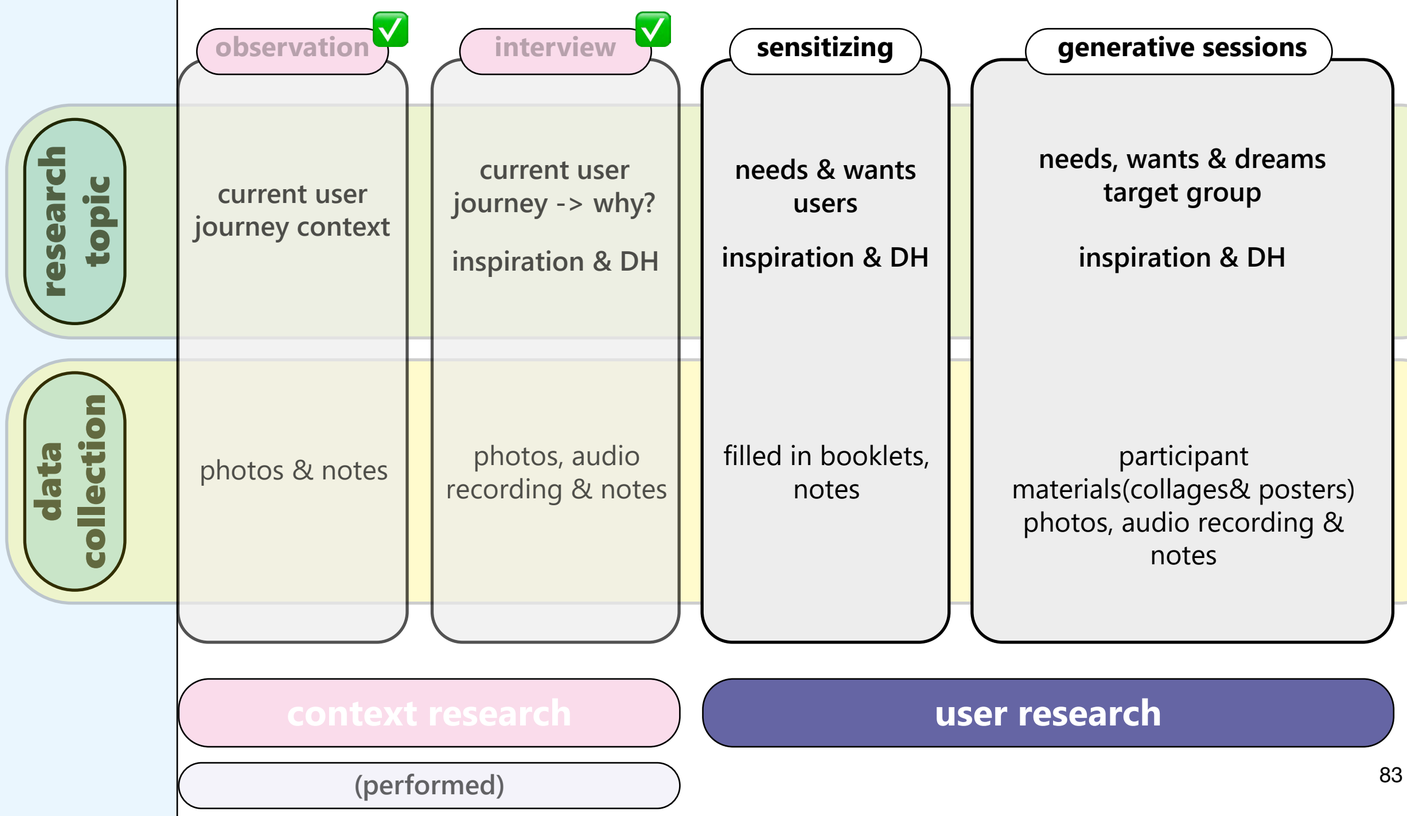
First the approach is discussed, followed by the participants and procedure. Afterwards the sensitizing exercise, and than the generative session. The chapter ends with a conclusion overview, answering the research questions based on the research.
On the right is an overview of the specific methods used, research questions and data collection methods used during the research.

The following research questions were posed to be answered;

1. What are the needs, wants and dreams of the users?

2. How do students currently get inspired (at the faculty) during their design projects?

3. What do students know about DH and what would they like to learn, if anything?



5.1 Research Approach

This final part of the user research is constructed on the context mapping method, in order for students to reminisce, reflect on their current situation, and voice their dreams.
The intent was to cover the pyramids(Figure 24) as much as possible, from surface level, to latent knowledge, now taking the baton from the context insights from the last chapter. Through interviews, observations(context research) and the use of generative tools, the latter described in this chapter.

5.1.1 Participants

For the research trajectory, participants from the target group were recruited, IDE students from first-year BSc. up to Master graduation students, to get an equally good cover. First-year students specifically were recruited via the DP2 course. There also was a 50/50 split between male-female.

5.1.2 Procedure

The research was composed of different stages to prepare participants and get as much valuable information as possible. First participants were asked to fill in and keep a sensitizing booklet, 'inspiry diary'. Here participants got primed to think about their past and current thoughts regarding inspiration and Design Heritage.
This was followed by a joint generative session with the participants. Due to differing schedules, this was split between two sessions, the first with 8, and the second with 4 participants.
Note that these two user research methods are forming one whole trajectory, yet the results can be interpreted exclusively. Meaning that not all participants who fill in the booklet have to join the generative session and vice versa. Ideally this would have been the case, however, this was not possible in reality. Eventually eight people performed the full cycle (sensitizing+generative session), 11 people filled in the sensitizing booklet and twelve participated in the generative session.

5.2 Sensitizing

For the sensitizing exercise, a booklet was made for students to fill in and keep. The pool of students filled in how they get inspired, during their design project, and their views on Design Heritage. Finally, they were asked to reflect on how they felt during two of their working days, how did they get inspired during the day? To see the entire booklet and filled in versions, please refer to Appendix E. On page 60, an overview of intermediate insights of the sensitizing exercise;

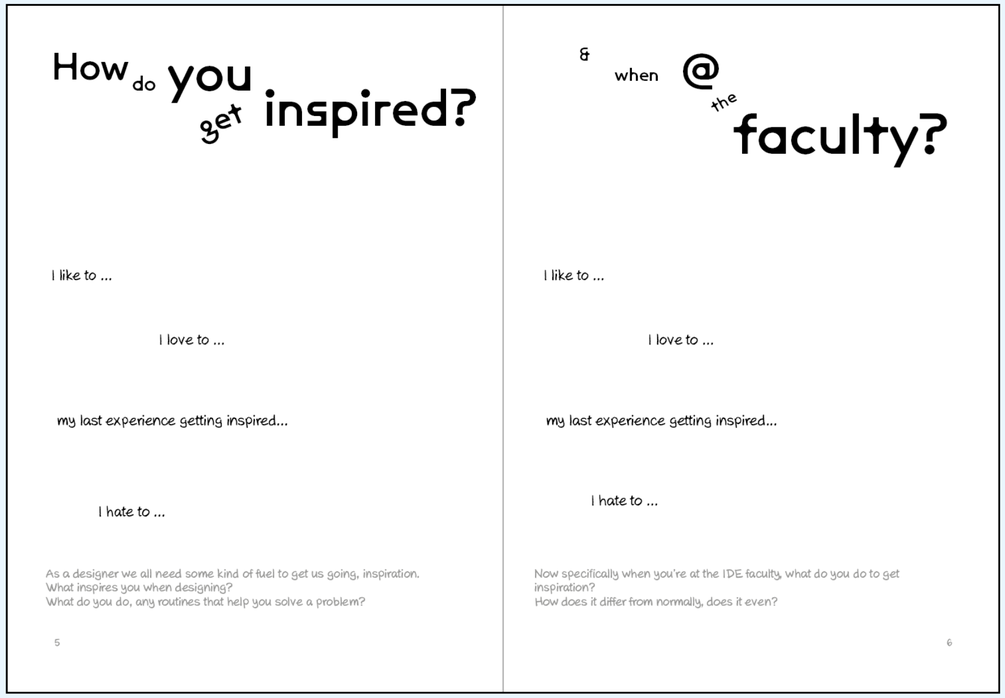


Figure 28: excerpt from sensitizing booklet

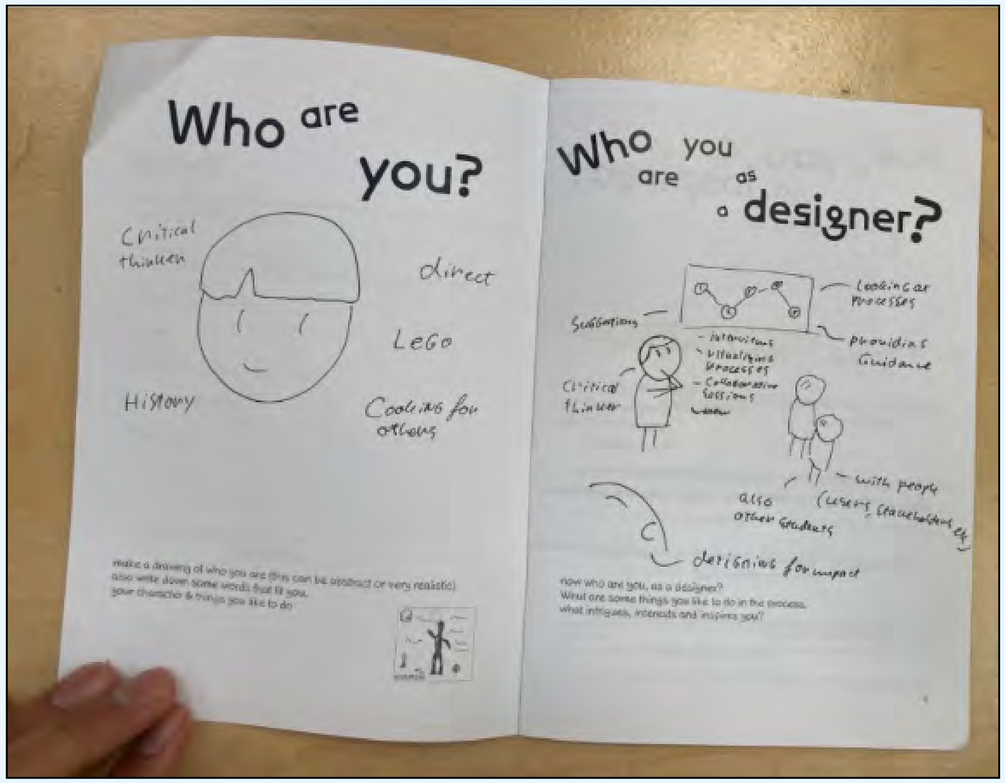


Figure 29: example of filled in sensitizing booklet

Sensitizing insights per research question;

1.Inspiration, how do students get inspired?
social; in their projects students like to get inspired socially, with other students. E.g. talking with other students about their topic, thoughts or ideas.
a break; to get inspired students like to change activities; go running, meditate, stretch etc.
visual; students enjoy looking at visual references, imagery online or in books to get inspired.
history; some students like to look into history for inspiration

2.Inspiration @ faculty, how do students get inspired at the faculty?
social; At the faculty number the one inspiration source is interacting with others, in a social context. Chatting with eachother, sparring, sharing thoughts etc.
a break; Students like to change their location when working. Say working in the studio, go for a coffee or walk around to roam the faculty.

3.Design Heritage - how much & what do they know?
not much/idk; curently students find they do not know a lot about design history or heritage. Their knowledge is (very) limited.
icons; students mentioned classic design when asked about which ones they liked. There seems to be no clear category students are intrigued by.

4. Design Heritage - what would students like to learn?
why?; Students want to learn why certain choices were made. Also how and why certain products became successful.
generic; the basics; who where the big designers, iconic designs & why(see point a).
timeline; lots of students wanted to know how a product changed throughout time
videos;videos were mentioned multiple time as a nice format, how students like to learn things. They like the videos to be engaging and short-format.
stories; students mentioned to want to learn more about the stories of DH products
hate text; Students do not enjoy reading (long) bits of text as a format.

5.DITL insights
random; students sometimes get inspired at random moments, things coming together in their mind subconsciously.
social; moments of inspiration usually are socially, with someone else or when interacting in group
context break; students like to take breaks from what they are doing, changing physical location. This seems to fuel and inspire them
visual; the visual element is repeated again, students getting inspired from images, spaces or physical objects.

Brief conclusion per research question;

1. Students get inspired **socially**, by taking a **break**, look for **visual** references or look into the past.

2. There are **no new insights**, students mentioned walking around the faculty as a break often however.

3. Students **do not know much** about Design Heritage.
For now they seem interested in design trailblazers.

4. Students are interested **why** certain choices were made regarding products. They also seem interested in gaining **generic information**, and multiple expressed interested in a **timeline** of (a period in) Design Heritage.

5. Participants seemed to have **random** bursts of inspiration, especially post-**break** or post-**social** contact they seemed more inspired.
Also meta-factors like being at home due to quarantine or sick played a big role in their inspiration levels, here negatively.

5.3 Generative session

The generative sessions were held on location at the IDE faculty with a total of 12 participants, of whom 8 filled in the sensitizing booklet before. Again here there was a mix of IDE students from different years. The main research objective was to reveal the dreams of the participants, regarding inspiration and Design Heritage. How would they like to get inspired and what would they like to learn about DH? Below is an overview of the session's structure.

5.3.1 Session structure

The session was a one-hour pressure cooker, where students reflect, discuss and create. The session started with a brief explanation of the intent of the generative session. Afterwards, they discussed the topics of inspiration and DH altogether.

The first exercise was to create a collage based on how they like to get inspired during a design project. A selection of words and photos was prepared intentively, partly based on the interim insights, on how students get inspired, by the context interviews. This was in order to verify/falsify these insights. The first exercise concluded with the students briefly explaining their collage.
As an icebreaker, a few objects from the HBI archive were revealed and shown. The students came forward and could carefully interact with them.

For the second exercise, students were asked to write down what they would like to learn on the topic of Design Heritage. Here the objects function as a concrete example.
The final exercise was in groups and synthesis of the first two: Create an experience where you get inspired and learn about DH? Here the participants came up with ideas and the session was closed with a short pitch on their concept.
To close the session the students were thanked and given a little snack or piece of fruit to rake with them.

For the first exercise, students were free to use the set of pictures and words, draw etc. to create their collage. For the provided set of pictures and words see Appendix E, also for the analyzed and original collages.

A pattern of recurring themes and ways to get inspired were identified during analyzing, in order of mentioned and stressed the most, the results below;

For the second exercise, the students brainstormed on the topic of DH using post-its.
On the next page an example of one of the student's deliverables.

The final exercise of the session was for students to create a poster where they synthesize both of their previous results. Creating a concept where they combine how they like to get inspired, with what they would like to learn regarding Design Heritage. They did this in the form of a poster and presented it at the end of the sessions. Please consult Appendix E for each poster with a brief explanation.

Figure 30: participants during the generative session

Figure 31: a duo presenting their concept at the end of the session

session photos

5.3.2 Generative session insights per exercise

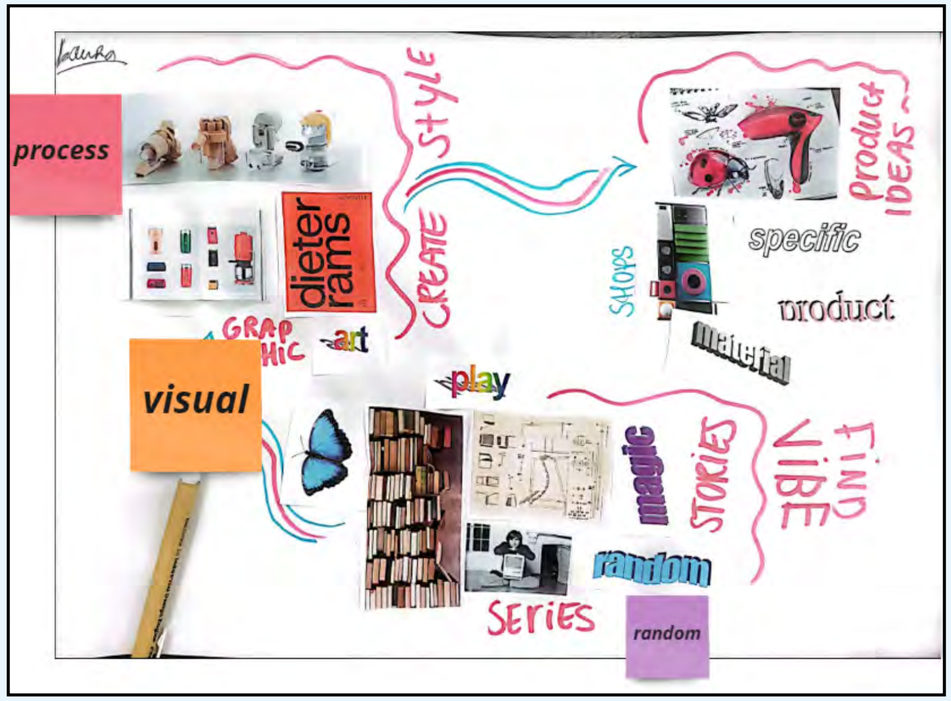


Figure 32: excerpt student collages & post-it analysis

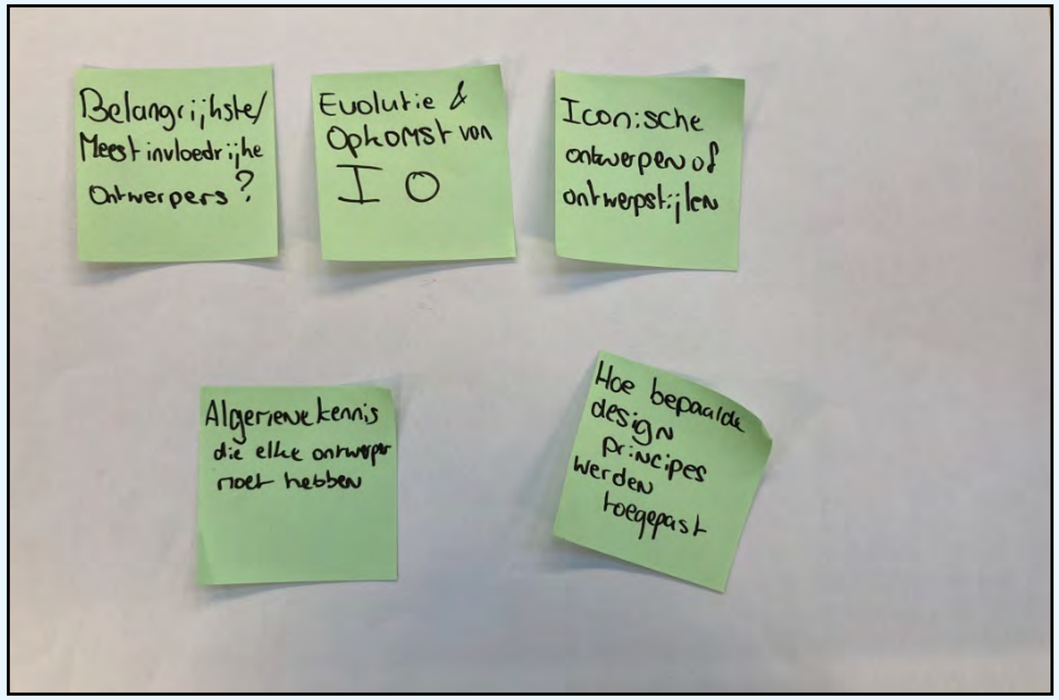


Figure 33: example of DH map students

1. **Collage**: *How do students get inspired (during their design project)?*

1. Students get inspired **socially**. This means working together, sparring or talking to get inspired. By talking to eachother, 'sparring' etc. (11/12 students)
2. Multiple participants stressed the **visual** aspect of designs than inspire them. Think of books with imagery, instagram or pinterest. (8/12 participants)
3. Students get a boost of inspiration from taking a **break** from working on their project. Students mentioned getting out of the studio, walking around, go for a run, meditate etc. note: the context change from their desk to somwhere else in or outside the faculty. (7/12 students)
4. Participants also liked to persue **random** or directly unrelated acitivities or material. Such as impromptu going for a cup of coffee, or longboarding a participant mentioned. Students also mentioned reading about topics that are directly unrelated to their design project. (6/12 participants)
5. Some students explicitly mentioned they get inspiration from **history**. Important here is that 4 of which had a picture of Steve Jobs on their collage, getting fueled by 'inspiring designers'. (4/12 students)
6. **Process** can be seen multiple instances in the collages. Students mentioned they like to see the process of other design projects, which in turn can inspire theirs. (4/12 students)

2. **Braindrawing/writing**: *What would you like to learn about DH?*

1. **Why success?**: The students want to learn from the past, understanding why a design was a success or a flop.
    a. -> What made this design a success, why? --> implement
    b. ->What made this design a flop, why? --> prevent
2. **Trailblazers**: Students want to learn about the 'big names' , designers that had major impact on the field of industrial design, say entailed a paradigm shift. Think of Rams, Jobs and other lesser knowns.
3. **Evolution**: Participants want to learn how a product evolved over time, say a tv. -> how did the design language change over time?
Also there is some interest how a specific design went from initial idea sketches to prototypes and final product.
4. **Waves**: Students want to get a better understanding of the design waves/ styles throughout time. What were the characteristics of a specific design wave, to be able to identify, and implement design styles and principles.
5. **Context**: Participants also showed interest in the broader context of designs of the past. How was living like back than, what factors had an impact on the design. What was the context like?
6. **General**: Students want a basic level of design heritage, design 101. Design, production methods over time. Eg. A date per object, users etc.

3. **Create Poster**: *How would you like to learn more about DH? (combination 1&2)*

Insights gained from students' posters, here students dream of a certain way they would like to learn more about DH. The concept posters were analysed, entailing the formulation of the insights below;

1. Students dream of a **timeline** where evolution of a specific product is portrayed. Showing how it, mainly how it changed visually over time.

2. Students dream to **use the past as a springboard to dive into the waters of the future**. Students dream to learn from the past, to prevent mistakes made and learn from past successes.

3. Students dream that the medium to be **experiential**, immersive. They came up with ideas that are spatial and multisensory. None of them proposed traditonal mediums of knowledge transfer, like books for example.

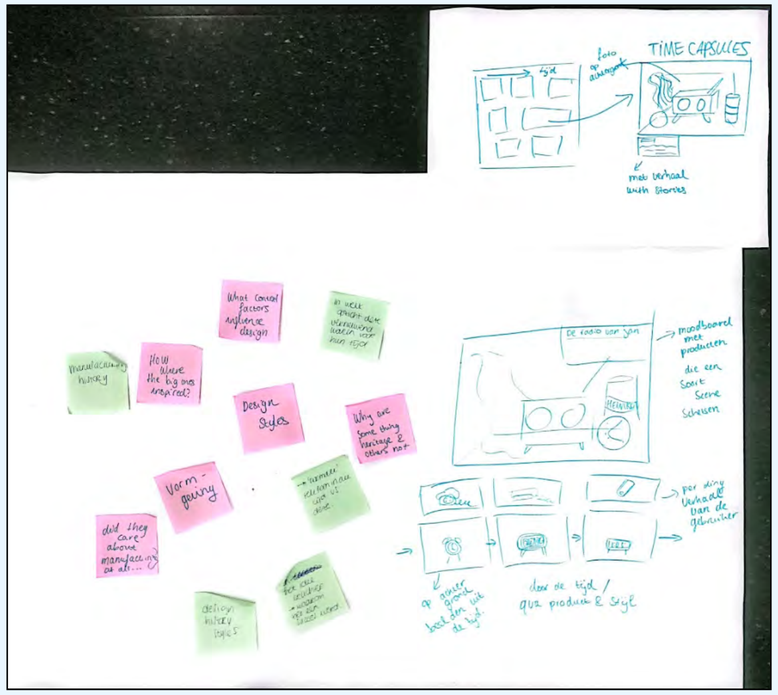


Figure 34: example concept posters students

Having performed the observation and interview study in context, the following can be concluded.

How do students want to get inspired?

Inspiration

It is apparent that students get inspired **socially**, by talking to teammates and friends about the project topic or casual chat. During their design project students often resort to **visual** references to get inspired, imagery in books, online or objects. Furthermore taking **breaks** from their physical location and activity was mentioned repeatedly. Also, **random** activities, such as impromptu going for a cup of coffee or for a jog have an inspiring effect on students. Mentioned multiple instances, but less often, was looking into **history** and getting inspired by the **process** of other design projects.

What would students like to learn about Design Heritage?

Design Heritage

Students showed high interest on why certain designs were **successful**, and others not. They would also would like to learn more about **trailblazers**, impactful designers, and learn about the **evolution** of a specific product(category) over time. Furthermore students showed interest in **design wave**, design periods or paradigms, the **context** of use and finally students want more **generic information** on the artefacts.

What are the students' dreams?

Dreams

Students dream to use the **past as a springboard to dive into the waters of the future**.
Students dream to learn from the past, to prevent mistakes made and **learn from past successes**.
They dream of an **experiential** intervention, rather than a solely informative one.
And finally students are interested in a **timeline** of sorts, portraying the visual change of a product(category) over time.

5.4 Conclusion

CH6:
Moving Forward

In this Chapter the insights from the previous chapters are translated into requirements, the sharpened design goal and interaction vision. These all to direct and inspire the next phase, of ideation and conceptualisation.

Chapter spine
6.1 Iterated Design Goal
6.2 Interaction Vision
6.3 Key Requirements

6.1 iterated Design Goal

Based on the insights from the research phase the initial Design Goal(see project brief), is sharpened.
Changes into the word choice and interaction qualities were made, the iterated design goal is the following;

Design Goal

For visitors to gain deeper insight regarding the institute's design artefacts, and their stories, through an **engaging** layered (e.g. multi-sensory) experience, in an **accessible** and casual manner.

Ultimately ***inspiring*** the visitors, and facilitating the opportunity for ***learning*** about product design history.

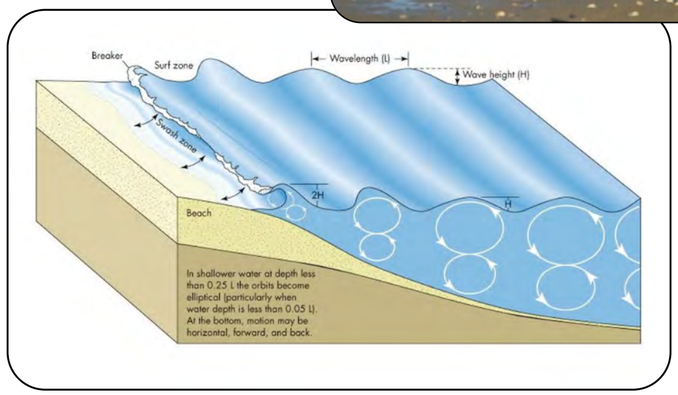
6.2 interaction vision

Based on the research and iterated design goal, the following interaction vision is set to inspire the ideation phase and represent the desired interaction qualities;

Interaction Vision

‘Pootjebaden’ (Paddling feet)

The interaction vision is based on the metaphor of paddling feet, ‘pootjebaden’ in Dutch.
One being able to step into the sea for a limited amount of time, in a **casual** and spontaneous way. Taking in the environment and seeing how the sunlight reflects on the ocean waves. You notice and create little waves by moving your feet **playfully**, seeing more and other shimmers of light glittering. If you feel like it, you can roll up your pants, get in even deeper, or just enjoy it briefly and hop out. You decide the depth and time spent immersed in the water(**autonomy**).



(Volkskrant, 2011)
(de Graaf, 2022)
(Griffin, 2018)
(ShutterStock, 2022)

6.3 Key Requirements

With the insights from the research stage, literature research, and theuser and context study , the following key requirements are presented. For the Plan of Requirements, please consult Appendix G.

LEARNING
3. The design facilitates learning through, at least half, of Kolb's experiential learning cycle.

CONTENT
7. The design communicates the information in a short and engaging manner. This could be in the form of storytelling.

INSPIRATION
9. The design inspires the visitors.

TECHNOLOGY
15. The design is able to be used on both IOS and Android platforms (multi-platform)
17. The digital experience can start instantly, the user not needing to install any apps or programmes on their device. Either that OR: the preloaded devices are accessible, to the users

EXPERIENCE
20. The design has a strong visual component in the experience, communicating mainly visually.

MID-EXPERIENCE
24. The experience engages users.
25. The experience is casual, meaning the user is in charge when they step in and/or out of it.
26. The experience is inspiring for the visitors. Inspiring them through highlighting Design Heritage.
27. The experience does not (solely) provide plain and dull information, but rather communicates materials for visitors to learn through.
31. The experience adds to the physical object and real-life experience, rather than trying to replace it with the digital. E.i the experience is complementary rather than trying to be substituting.

POST-EXPERIENCE
33. The experience gives visitors food for thought, so they can reflect on the newly gained knowledge and apply it to their practice for example.(Kolb's Learning Cycle)

INTERACTION
36. The interactions are casual, fun and engaging. [IV qualities]
37. The interactions [per object] can be both short and sweet or long and deep depending on the user. The user has autonomy over their experience.
39. There is a balance between real-world and digital interactions

CH7: Conceptualisation

In this chapter, the conceptualisation phase of the graduation project is presented. The previous chapters were research and insight-oriented, this chapter shows the process of moulding the identified problems and insights into the solution space. All to fulfil the proposed design goal (section 6.1).

To start, the approach to the conceptualization phase is discussed. Secondly the ideation and concept development, afterwards the converging (chosen direction) and the concept storyboard are presented.
Afterwards the exploration of AR technology and the concept through prototyping is discussed. Lastly the small-scale iterative user tests are discussed, to improve the concept and prototypes.

Chapter spine

*Bonus sub-chapter

7.1 Approach to Design Phase

To be able to reach the design goal, in the dedicated time and guide the process, a specific approach was taken for this phase, especially in order to come up with novel and new ideas. A combination of methods was used, further discussed in section 7.3. To direct the ideas and concepts an interaction vision map was created, discussed in the upcoming section.

7.2 Envisioned interactions

Before starting the project, an initial project/ concept vision was created regarding the current state of interactions between artefacts and museum visitors and initially envisioned (Figure 35). This initial vision now set the basis for a more developed vision of interactions. How would the visitors interact with the artefact (digitally)? How do the Design Goal elements play a role? And what about the Interaction Vision qualities? Figure 37 shows this more developed interaction board.

From a more zoomed-out view, the interactions should act as the means to an end. The end, being the users to learn about the artefact in regards to DH and become inspired, essentially achieving the design goal. FIgure 36 shows this overall intent and the interaction qualities.
The means themselves, the interactions the user has, should have the following qualities: be playful, engaging and feel casual.
An envisioned interaction storyboard was made that combines these envisioned qualities into four steps on the next page.

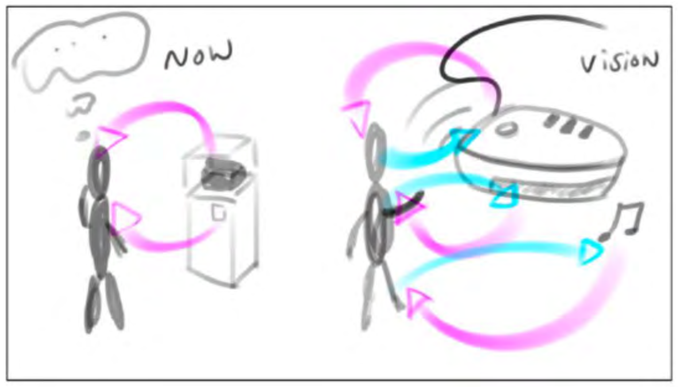


Figure 35: initial interaction vision

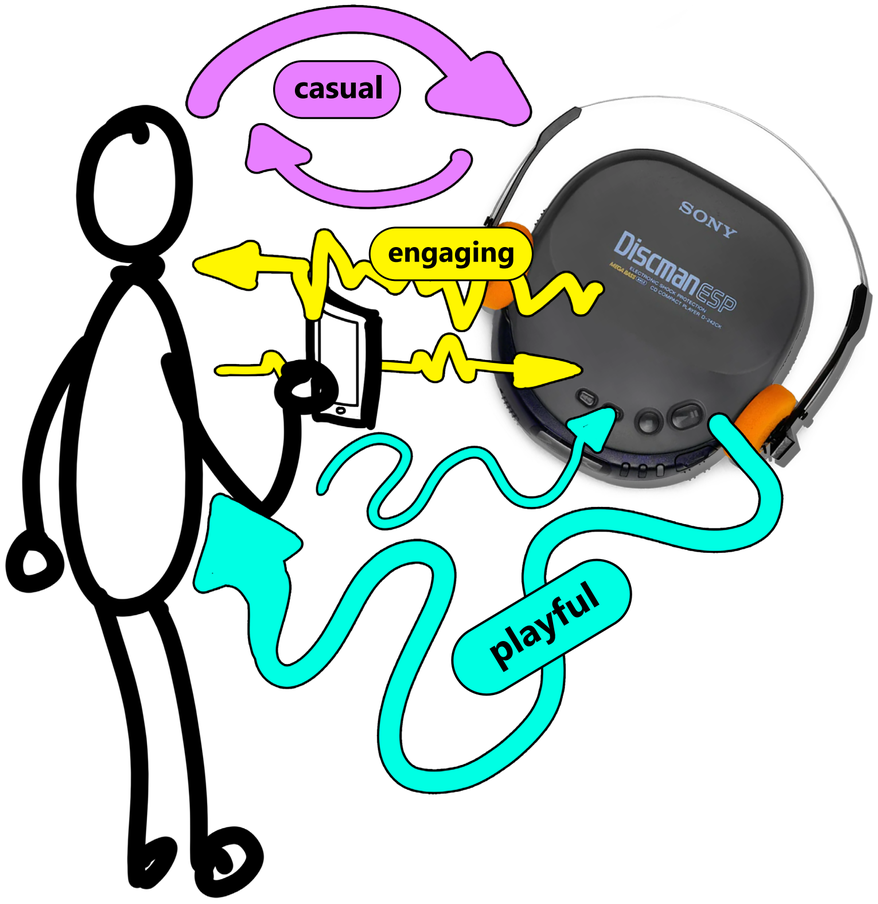


Figure 36: overall interaction qualities user <-> artefact

Step 1: When arriving at the artefact the user first appreciates the physical object itself. There is a moment of exploration, discovery and 'getting to know' the artefact, beofre diving into the digital world. This would be fully analogue, with no devices yet.

Step 2: Before diving into full-on learning, the visitor interacts with the object in an engaging and playful manner. This could be done by exploring the object further for example. In this step augmentation effects are playing a role, to overlay AR elements and inspire the user.
This inspiring experience ought to be achieved based on the findings from the research phase, how students like to get inspired (section 5.4). For example by having strong visual elements, socially or having random and surprising parts.

Step 3: The main goal of the third step is to invoke learning more about the artefact and its backstory. What is it? Why is it important now? What was its historical context? This interaction is intended to be casual, not formal. Again the above would be achieved using AR technology to facilitate these interactions.

Step 4: The final step is meant to close Kolb's learning cycle, for visitors to reflect upon what they just experienced and apply it. This could be in their practice post-visit or immediately in the space. This part is envisioned to be playful and push visitors to reflect (post-visit).Here again, augmentation can play a (small) role.
From here the user can re-experience parts, go to the next artefact or at the end exit the space.

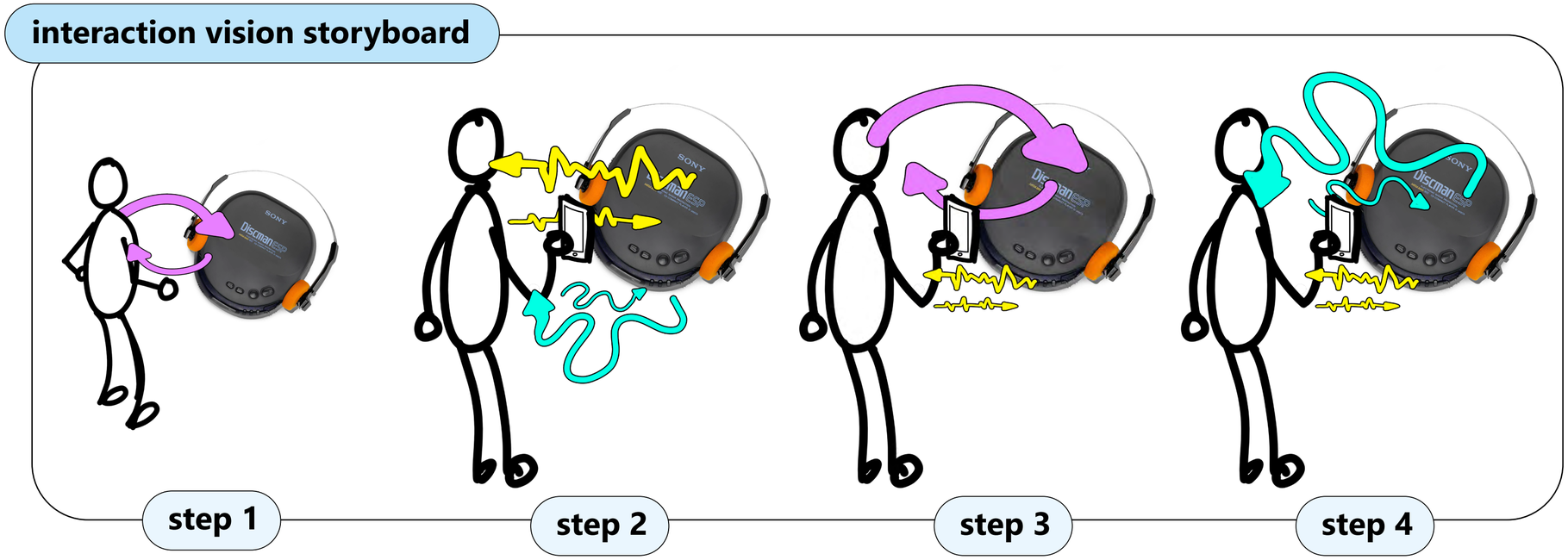


Figure 37: interaction vision storyboard

7.3 Ideation process

This section discusses the ideation to concept process, by highlighting the major steps taken, and the diverging and converging moments throughout the process. Figure 38 shows a visual overview of the process and key delivery moments in.

To kickstart the ideation process, a goal was set to first come up with 100 ideas. The premise was not to specifically look into references, but freely ideate to get the first ideas out. From there a 'bottleneck' occurred and AR's building blocks, see Figure 38, were consulted to mix and match these building blocks into ideas.

Within the 100 were ideas on a digital, relating to the AR experience, but also on a spatial level, relating to the environment the artefacts are placed in and visitors go through the space. Figure 39 shows excerpts from this ideation, which were mostly sketches and written text.

To not get stuck in one's ideation process and get a fresh new perspective, a small co-creation session was held to get fresh insights and perspectives regarding the design challenge. The session was held during a Musem Futures lab meeting, wherein IDE students and staff members participated.
Firstly the graduation topic was introduced, and a collective discussion on the definition of AR was held. After the participants were given the 'AR building blocks' to ideate with. Lastly, the participants were asked to come up with ideas regarding the IDE context, so incorporating physical space. Figure 40 shows examples of the co-creation results.

This session gave a fresh blow to the ideation process, seeing different ideas and perspectives of approaching the design brief. Some of these (part)-ideas were further developed and combined with prior ideas.
From here the first converging moment took place, picking ideas based on whether they already existed. How innovative is this idea, interaction or experience part? From here the ideas that were selected were further iterated and developed. The reference projects, discussed in section 3.6, were used as a comparison,

A second round of converging took place, which was based on how well these more developed ideas fit the envisioned interaction storyboard.

From here the ideas that stuck underwent a third cycle of development and, again, went through a funnel. This time based on the key requirements.
From here on, several concepts were created and combined to create one final concept. From here the concept storyboard was made, containing the subparts and the main digital concept is highlighted.

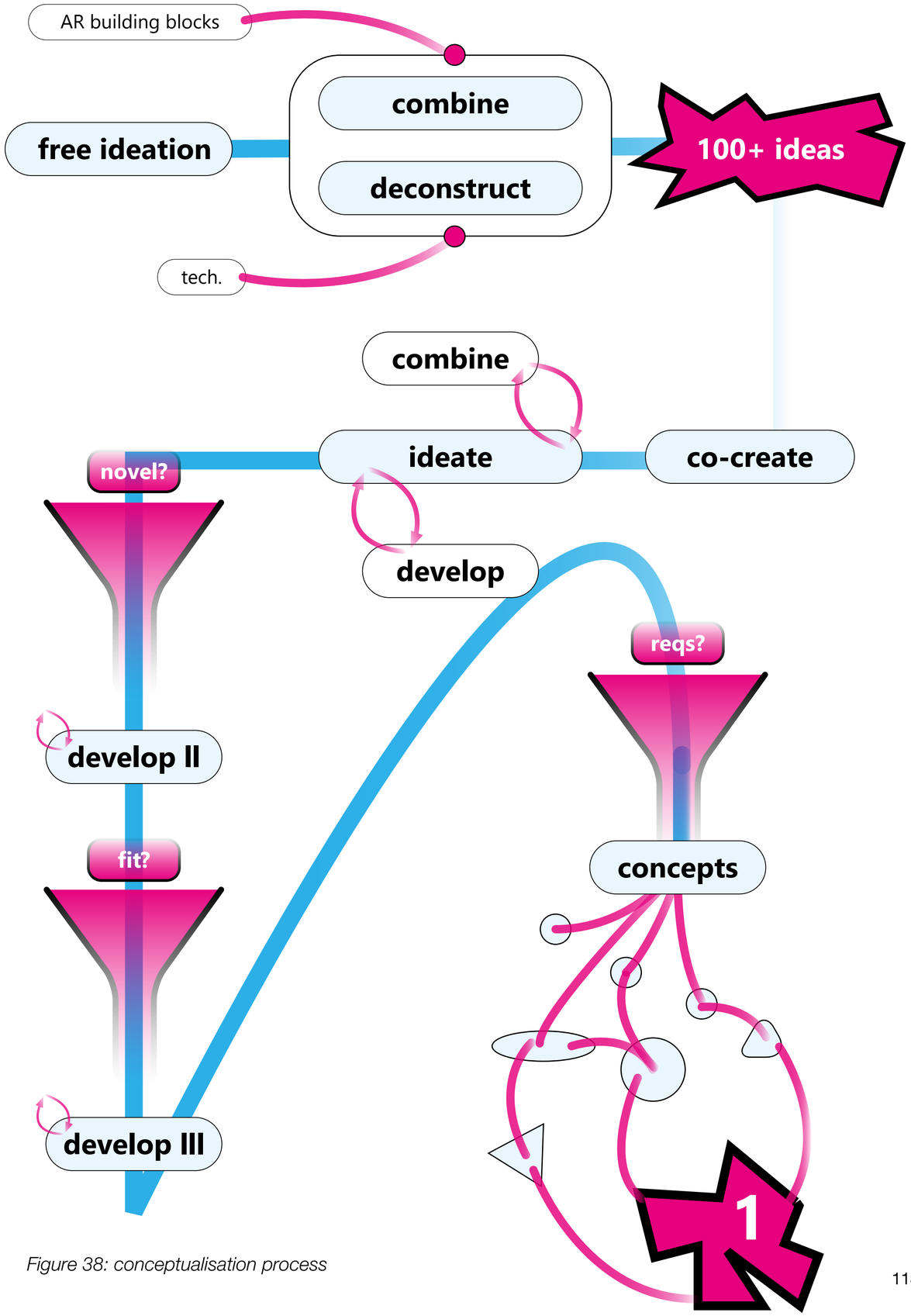
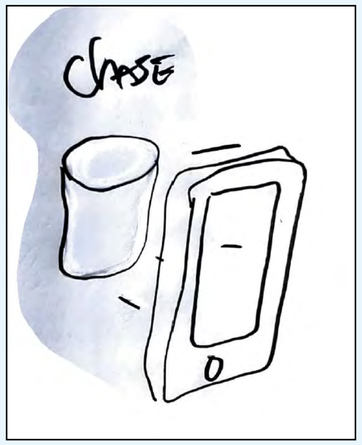
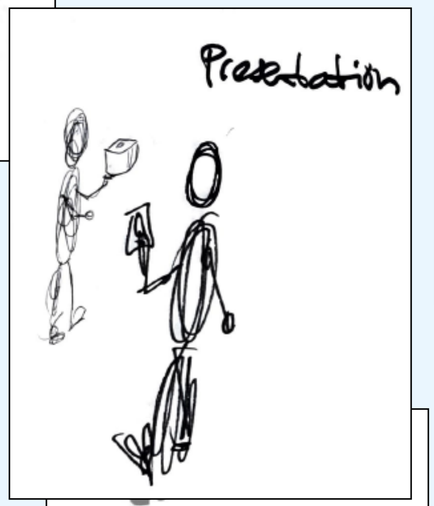
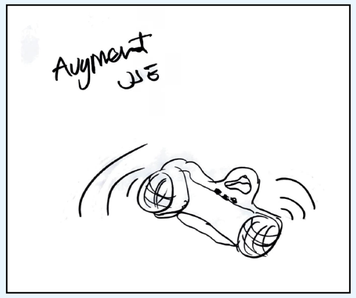


Figure 38: conceptualisation process







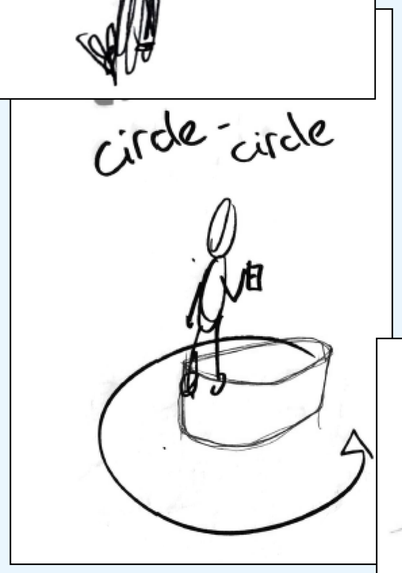
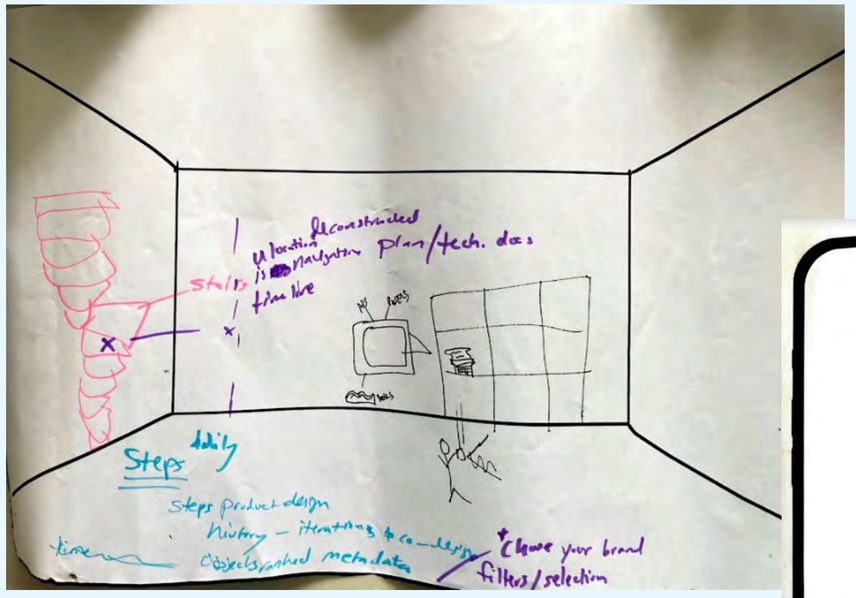
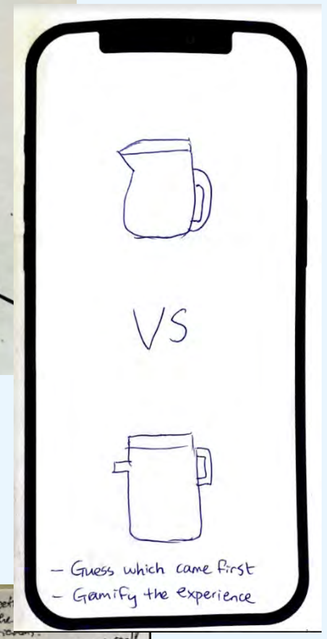


Figure 39: Excerpts ideation sketches





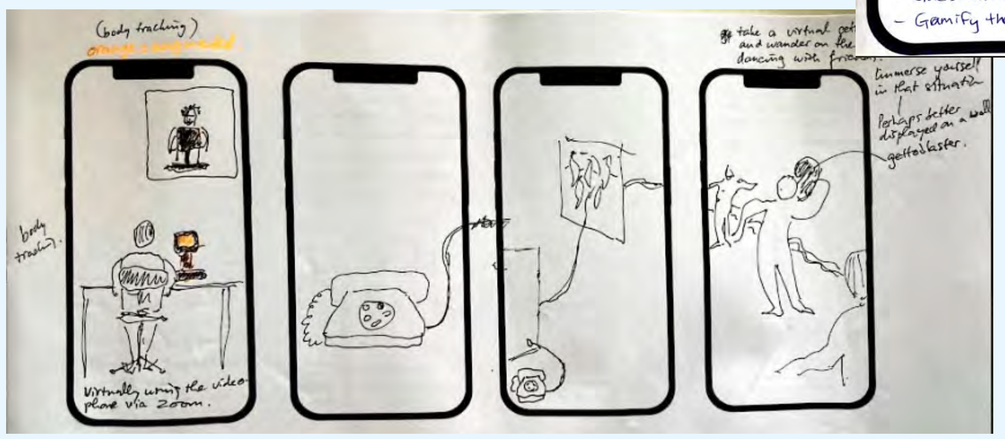


Figure 40: select ideas from co-creation session by the participants

7.4 Directing digital concept

Based on the interaction vision, and the development of the digital AR part(s), a framework was made to fit in concepts and stay in direction. Figure 41 shows this framework.

7.4.1 Digital concept complexity

The first category is for AR experiences which are relatively superficial, in terms of interactions. They are limited AR experiences, with 1-to-2 interactions possible. Think of the ReBlink reference project example(Figure 17) or Snapchat filters(Figure 14).
In the latter, the camera is pointed towards the face and for example, a hat is augmented. The hat might even move when tapped or change colour, but that is the farthest these kind of experiences go.

The second category is for AR experiences that have a bit more depth to offer. In these experiences, users can have more thorough interactions and more options to explore.
For example the Skin & Bones AR experience. Here users can point their devices, to see augmentation and tap for more info. Each artefact has a tailored effect and animations for example.
However, there still is a cap, keeping the experience limited and not too long.

The third category is for very expansive AR experiences. These are very intricately developed, with lots of options and elements, a big interaction process tree is an effect. These experiences typically are downloadable AR apps, especially since a bigger more intricate AR experience demand more computing power and disk space.
Think of Augmented Reality experiences like Pokémon GO, where the user can explore a digital AR world. In this case with chance algorithms, where users can walk around and catch Pokémons. Through this randomization and 'chance-effect', the options are virtually infinite, resulting in enthusiasts playing for hours per session.

The intent is for the AR experience is to fit within the second category. This would strike a balance between intricacy and simplicity, keeping the experience engaging yet short and sweet.

note: this is not an existing categorisation framework. It solely is based on the insights of the designer and the research on existing AR project, in order to direct the AR concept. (See it as a thought experiment, not definitive empirically backed wisdom ;)

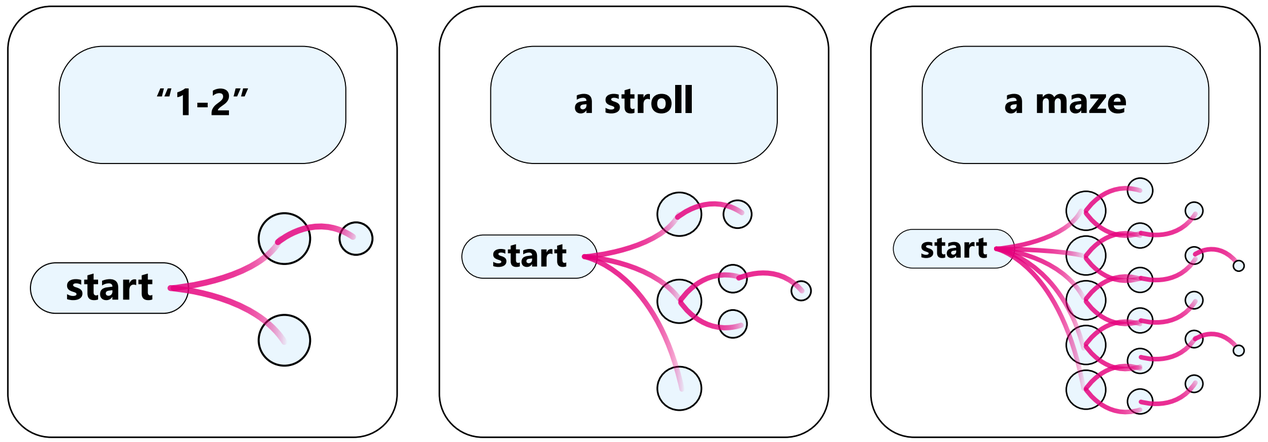


Figure 41: categories of AR experiences in relation to complexity

7.4.2 Visual Form & Style

An important part of the design is the visual style. A mood board was created as a reference to direct ideas and visual style. The images picked are based on the desired experience, based on the interaction vision, to be playful, engaging and casual.
The use of striking colours and contrast is recurrent. Especially the work of Slovenian graphic designer Nejc Prah, was taken as inspiration for the visual style.

Figure 42: Moodboard to direct visual style concept

7.5 Concept storyboard direction

Aside from digital AR elements, the broader setting and context for the project are museum environments, as a testing ground specifically for the IDE faculty.
During the research phase, students mentioned they would like the learning to take place as an experience, rather than 'stale' information absorption in traditional forms. Taking the research insights, the envisioned interaction storyboard(Figure 37) and the 'Relevance by Play model' by Vermeeren & Calvi(2019) (Figure 43). A concept storyboard was made describing the steps a museum visitor (IDE student) will take:

1. Attention: Before the visitor interacts with the design objects, attention needs to be drawn toward the space. Especially since one of the major insights is that students ignore the displays and objects within.

2. Interest: The second step is building interest in the visitor. Communicating what the exhibition/installation is about in a very concise manner while keeping it engaging.

3. In-the-water: In this phase, the user chose to lift her or his pants up and get in the water. Here they are in the exhibition space, ready to be fully immersed in the experience and interact.

4. Post-visit: Having seen it all, and interacted with the objects(digitally), the user has food for thought to reflect upon the experiences and what they learnt. Finally, the visitor exits the exhibition space.

The steps above form the steps of the visit storyboard, each giving space for multiple ideas to be realized if fitting. A process of further ideation and development followed, puzzling with and combining the different elements of AR, the artefacts and spatial components.
The steps above form the foundation of the concept storyboard to inspire ideation and direction selection.
The next section dives into concepts and concept selection.

7.6 Concepts

After having ideated and developed a select few into concepts, concept selection took place. This was done by, again, referring to the interaction vision and design goal. Also, the references, existing AR museum experiences, were consulted, to gauge how innovative the concepts are.
Finally, the Plan of requirements functioned as the ultimate filter to identify and develop potential concepts. The next page shows visualizations of some of these concepts.

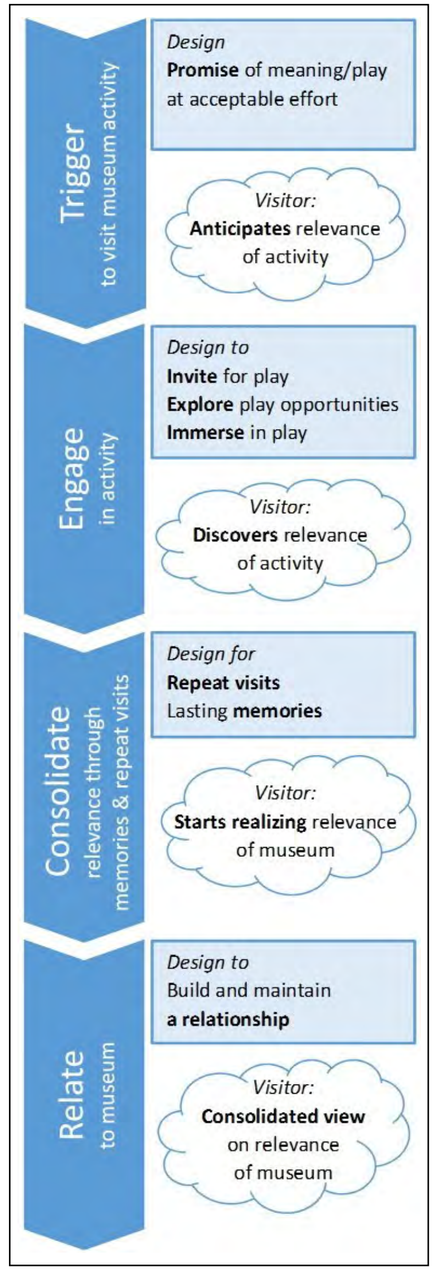
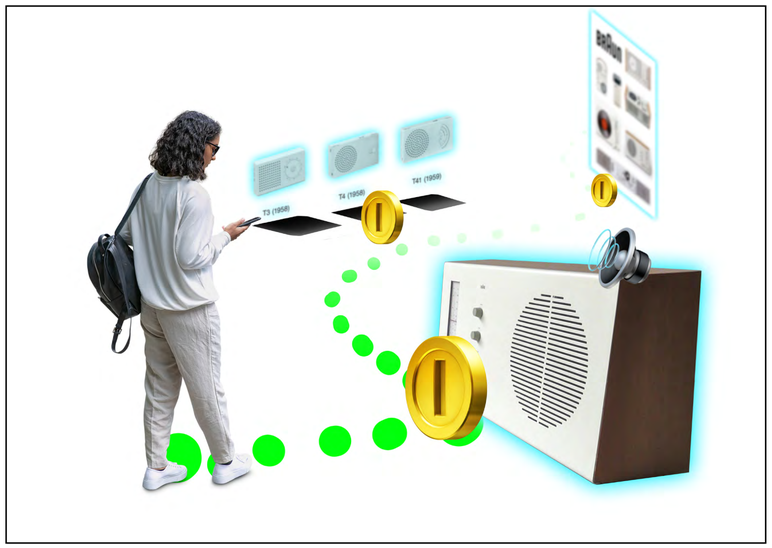


Figure 43: Framework Design for Relevance by Play (Vermeeren & Calvi, 2019)

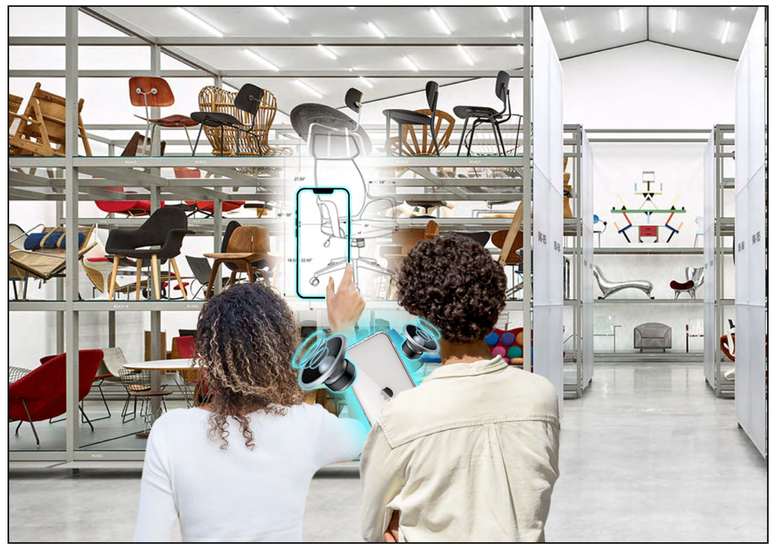


coin route

Visitors having to follow an augmented road, the coin route, to discover and explore the objects. The more object ‘pit-stops’ made, the more coins collected.

chase!

Artefacts are on the loose and everywhere! Visitors need to catch them using their phone, by having them on the screen for a short period of time. After being caught, the objects reveal themselves and their stories.



whisper-see

Concept for a duo experience specifically. One of the duo holds their phone close to their ears, to listen to the audio guide, this is the whisper part.
The other half of the duo, uses their phone to augment over the objects in real-time.

7.4 Chosen concept Storyboard

The concept storyboard takes the form of a sequence, where the steps of a visitor(student) are reflected. Herein having AR touchpoints, and interacting digitally with the Design Heritage artefacts.
Figure 44 shows this storyboard, below a step-by-step explanation, based on the storyboard steps explained in the previous section.

concept storyboard

7.7 Concept storyboard

1.Attention: The visitor's attention is drawn by (fluorescent) markings on the ground, engaging them, feeling drawn to look at where it leads to. Ultimately evoking, a sense of curiosity.

2.Interest: Now the visitor is near the exhibition space, a short and sweet insight into what is to come is given. This is done through the form of short videos, showing the iconic products in use, with matching audio, and bits of the AR experience are shown. The user now gets a sense of what this experience will be about and what they can expect when going in.

3.In-the-water: Now the visitor entered, fully immersed in the space, and is able to see the physical objects and interact with them (digitally). The first touchpoint here is a table with markings around each object, so they can be recognised through the AR software. Walking around the artefact reveals different AR elements.
The other touchpoint is a wall that highlights an iconic product, showing the products of the past that were influential to it and contemporary products it influenced. On this wall there are AR icons, scanning the icon spawns each product in Augmented Reality. Users can walk through the full story by listening to the audio guide.
Finally, there is an interactive and open section for visitors to stick their ideas to regarding where the future is headed for each product.

4.Post-visit: Before exiting the space visitors can take a 'souvenir' with them, the AR marker. This disc shows the image of a certain product, with a short description on the backside. Scanning the QR code and flipping it, spawns the object in 3D. This functions as a reminder of the visit and is intended to invoke reflection.

From a learning point of view, the steps above are purposely built on Kolb's learning cycle, to go from concrete experience(step 1) up to active experimentation(step 4). This is to make sure learning can take place to the fullest extent possible within the experience.

Figure 44: concept storyboard

7.7.1 Chosen AR concepts

In the 4 step storyboard presented on the previous page, there are 3 AR touchpoints. These touchpoints are explained below;

circle-circle
The circle-circle concept is built on the notion of exploring the physical object, whilst having digital AR elements. Visitors point their device toward the artefacts, which shows an AR element. Depending on the angle they make with the object, new AR elements are revealed and can be interacted with. This in the end makes the user do a 360 walk around the artefact. Figure 44 shows a mockup of the concept, and Figure 45 shows the storyboard.

Users scan a QR code near the artefact, say at the edge of the table or cabinet. This leads their device to the web-ar website and initiates the AR effect. The user points their phone camera to the object, in return, the AR engine recognises the objects and augments specific information, content and interactions. Which are visible, dependent upon the angle the visitor has in relation to the object, pushing the user to circle around the object to fully discover it and explore each interaction. This also pushes the user to see the physical object from every side in real life, instead of keeping still and tapping behind a screen.

The interactions here can be an exploded view animation, sound effect, video etc. This circle-circle concept can be seen as a framework where different lego blocks(content), and interactions, can be placed within. Meaning the contents can be customized, depending on the institute's curatorial wishes.

Ultimately the concept brings a novel AR interaction between users and historical design objects. Aiming to maintain a balance between the digital and physical interaction in the museum setting.
For circle-circle, the technology to materialize the concept is object recognition. In upcoming sections, this technology and possible alternatives are explored.

Figure 45: concept storyboard

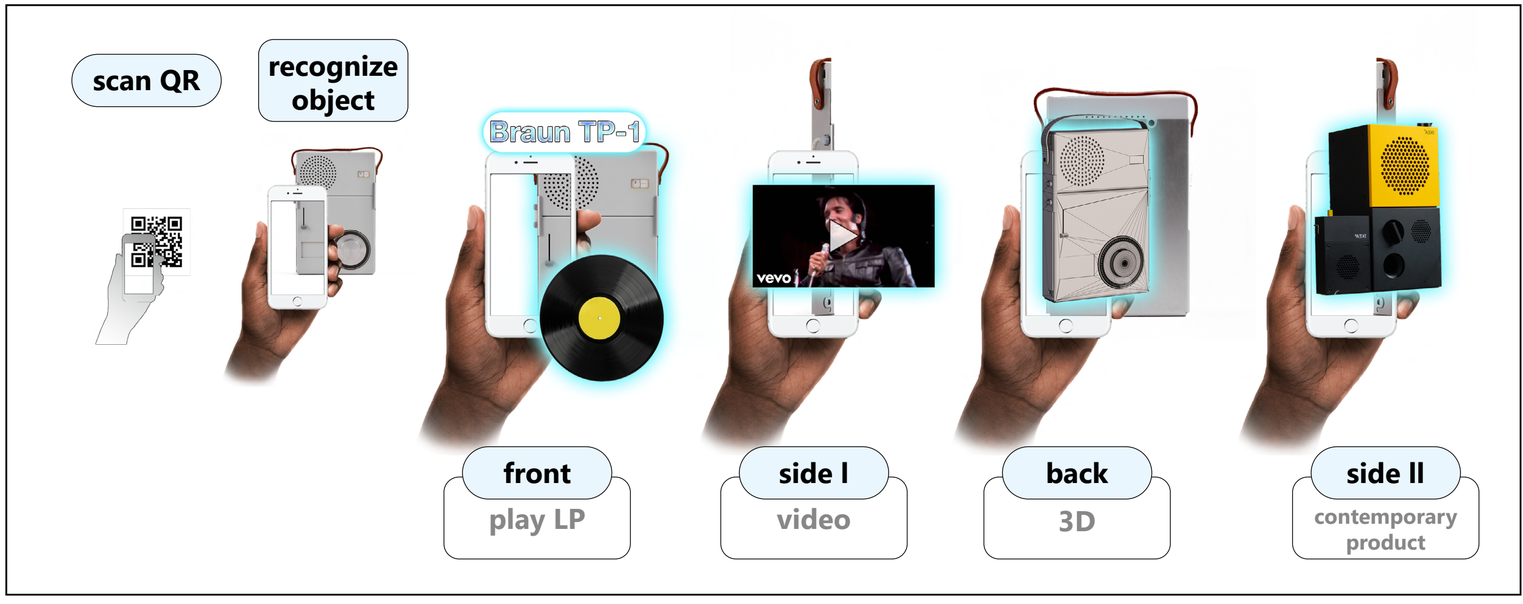


Figure 46: circle-circle sequence from first person perspective

time travel (wall)
The second AR touchpoint in the storyboard is time travel. This part is all about adding depth to the stories told about the artefacts, for students to learn and gain in knowledge.
The original concept is a big wall, where visitors can look towards and hear the story, and see matching elements in AR. During the audio story plays into the research insights, for example by highlighting why the designer and why a product was (not so) successful.
The AR effects here are using image recognition technology.

AR disc
The final touchpoint is the AR disc. It is a paper disc that visitors can take with them, as some sort of souvenir. The front shows an image, title and brief information on the product. The backside contains a brief description of the product and QR code. This QR-code zaps the user to webAR where pointing your device at the disc spawns the object in AR.
This is possible through image recognition.

Focus
In order to get valuable insights in the available time, a focus is set on the third, 'in-the-water', stage and its AR elements of the overarching storyboard(Figure 44).
Also to ensure testing in the context with the target group, in order to get feedback and efficiently iterate. Meaning from this moment on the grabbing attention(1), interesting stage(2) and post-visit stage(4) are not necessarily developed further.
As for time travel , this will be scaled down to poster-size for proper testing.
Deepening of the concept continued within the focus area, starting with prototyping discussed in the upcoming section.

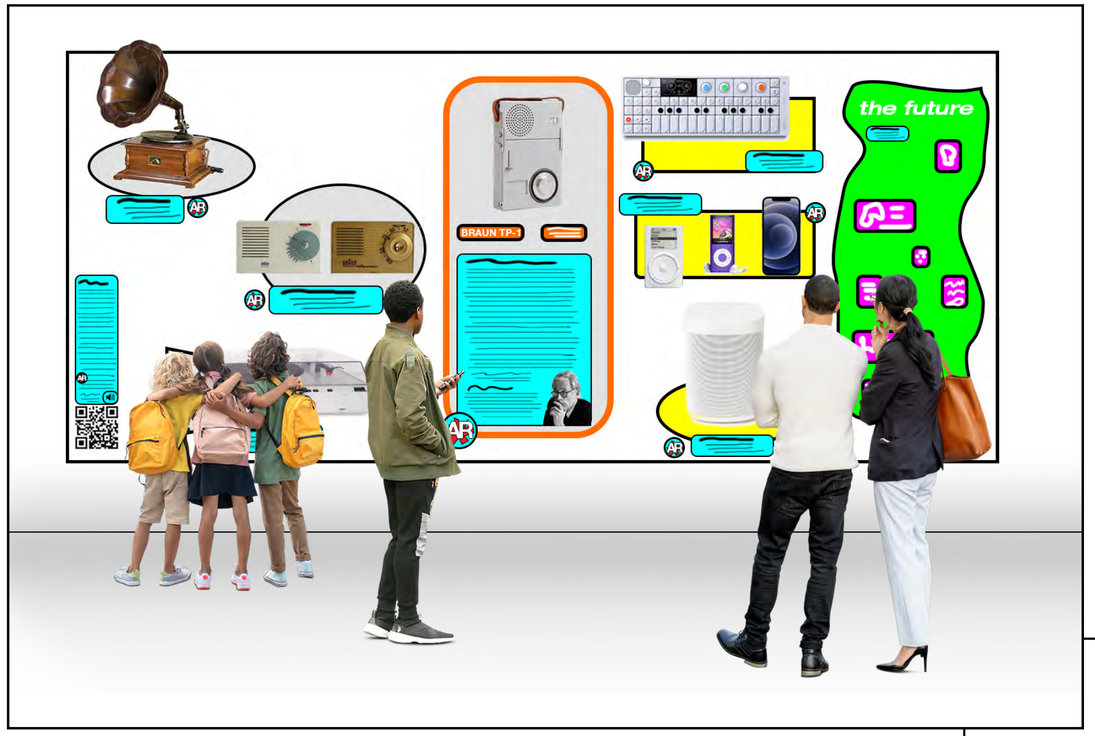


Figure 47: concept storyboard

Figure 48: circle-circle sequence from first person perspective

7.7.2 Concept combination

For example: in the chosen concept, circle-circle, there is a form of discovery, per object when walking around. This is a milder form of the **coin-route** concept proposes, which is inter-artefact discovery and exploration.

The **chase** concept for example does not fully incorporate the physical object themselves. It is a digital-first concept, with exploration and discovery at the forefront. Due to the fact that striking this balance between physical artefact and digital is so important(requirement #31), the concept was not incorporated chosen. However this concept does take into account the space, used for exploration, and would have quite a high engagement one could imagine.
It was used as a source of inspiration for the development for the concept storyboard.

Finally, the **whisper-see** concept tries to use the devices of a duo in a new manner. Rather than seeing the duo experience as an obstacle, both devices can be used to have specific roles.
This concept however is a (small) adjustment to an overarching one. Also, it needs to be discovered how this would go in real life, a duo experiencing the AR on a small screen and blasting the audio in space. Even if on 'whisper' audio levels, this can disturb passersby, individuals and other duos in an exhibition space.
Nevertheless thinking about the duo experience is important and this thinking was brought along from this concept.

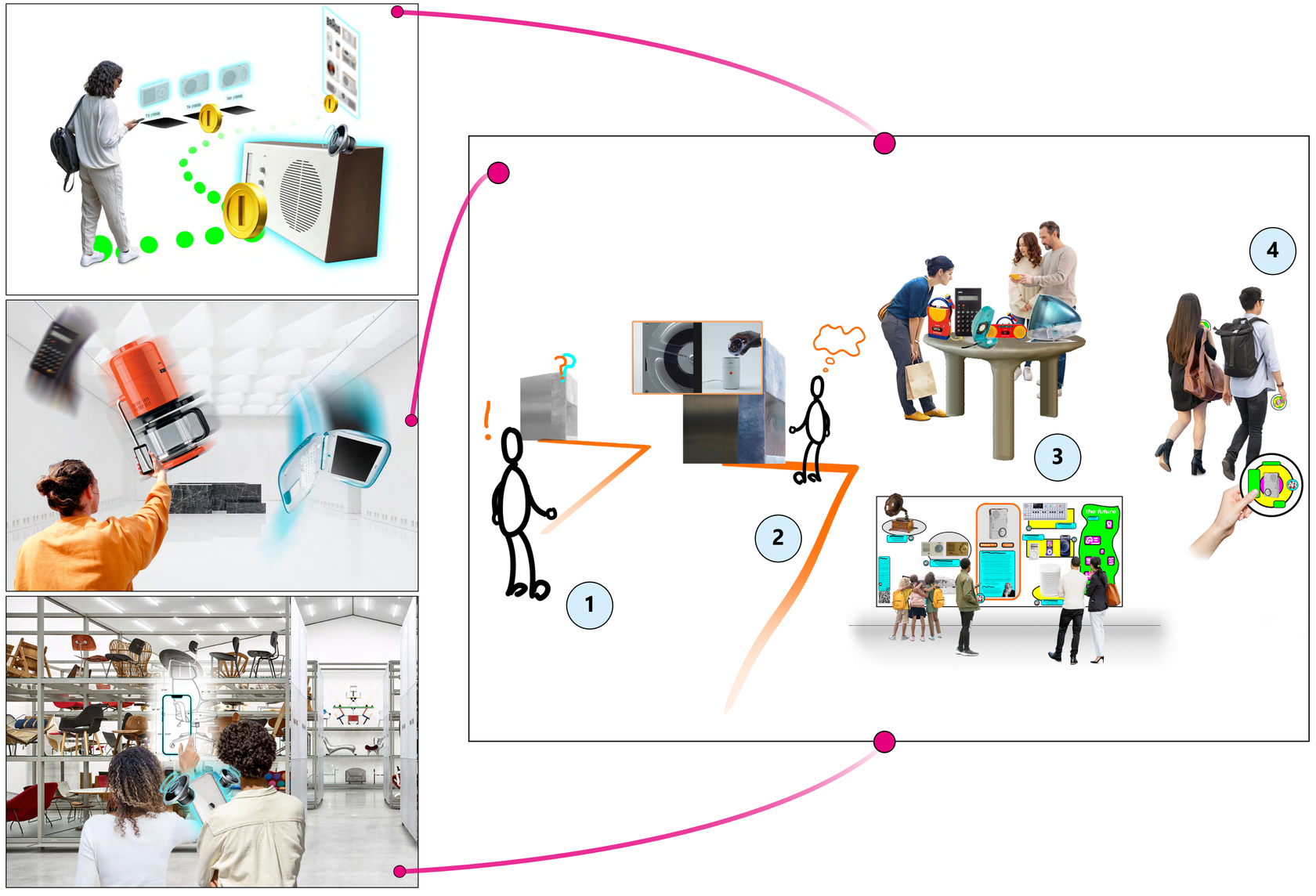


Figure 49: circle-circle sequence from first person perspective

7.8 Asset preperation

To evaluate the potential of the AR concepts, they need to be put to the test, during iterative user tests. Before this can take place, however, prototypes need to be built. This section shows the core process regarding the concepts and prototypes built.
First, for the circle-circle concept, different AR technologies were explored to pick the most fitting one for the concept itself and for prototyping.

7.8.1 3D Scanning

Before fully starting to prototype for AR, a handy asset needed to be made: A 3D model of the Gameboy artefact. The specific artefact was chosen from HBI's archive, based on its potential and how fitting it is to create a multisensory AR experience. The original GameBoy also was chosen, due to the digital interaction possible, available information on the internet and 3D scannability.

The object was 3D-scanned at the TU Delft's BodyLab inside IDE, using the Artec EVA 3D scanner and Artec Studio 16 software.
The Artec EVA scanner has multiple built-in cameras, using the Structured Light method, to create a 3D model of the object. This way a 3D geometry is recognized and a texture is made of the object (Scheffler, 2022).

The artefact was placed on a rotary plate for high-fidelity scanning, this way the scanner is held relatively still and all sides can be captured.

After scanning the raw file was, edited in the Artec 16 software. This consisted of improving the raw geometry and texturing. From here Cinema4D and Blender were used to reposition and export as a usable AR file format, .glb or .gltf.

Figure 50 shows the process and final textured render, Having (minor) 3D scanning experience prior, the scanning, with setup help from a BodyLab staff member, took less than 2 hours.

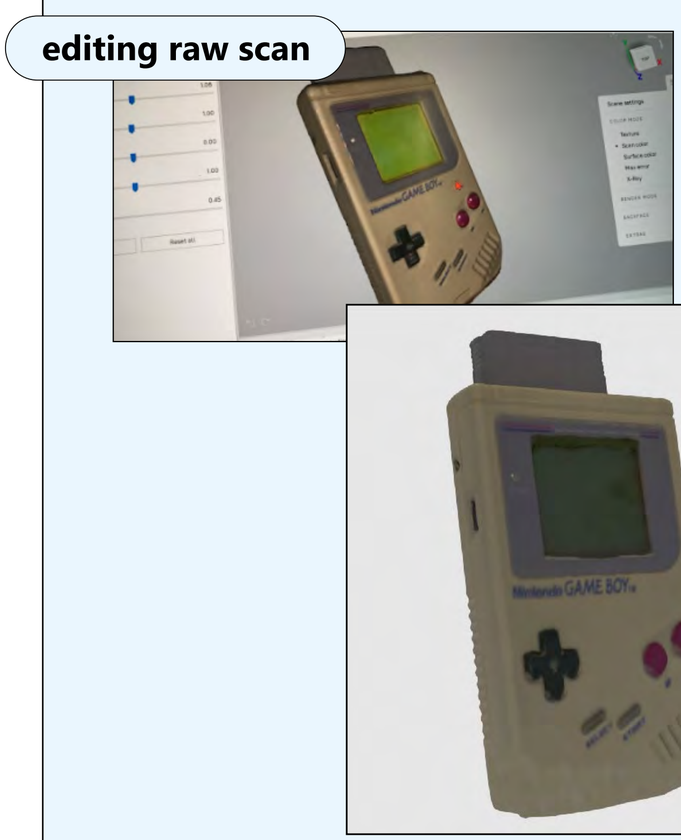


Figure 50: 3D scanning process of GameBoy at the IDE faculty

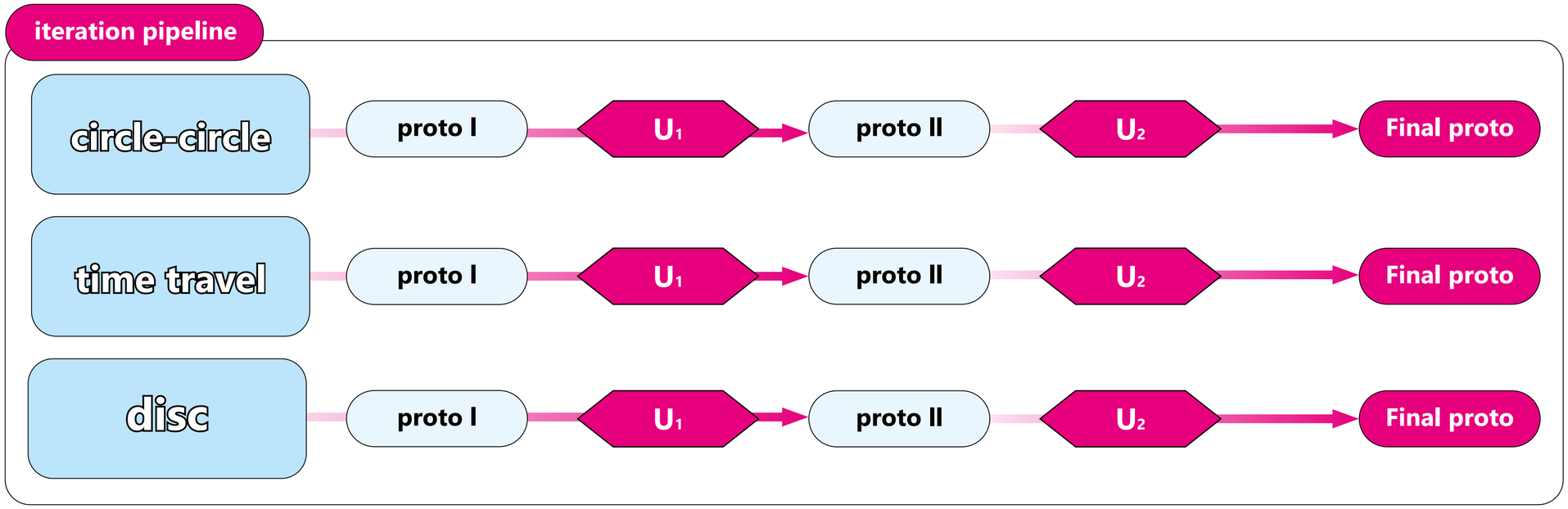
7.9 Small scale iterative tests

In order to verify the strengths and weaknesses of the overarching concept, small-scale user tests were set up. During these tests, three prototypes were made, for each concept part; circle-circle, time travel and disc.
Iterative tests were performed using the prototypes built per concept part. The goal for these two user tests was to quickly iterate and improve the concept and prototype. This by getting feedback from the target group and observing them interact in real-life. The first iterative user test is discussed first. Hereafter the second one, with improved prototype and concept. The section concludes with the adaptations to be made for the final concept proposal and final prototype.

Students from the faculty were invited to participate and communicate their gut feelings regarding their initial experience. They experienced the prototypes back to back using the researcher's phone, loaded with the AR prototypes. At the end, participants were asked general questions and asked to rank each prototype experience.

On the right the approach to the user tests visualised and an overview of the prototyping rounds per concept.
From section 7.9.4 each iterative test and prototyping round is discussed more extensively. First an overview of the prototyping per concept is given in the upcoming pages.

Figure 51: prototyping the concept parts using ZapWorks and SparkAR. Top section: circle-circle. Middle: time travel. Bottom: disc.



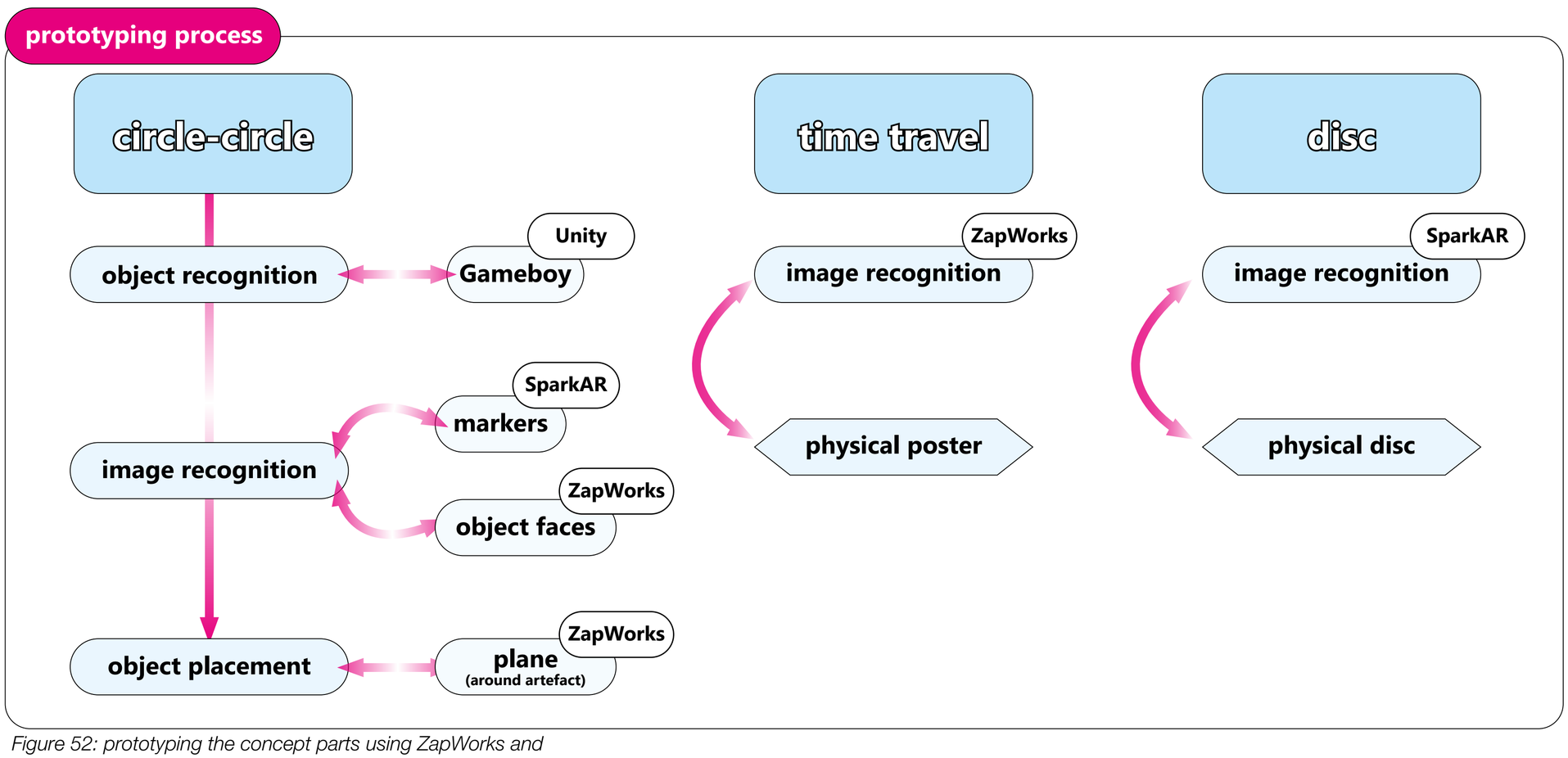
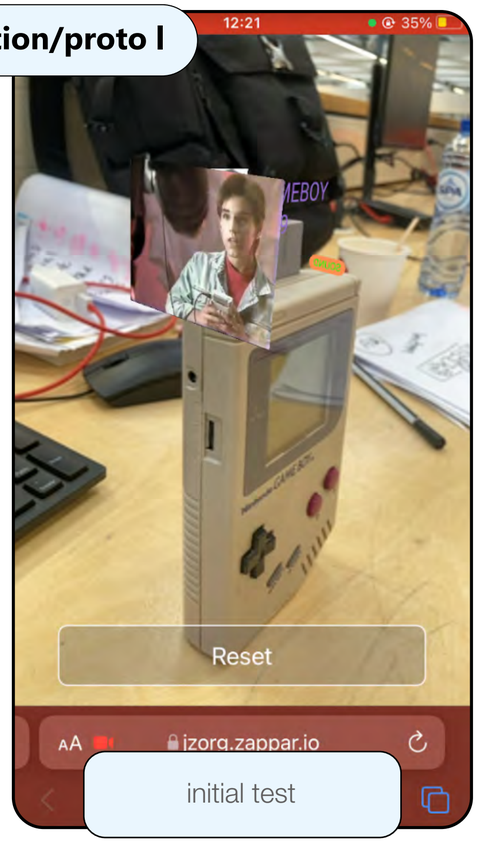


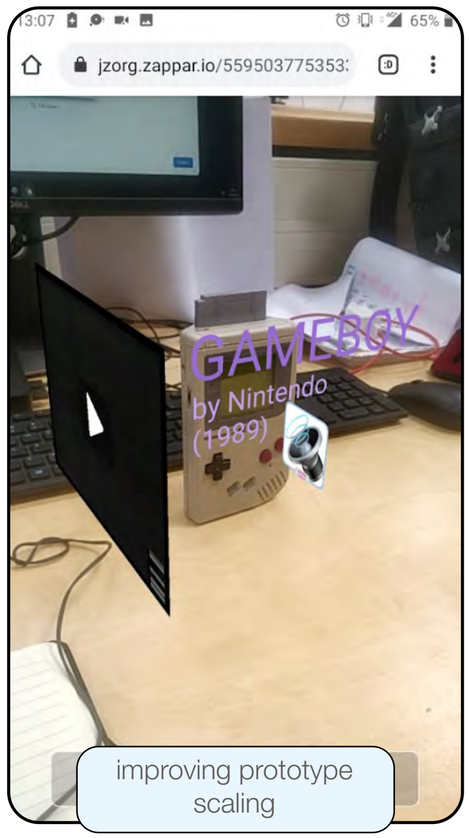
Figure 52: prototyping the concept parts using ZapWorks and SparkAR. Top section: circle-circle. Middle: time travel. Bottom: disc.

circle-circle prototyping

iteration/proto I



initial test



improving prototype
scaling

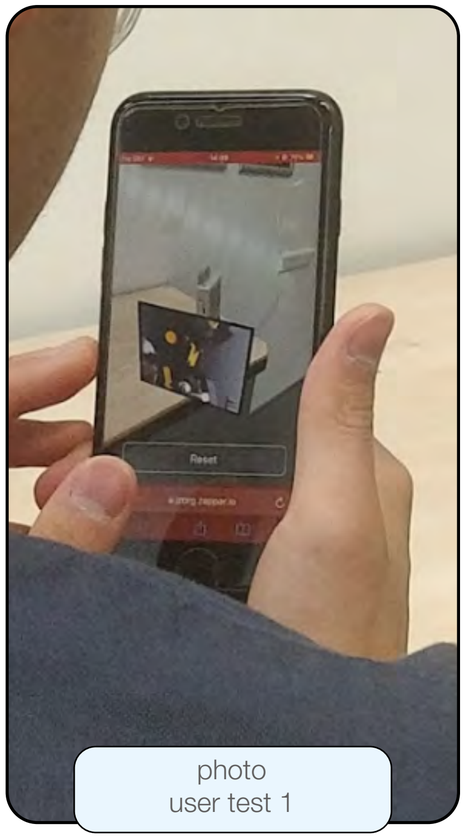
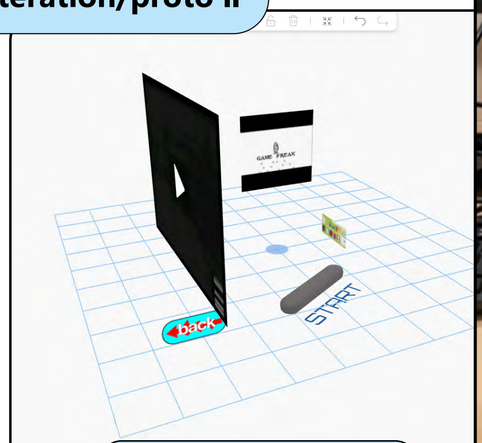


photo
user test 1

iteration/proto II



process in ZapWorks

second iteration
(front)

second iteration
(angle)

use-interaction
(start button tapped)

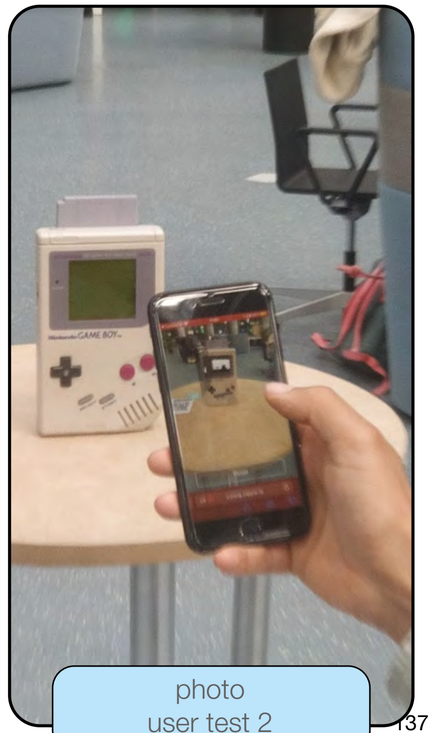


photo
user test 2

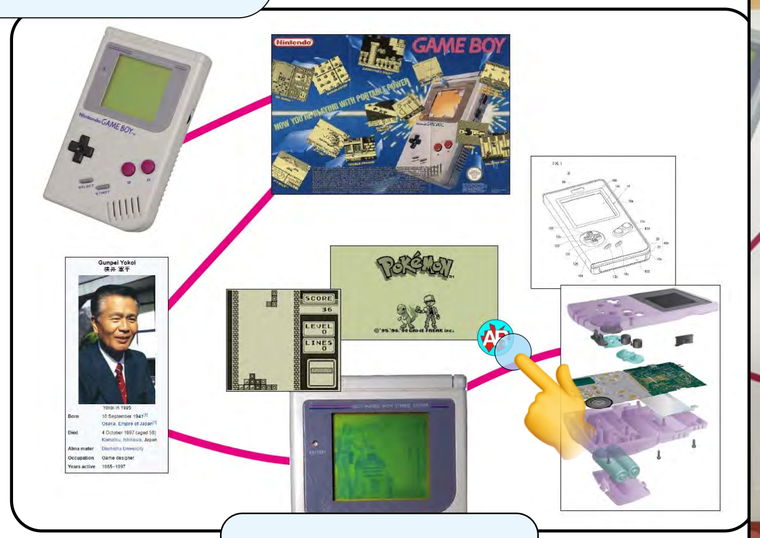
7.9.1 Part 1 Circle-Circle

For the first iteration the concept was prototyped to augment the object title, video and sound button on the side. This was done using WebAR tool ZapWorks. With this a link or QR can be exported to access the AR experience.
From testing users would have liked to fully walk around the object and were interested in its use.
For the second iteration a product-use interaction was added. Also a stand was made to invite circling around the artefact.

From the second test it came to light that the flow from circle-circle to time travel should be improved.
For the prototype, something needs to be done to improve the object placement in the exact right place.

time travel prototyping

iteration/proto I



poster(image target)

AR effect in action

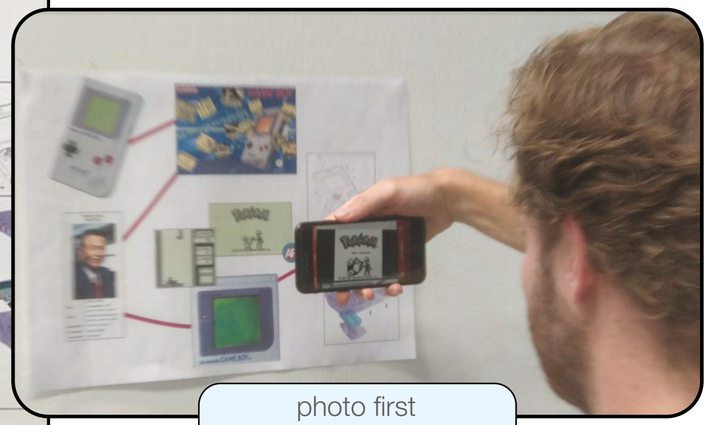


photo first
user test

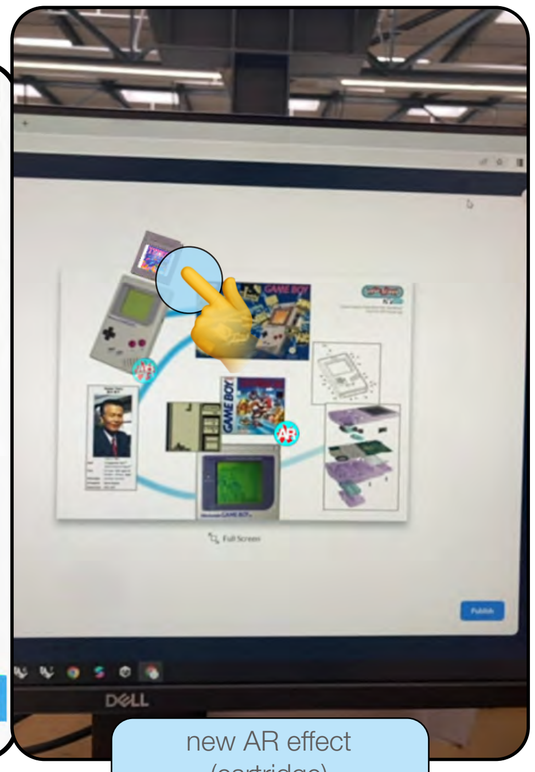
7.9.2 Part 2 Time Travel

A poster was made, with AR prototype that recognises it using image recognition. Also ZapWorks was used for the time travel prototypes.
Audio played when the experience launched, explaining the story using an AI voice. From the first test, a stronger story structure was the big take-away.

The second iteration now has a stronger structure for the audio. Also a new AR effect was added (D cartridge).
The big take-away from test 2 was to enable listening to sections of the story and guide when to press what AR effect.

iteration/proto II

process in ZapWorks



new AR effect
(cartridge)

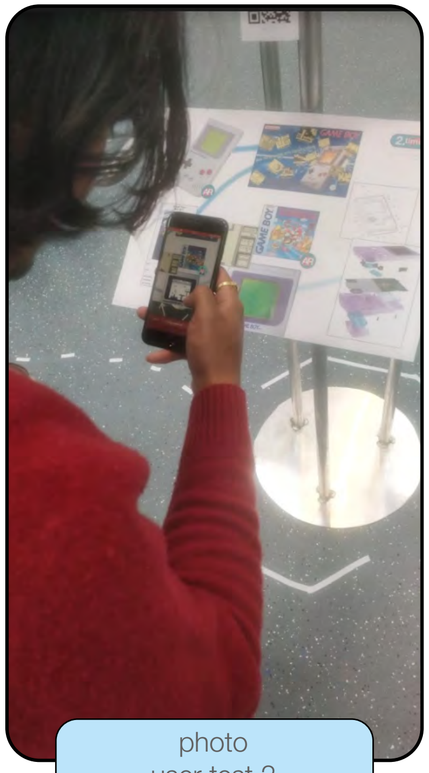
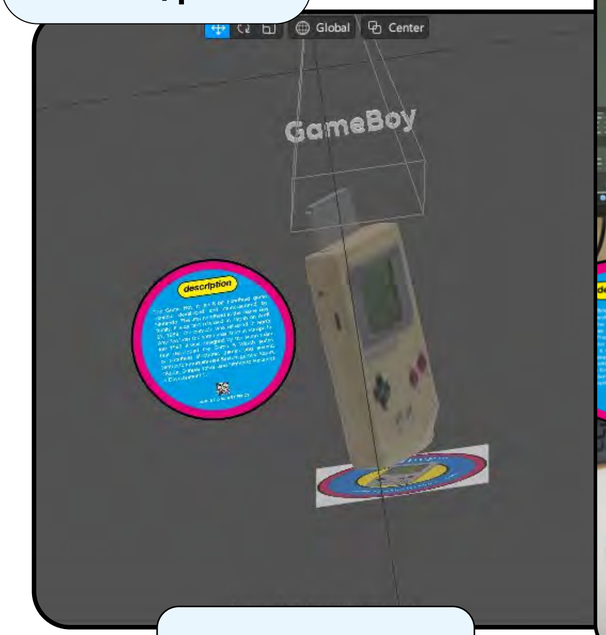


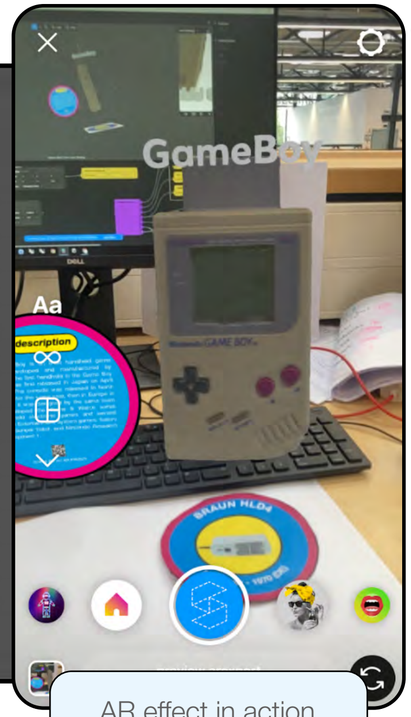
photo
user test 2

disc prototyping

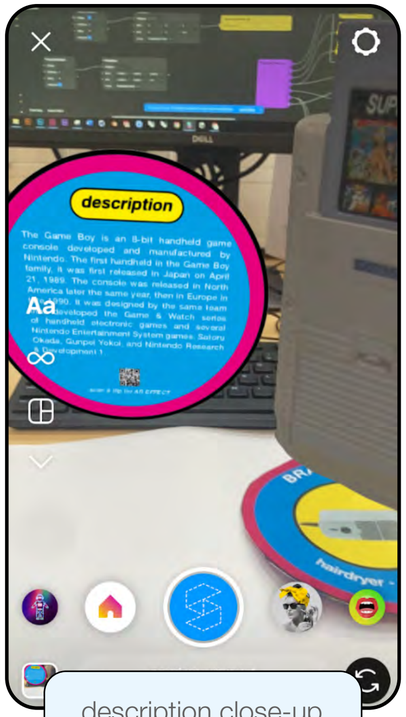
iteration/proto I



process in SparkAR



AR effect in action



description close-up

photo first
user test

iteration/proto II

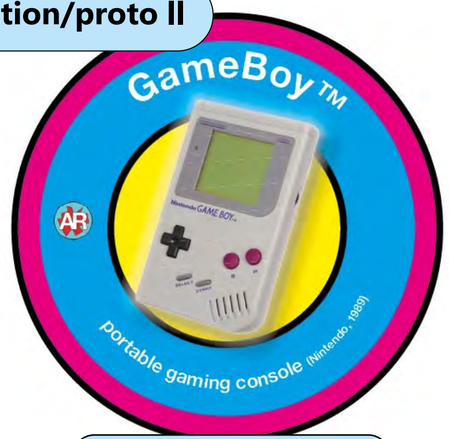
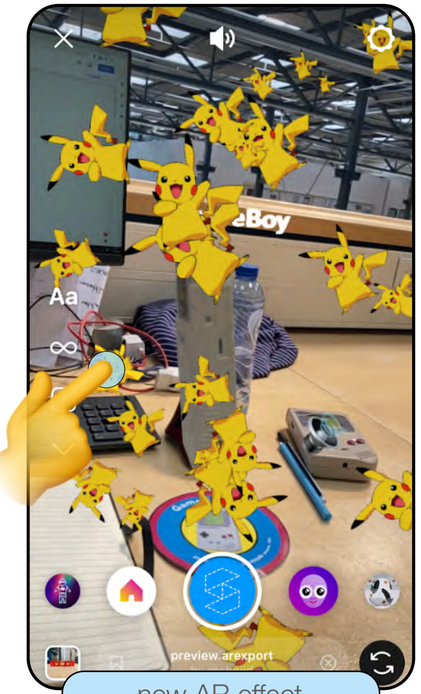


image target



new AR effect
(cartridge)

photo
user test 2

7.9.3 Part 3 Disc

From the first prototype and test students really liked the disc AR effect. Most participants expected more information to be displayed, so an animated GameBoy spawning came as a suprise for many.
From the first test, the text next to the object was difficult to read and participants where curious what more interactions were possible in AR.

For the iteration, two interactions were added, a sound button and surprise effect button.

The second test revealed that to create a better coherence between the 'tought tower' and disc, by integrating them with the stand for example.

7.9.4 iterative user test I

For the first iterative testing round the goal was to test the concepts and users' reactions - are the concepts engaging, educational and fun? Another research goal was to see how participants used the prototype, and how do they naturally interact with the prototypes?

Participants were asked to partake in a short prototyping test. They were asked to think out loud and interacted with the prototypes back to back. In the end, the participants were asked about their first impression, questions per prototype and to rank the prototypes on which one was most engaging and most informative. Fig. 53 shows the test setup and participants during the test.

insights
Overall participants, a total of 7, found the short experience nice and fun. Liking the added elements AR added to the physical object.

circle-circle
Participants found it to be short and sweet. This experience was found to be the most 'balanced' one, balancing engagement and educational value. People explicitly mentioned they liked walking around the object to discover more. Also, the content of an old Gameboy commercial ''from that time'' participants valued.

The most occurring issue was tracking shift, due to the prototype being sensitive. Furthermore, a duo mentioned experiencing this together on a bigger screen(iPad) would be more enjoyable.

Time Travel
This part, was as intended, found the most educational. Participants enjoyed the audio walkthrough discussing the parts of the visual poster. Also, people quickly understood which parts were interactive, through the AR icon being visible physically and digitally.
Some people mentioned the voice can be difficult to follow, a text-to-speech AI voice was used. Also, the sound directly came from the phone's speaker, participants would prefer headphones.

Disc
This part people found most engaging, having the biggest 'wow-factor'. Participants did not expect a 3D scanned version of the Gameboy to appear, rather ''just more info''.

On the paper prototype the front part of the disc is visual and for image recognition, with information on the backside. The backside was also viewable in the AR prototype, however, this was difficult to read, since it was a small paragraph of text. Also, students mentioned a small interaction would be nice to add too. Currently, the Gameboy pops up and starts spinning, that being it.

From the test's insights, the following iteration changes were made for the overall concept, per AR touchpoint and each prototype. Each iteration point is categorized whether it is an iteration on concept or prototype level. Note that concept iterations will of course affect the next prototype.

The next section is on the second iterative test, improvements mainly based on the points above.

Figure 53: Testing setup and photos of prototype use.

iteration points I

Overall
The experiences need to be more connected, flowing from part to part. Now I personally started up each prototype, this of course is not the case in an exhibition setting.

Circle-circle
1. Enable users to fully walk around and circle the object. During the test, the artefact was put on the side of the cupboard, allowing for just 180 degrees of circling. (concept)
2. Optimize the height of the object, the object was quite low for some students on the cupboard. (concept)
3. Iterate the concept to scale more perfectly when loading, instead of having the user scale by hand. (prototype)
4. Add an interaction with the product; simulate using the product. (concept)

Time Travel
1. Create a better structure of the audio story (concept)
2. The tone of voice; have a more human tone of voice (concept)
3. nstead of using speakers, use headphones for better listening (prototype)

Disc
1. Ditch the text; No longer the backside viewable in AR (concept)
2. Add small interaction; to make it even more fun/surprising (concept)

7.9.5 iterative user test II

For the second iterative test, the improvements above were implemented, iterating the concepts and subsequently prototypes. The same engines were used to create the iterated prototypes.

For the circle-circle part, a button was added to simulate real use. When the start button is pressed (digitally), a Pokémon game boots up like in real life. Also, the asset scale was improved in the prototype, fitting better around the physical object.

Furthermore, a custom stand was built to facilitate walking around the object. The stand has the shape of a cylinder, to invite users to walk around the object.

Its height was determined by asking several students(short and tall) how they liked the height of the plate in the PMB, a more comfortable height was found.

Finally, the previous startup sound interaction was replaced by a pop-up of a Gameboy timeline. This shows contemporary products it was the predecessor to.

For the time travel part, storytelling was briefly explored, to reference and be able to build a short yet clear audio asset. Figure 55 show a generic build-up of stories, this was used to create a structure for the audio story.
The audio closes with some food for thought, asking students to think about the future of handheld gaming and write or draw it on a post-it, to improve the flow between part 2 and 3.
Also, some minor adjustments were made to the poster, to introduce the segment and its intent.

For the disc prototype, more interactions were added to end the entire experience on a high note. A digital button simulates Gameboy sounds and an easter egg when pressed starting a Pikachu(Pokémon) confetti.

The testing setup (Figure 54), was this time set up in the main hall. A similar brief was given to participants, imagining them walking by and wanting to interact with the stand. A phone was given to participants to imagine as theirs and a pair of wireless headphones. No extra information was given on the prototypes, the research goals, or things to come. Finally, they were asked to think out loud again.
Nine students participated in total, 5 individuals and 2 duos.

On the next page are the insights from the second user test.

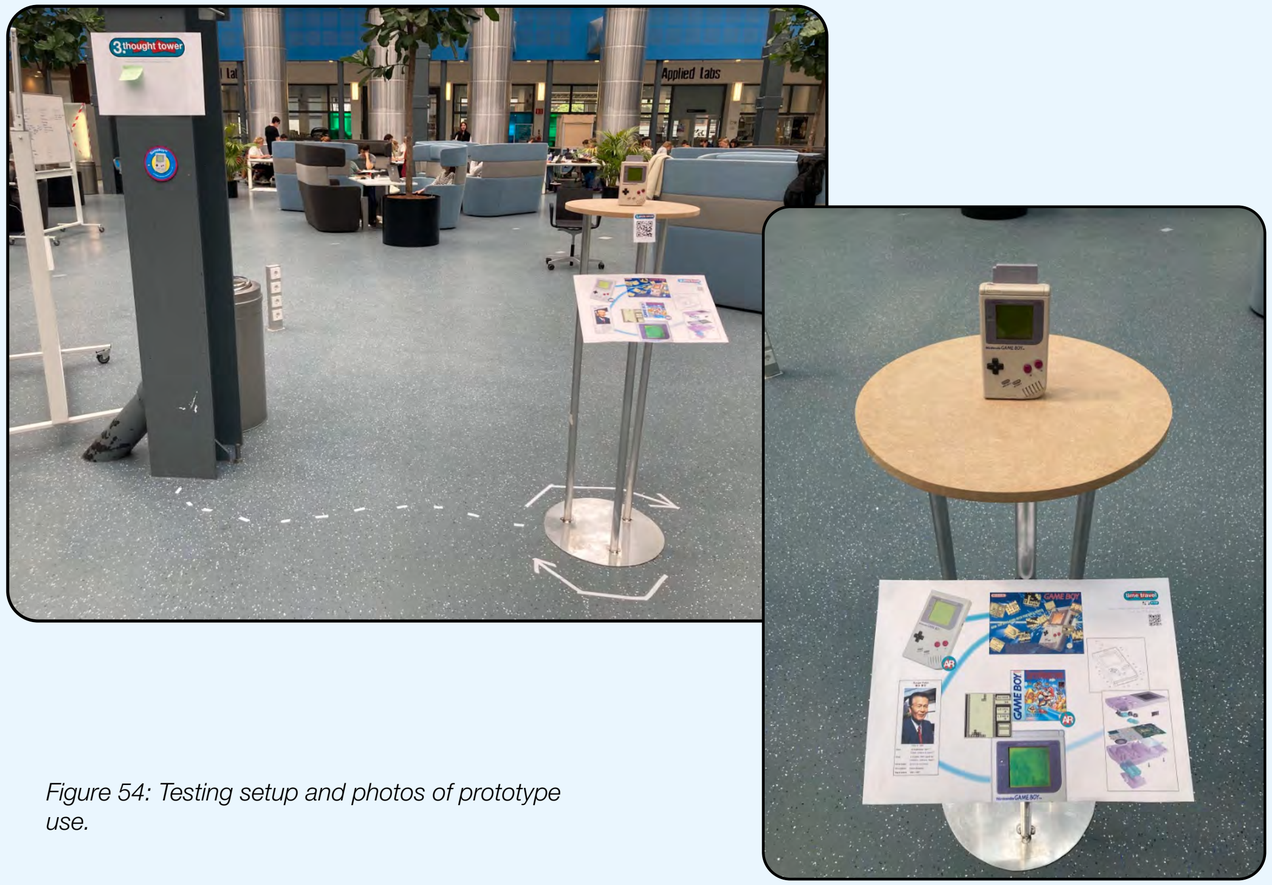


Figure 54: Testing setup and photos of prototype use.

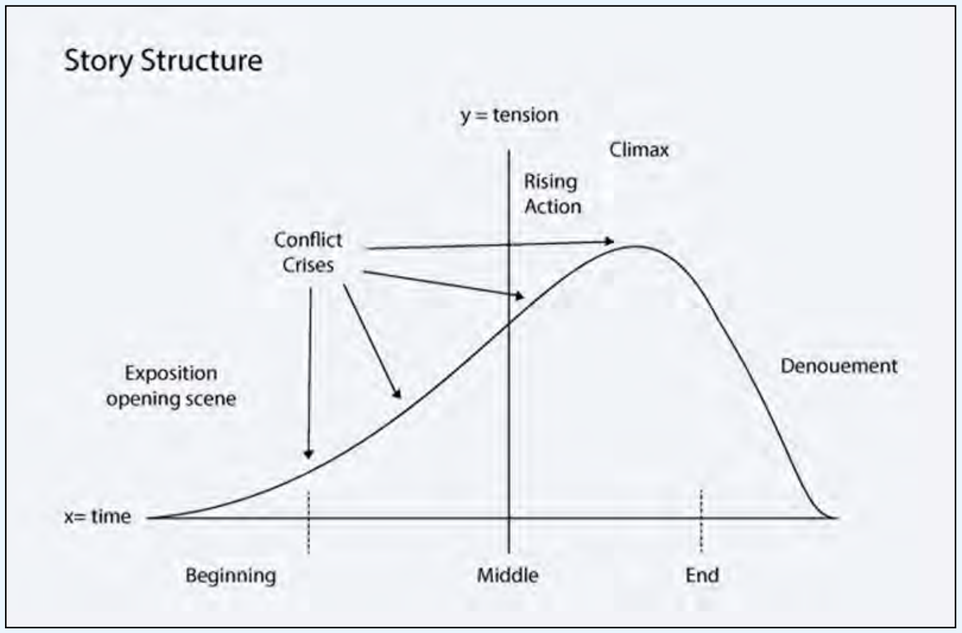


Figure 55: Generic structure of a good storyline (Bulsyte, 2017).

insights iterative user test II

Overall
Participants found the experience to be fun and educational, this time more quickly understanding what to do. Similarly, students found the second part, most educational, and the disc the most fun and engaging one. Below are insights per part.

part 1 - circle circle
Students enjoyed they can fully walk around the object and most did so quickly. Students also mentioned enjoying the interaction of pressing the start button and the Pokémon game booting. An issue, still, is the placement of the AR prototype. The AR elements shift and move when quick movements are made, this occurred a few times. Two students also did not intuitively know where to place the assets, one first placed it on the time travel poster and the other on the ground in enlarged scale.

part 2 - time travel
Students learned the most in this part and multiple students mentioned this AR part being their favourite. Specifically the (precise) overlay of the augmented game video over the Gameboy. A student mentioned being a 'Nintendo boy', however, mentioned not knowing about the Gameboy's inventor, and liked the story. Most participants found the audio length of the voice-over to be a good length, now being 02:35 minutes. Two participants mentioned it feeling long, since not knowing how long it would take in total.

part 3 - disc
This part evoked a few ''wooow's'' post-scanning the disc and seeing the AR effect. Again participants enjoyed this surprise element.
As for the 'thought tower' element, students liked this. They enjoyed thinking of new ideas. However, just a few students actively went to that element and knew what to do.

Overall
From the perspective of the entire experience, the flow between parts 1 and 2 needs to be improved. Now there is no clear push to try the second part after 1, except for the numbering.

part 1(**circle-circle**); More guidance needs to be added for users to feel free to walk around the object initially. In terms of the prototype, assistance for the placement of the AR effect.

part 2(**Time Travel**); Adding more autonomy, for visitors to choose to listen to the whole section or select to get in-depth on the designer or technical background. Also linking when to press the AR effect matching the audio voice-over.

part 3 (**disc & thought tower**); To integrate the thought tower into the stand, instead of on a separate wall. Two participants instinctively tried to stick the post-its to a wooden plate on the stand.

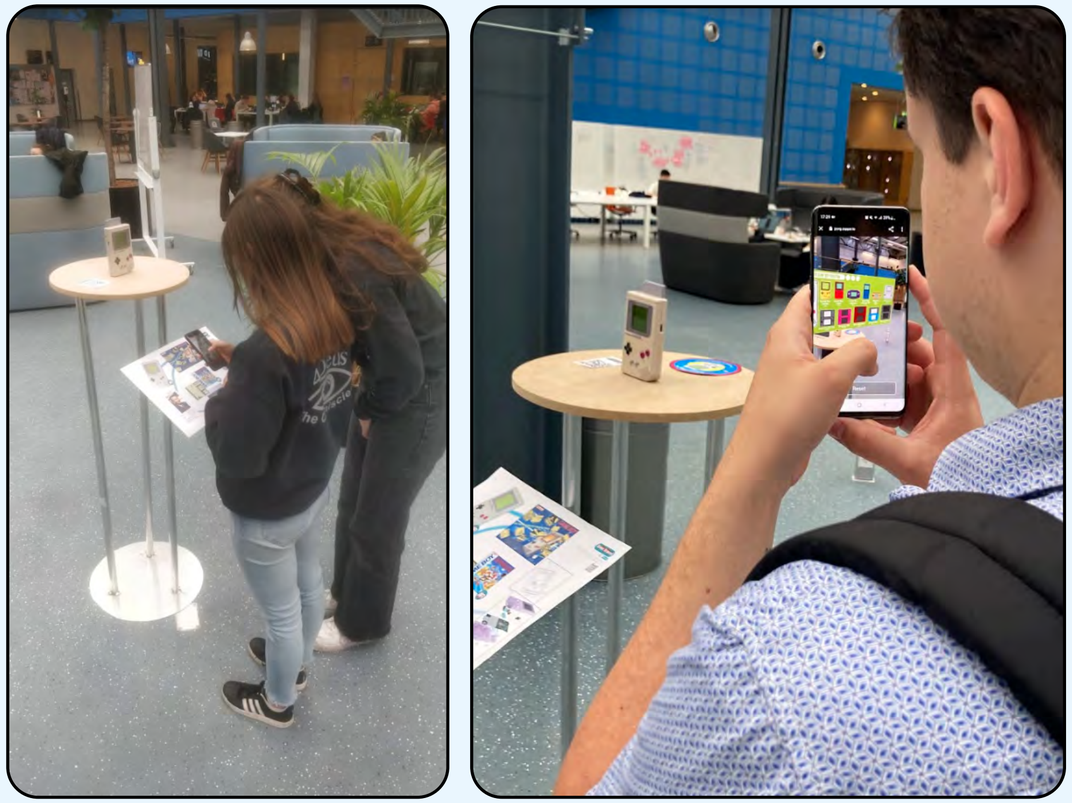


Figure 56: Testing setup and photos of prototype iteration 2 in use.

iteration points II

Circle-Circle
1. Guidance needs to be increased for people to walk around the artefacts intuitively (concept)
2. The Object Placement needs to be guided more to ensure good placement (prototype)
3. A connection needs to be made between this part and the next, time travel (concept)

Time Travel
1. Add autonomy for listeners, i.e. being able to listen to certain section solely (concept)
2. Guide users in when to launch the AR effect (concept)

Disc & Thought Tower
1. Integrate 'tought tower' part to the stand, instead of afar (prototype)
2. Have the discs be part of the stand as well, e.g. through a pocket on the side (concept)

7.10 Conclusion

In this chapter, the conceptualisation of the project was discussed. Started with ideation, to concept development and chosen direction. From there a concept storyboard journey and focus for the rest of the phase was made.

Through prototyping and two iterative user tests, the concept and prototypes were able to be effectively improved in a short time span. The latest user test insights are used to finalizing of the concept, which is presented in the next chapter.

CH7B: Additional Explorations

This bonus sub chapter highlights noteworthy explorations from during the conceptualisation phase, especially relating to the circle-circle concept. The throughline of these explorations is trying to push what is possible with touchscreen devices and AR, in less straightforward manners. Also other approaches to the circle-circle concept, aside from object recognition technology were explored.

Chapter spine

7B.1 Circle-Circle exploration
- 7B.1.1 Object recognition
- 7B.1.2 Image recognition
  - 7B.1.2.1 External markers
  - 7B.1.2.2 Artefact sides as image markers
- 7B.1.3 Gyroscope

7B.2 Virtual button

7B.3 Haptics - device vibrations

7B.1 Circle-circle exploration

The concept of circle-circle essentially is augmenting different elements, based on the angle made with the artefact. Pointing and standing in front of the object would show a use-interaction and on the side of the object a video for example.

Augmented reality is comprised of multiple technologies, as described before in Figure 12. These were explored to be able to materialize the circle-circle concept;

1) Real-time **object recognition** of the artefact(Gameboy). Through the use of this technology, each side of the artefact can be recognized. Based on the angle made, and face recognized, a specific AR element can be spawned.

2) The use of **image recognition.** Two ways how that could be achieved are described below:

a. By smartly using the placement of image targets(markers) around the artefact. The idea is when the phone is pointed toward the object, the marker also is in view. The engine recognises the image target and spawns the AR effect.

b. By treating the artefact's faces(front, side,top etc.) as image targets. In theory, in uniform lighting conditions, these could be recognized by the engine. Again revealing the dedicated AR effect on each side, as the user is circling around the object.

3) Using **object placement**(plane tracking): By placing the AR elements as a world object, over the physical artefact. The AR elements are tailored and prepared in such a way that they face the different sides and can be interacted with when the user's device is pointed in the right direction.

The above-mentioned ways of tackling the circle-circle concept have been explored through prototyping, to figure out which one would be the most promising to make a final prototype.
Object recognition is currently not supported in any web-ar engines, however, would be the logical next step for WebAR since it is the only big feature between AR app and AR web experiences.

7B1.1 Object recognition

To experiment with object recognition, prototyping was done using Unity and Vuforia. Also, the concept was presented to the VR-zone staff. They became excited and felt it is possible to make such a prototype in AR. Figure 57 shows the object recognition prototype made in Unity. Using the unity model generator, the 3D scanned Gameboy was processed. A prototype was made to spawn a red sphere when the object was recognized. Using the Unity and Vuforia tools, also image recognition was explored, see figure on the right.

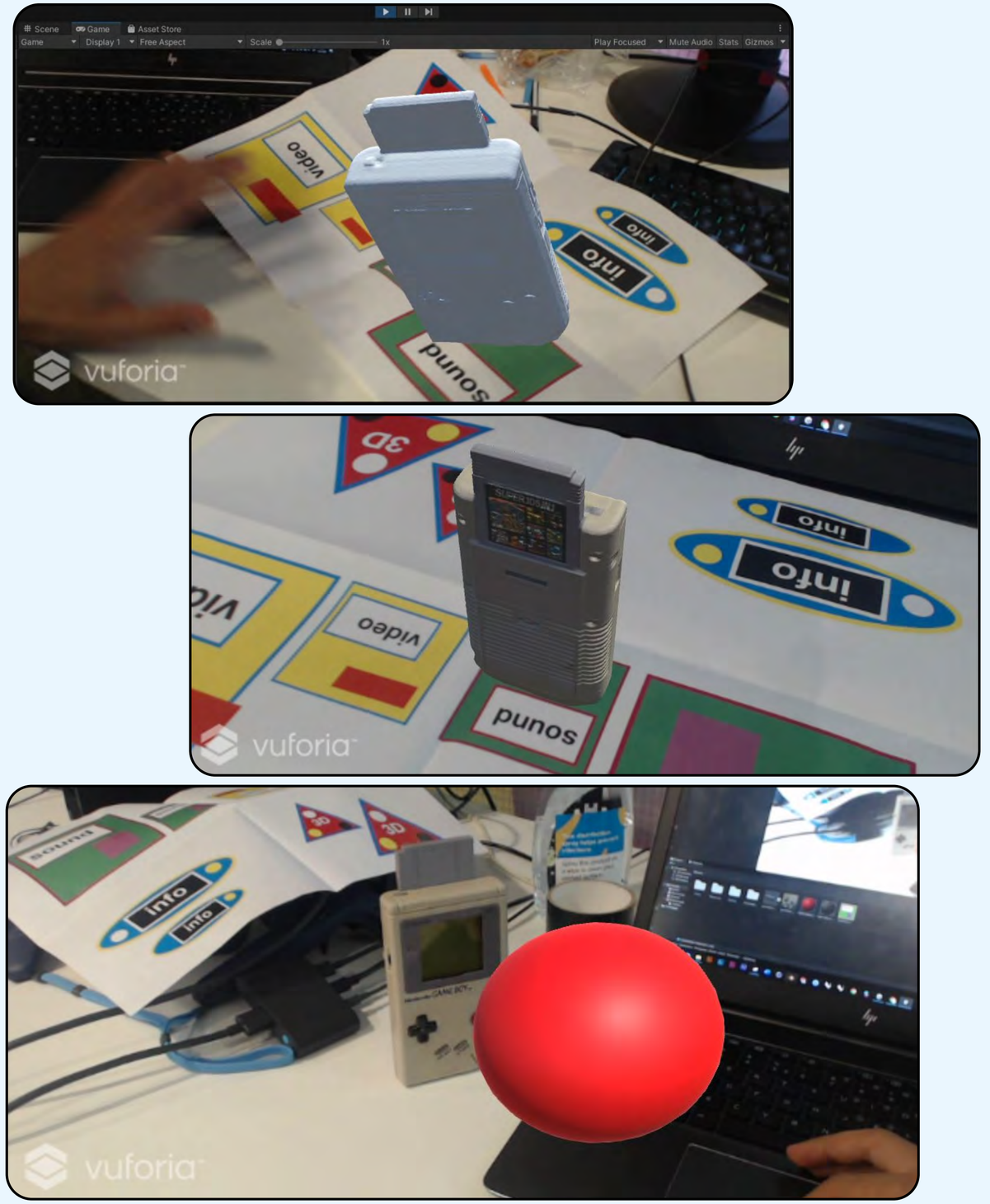


Figure 57: experimenting with Unity & Vuforia engine
(top two image recognition, bottom object recognition)

object recognition as prototype?

The fidelity possible in Unity is high, with that also development time and a coding barrier. During development, Unity crashed a lot of times, given unexpected errors. The expertise and experience of different VR-Zone staff members was consulted, unfortunately without success. It is also only possible to be exported to a device via USB, as an app, on an Android device. All in all the above factors fueled the reasons to explore other options for prototyping and testing the concept, the experience and exploration was valuable nonetheless.

7B1.2 Image recognition

The second option, now the use of object recognition prototype is eliminated, image recognition was explored.
The two ways described earlier were explored: image recognition using external markers(2A) and treating the object's faces as image targets(2B).

7B1.2.1 External markers

Surrounding the artefact with markers, that seemingly for the viewer have no specific meaning, spawn the asset on each side. Essentially using image recognition to spawn these assets when the right angle is reached, in theory 'finessing' object recognition.

Figure 58 shows this prototype exploration. This would be possible, however, there are two impractical aspects found:

1. The marker needs to be visible at all times. Meaning that if the marker is not visible well, the effect is aborted and needs to be restarted by recognizing the image target again. The most common way the effect was aborted, was when making an angle that had a big angle, compared to the ideal situation, see Figure 59 alpha and beta angles.

2. These markers take away from the artefact experience, especially when placed in a way to ensure good tracking, in an upright fashion. This can work as a distraction from the object and AR elements of course.

The two reasons above fueled opting out of this prototyping method, due to its unreliability.

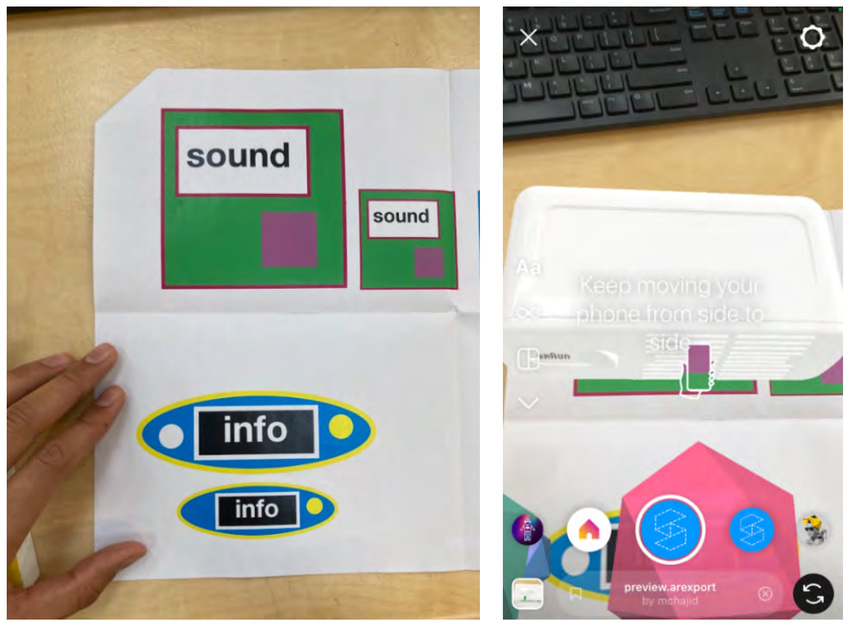


Figure 58: multiple marker image tracking
the markers(left), augmented objects(right)

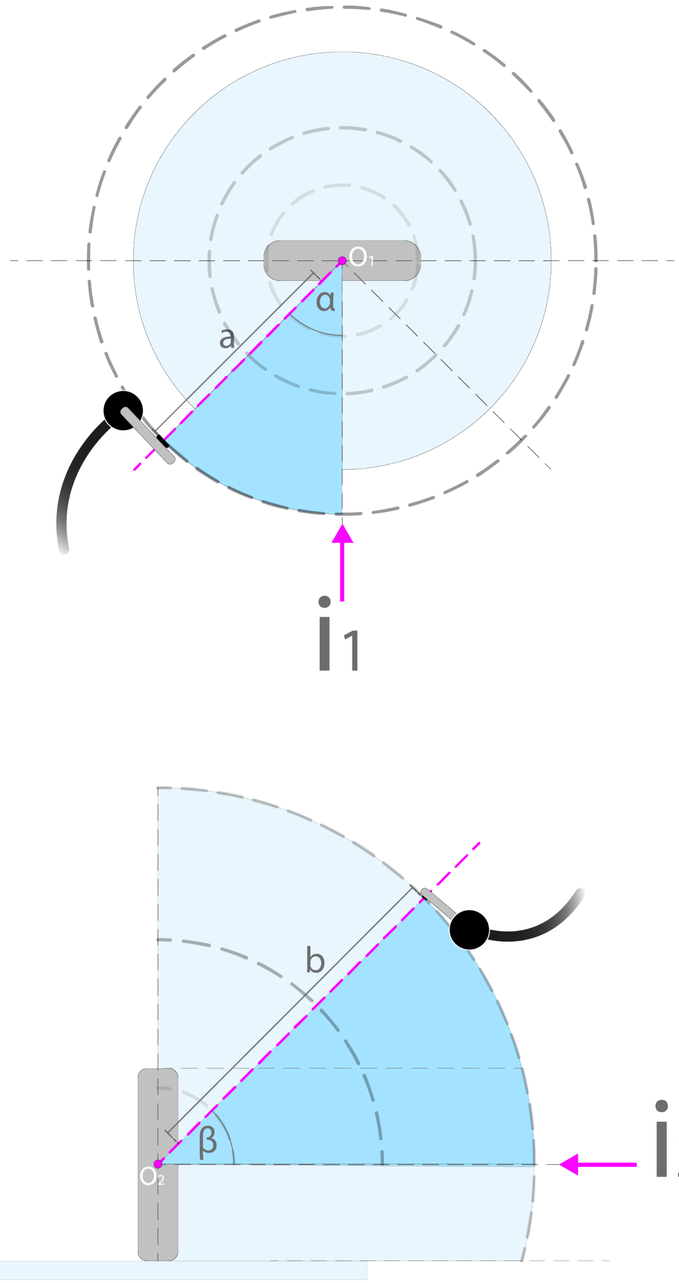


Figure 59: experimenting with Unity & Vuforia engine
(top two image recognition, bottom object recognition)

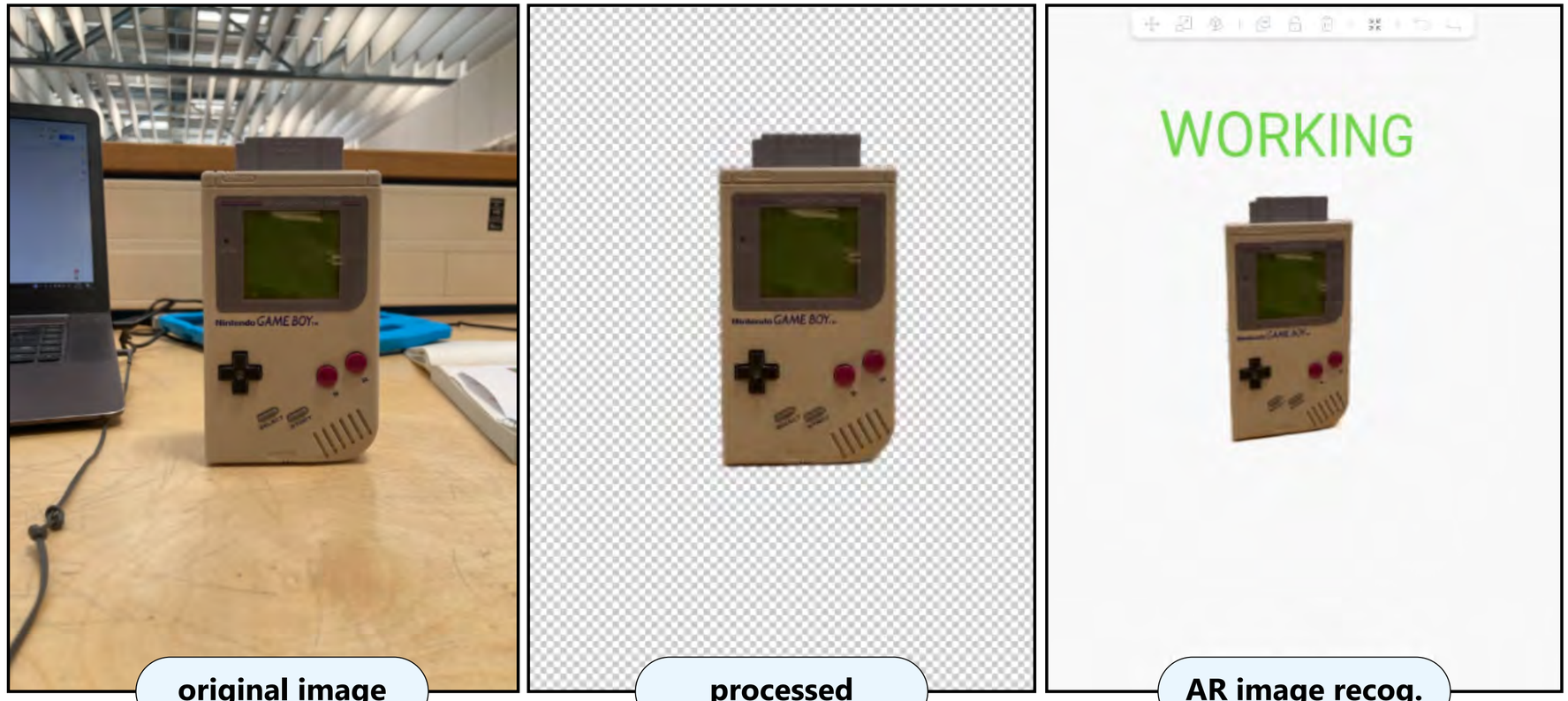
7B1.2.2 Artefact sides as image targets

Object recognition essentially is the recognition of an object through (Vuforia, 2022).
A: the object's visual features, think colours, saturation, contrast etc.

B: the object's physical features, i.e. its form and shape.

In theory, an object could be recognised also just by A, its visual features. This was explored by taking a picture of an object in the environment, a Gameboy. The image was processed in photoshop, to just have the front face be visible, to function as the image target. Subsequently, a simple prototype was made, to spawn the letters 'WORKING' in AR, when the image was recognised. The process and steps taken on the right.

Figure 60: image processing process



Now, how well does this work? The prototype functions when the phone is close to the object, the AR letters spawn above the object, see Figure 61. It recognises that face of the object, as an image. However, similar to the previous prototype, when the device moves too far, the AR experience aborts. Also when making too big of an angle, or moving quickly with the phone augmentation stops. Furthermore, sometimes the prototype just did not work, not detecting the image target, even if not making a big angle or being too far.

For prototyping this is not reliable enough, however, it could be an interesting way to simulate object recognition. Object glossiness of the object and external lighting conditions can play a decisive role in whether the AR effect starts or not. A big change in external lighting conditions might have a hindering effect to the AR recognition.

Potentially, a smart way to go around the found limitations is a combination of image recognition and plane tracking, the image target being recognised by the engine and spawning on the plane. The script then recognises the plane and keeps the effect visible, when the plane can be recognised of course, even if the image target is not necessarily recognised constantly. Image targets function as a start of the effect, and plane tracking taking over essentially.

In a way this also feels like a roundabout route, why not just have the objects set in place beforehand and placed perfectly, just using plane tracking? A scenario where the latter would be more difficult is if the object is somewhat dynamic or there is no recognisable plane, say an artefact afloat mid-air. This is not the case however, prototyping for the circle-circle concept continued using plane recognition(object placement), discussed in section 7.9.1.

This concludes the explorations performed for the circle-circle concept. Different methods of approaching and materialzing a protoype for the conept were explored: Object recognition, image recognition(markers and image faces as targets) and object placement (plane tracking).
Ultimately plane tracking was chosen to continue prototyping with, due to the time and expertise needed for object recognition and unreliability of the image target prototypes.

Figure 61: experimenting with Unity & Vuforia engine (top two image recognition, bottom object recognition)

7B1.3 Gyroscope

Aside from a camera, microphone and vibration motor, modern smartphones also have a gyroscope embedded.
This might be a way to detect the orientation of a device, linking that to the angle made with the artefact, could be a way to actualize the circle-circle prototype, at least this was the hypothesis.

Gyroscopes are essential for the use of proper AR experiences. It facilitates the device's recognition of displacement and rotation, and in which direction. When an AR experience loads, it sets a benchmark of the device's starting position, this is the base reference, and depending on how the device moves from there on, the AR experience adapts, see Fig. 62 (8th Wall, 2021).

Another way could be, is to have a sensor hidden near the artefact, that communicates with the visitor's device sensors. These can have a 'dialogue', to alter the AR experience when the user moves, depending on the device's angle to the static hidden sensor. This however feels like quite a roundabout way of doing things, with proper development it might be possible and a viable option for very specific situations nevertheless, see Figure 63.

Exploring this hypothesis, concluded that a gyroscope data solely is not enough to have a proper AR experience, it is this back and forth between the device's sensors and the AR engine that creates the experience(Islam, 2018). Especially the camera is essential, it either detects the plane(plane or world recognition) or image and superimposes the AR elements on it(image recognition).

This means that solely the use of using the gyroscope as the main driver for AR is not possible, it needs to work with either plane tracking or image recognition for the circle-circle concept to take place.

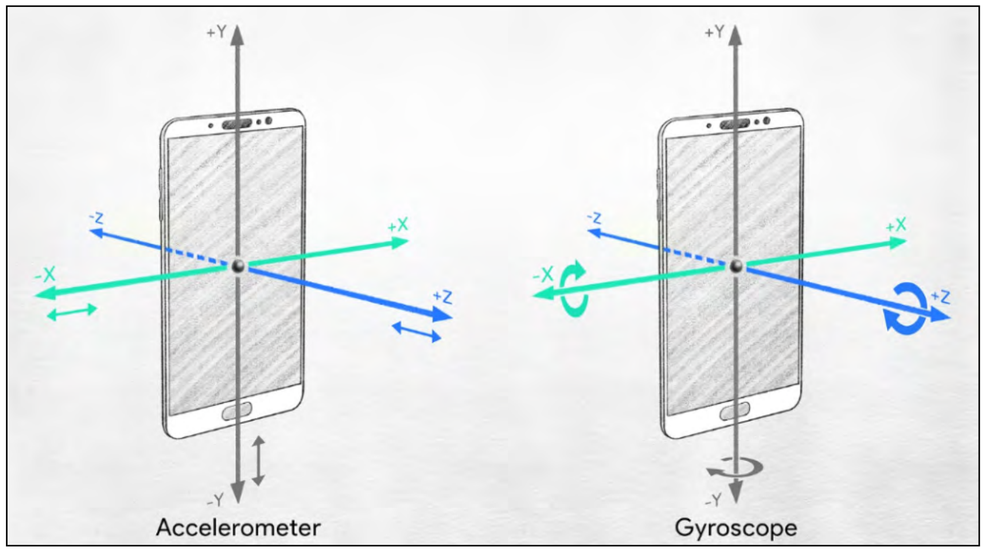


Figure 62: Accelerometer(detecting 3D acceleration) & Gyroscope(detection 3D rotation) images (Islam, 2018)

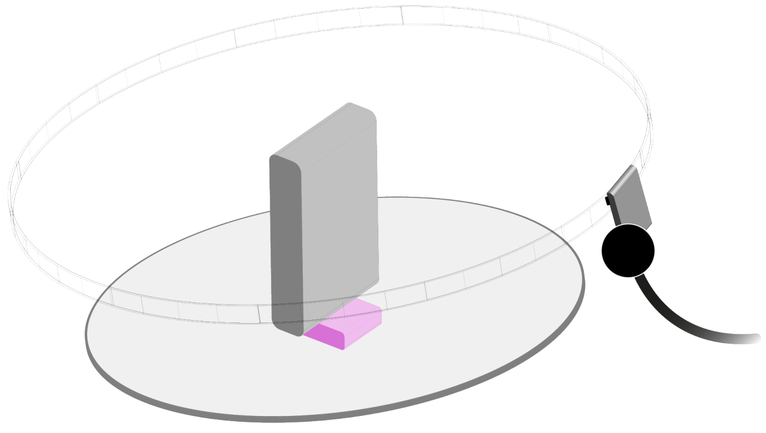


Figure 63: sensor hidden under artefact, which communicates with device's gyroscope and accelerometer to alter the AR experience.

7B.2 Virtual button

Generic interactions on the phone are gestures like: swipe, pinch-to-zoom- tap, hold-tap etc., see Fig. 84. These are virtually universal between devices and intuitive for most users. However, how could we go beyond these, and try to push the limits of what is possible on our phones?

Instead of pressing on a button that is on-screen, what if you could press it in the AR space, instead of tapping on-screen.
When exploring Unity and the Vuforia library, a similar concept above was found. In the engine one could virtually press the button, in AR, the application detects this. Figure 65 shows an image, where a hand is covering the virtual button, triggering the cube to start spinning.

This is also possible in web-AR, however, would require, similar to unity, avid coding and development time (8th Wall, 2021). Hence the abortion of further exploration within this project timeline.

7B.3 Haptics - device vibration

The usual senses that are stimulated during AR experiences often are visual, and sometimes sound too. What if we could use haptics? Virtually every smartphone has a small vibrating motor in the end.

Think of the phone starting to vibrate when the classic KF 20 Braun coffee machine is grinding beans in AR, aiming to make the experience even more engaging and immersive. Would this be possible for a web-based AR experience?

Desktop research showed this is currently not possible, at least not for all devices. Figure 66 shows an overview of supported browsers and devices. Unfortunately, Apple devices are not currently supported. A small test was pursued, on an iPhone and Android smartphone, using the following website: https://codebeautify.org/online-vibration-simulator

On the iPhone, both Safari and Google Chrome web browsers did not respond to the website vibrating request. On the Android device, it did work, using Google Chrome.
Since the multi-device support use is a must for the concept, and the coding skill needed to build a custom AR experience with vibration parts, further exploration was discontinued.

It could be very interesting how haptics can be simulated on everyday smart devices. Imagine making a choreography of vibrations, depending on the AR experience. Playing with time, frequency, intensity etc. This could make the experience more immersive and engaging, without the use of haptic gloves or other external devices.

Device	Support
iOS Safari	NO
Opera Mini	NO
IE	NO
BlackBerry	NO
Android Browser	Since Android 4.4
Opera	Yes!
Chrome	Yes!
Chrome for Android	Yes!
Firefox	Yes!

Figure 66: overview of browsers that should support web activated device vibration (Ismanalijev, 2022).

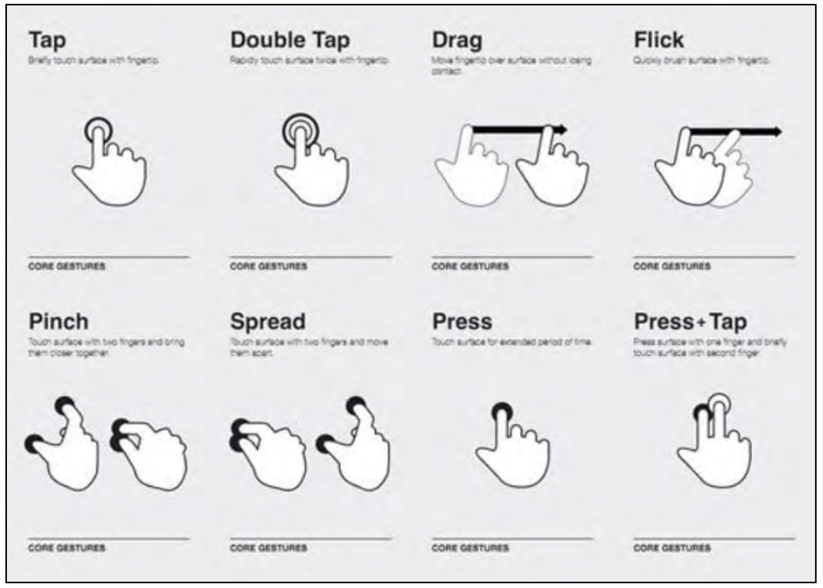


Figure 64: Widely used touchscreen gestures (C., 2021)

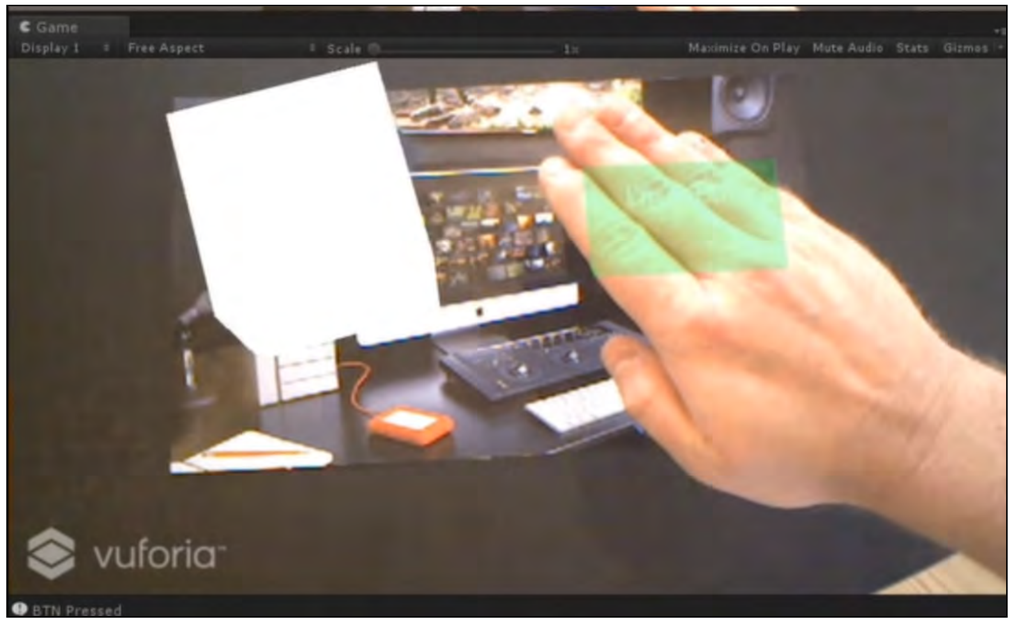


Figure 65: Image of AR virtual button using Unity with Vuforia (CubicBrain, 2017)

CH8: Demonstration

In this chapter the final design is presented, the design and its corresponding user journey are presented.
First, the storyboard, followed by zoomed-in visualisations per part and screens are offered.

Chapter spine

8.1 Final Concept

This section is dedicated to presenting and explaining the Final Design. The final design is iterated based on the improvements from section 7.9.5.
First, the design is briefly presented, after the storyboard of the user, followed by a more detailed explanation per step of the journey and the connected AR elements.

ARchive is an interactive museum experience that brings artefacts to life in an engaging and educational manner. Through the power AR technology and visitors' smart devices, the now normally hidden stories of these objects can be unlocked. The concept offers a multisensory experience where visitors can interact with, and learn about the artefacts in a casual way, all from devices familiar to them.

On the next page a short explanation each of the storyboard's steps.

Part 1
This is the first part where content and interactions are digitally augmented over to the object. The user accesses these by scanning a QR code with their device, where they are directed to the ARchive's webAR page and can start their digital experience.

1

2

Part 2
The second is all about the story and depth of the artefact. Here visitors can listen to this story and interact while it's told, through AR elements.

3

Part 3
The full experience ends with part 3. Visitors are challenged to go from consuming information to creating. To draw or write down their thoughts regarding the object. Finally, they can take a souvenir, ARdisc, to remember and spawn their favourite artefact on demand.

Part 1 Zoomed-in; circle-circle

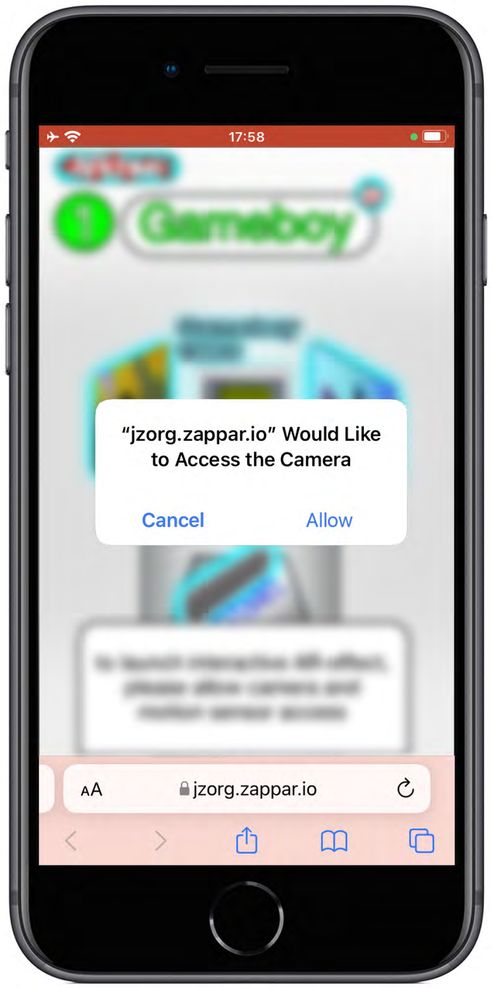
1

Circle-circle is the name of the first part of the experience. Like the name suggests, the underlying concept is for visitors to circle the objects in space, to discover more and more about and interact with them.
The experience starts with the guide, sharing the full experience's intent at a glance, for all the steps(1,2 & 3). Here too, the user scans a QR to be directed to the AR page and start their adventure.
In the experience from the users' point of view(POV), they see the augmented elements. These elements' viewability are dependent on the angle the user makes with the object, moving them to walk around and explore the object from different sides. Viewing the stand and object from above(TOP), the four main elements on each side are; a user interaction, video, a 3D effect and a picture(e.g. timeline).

Part 1 Zoomed-in; circle-circle

After scanning the QR code, the first page the user sees is the landing page. The landing page gives a simple view of the object, confirming the title and a glimpse of what's to come. To be able to use AR on their device, access has to be granted (screens 1 & 2).
After giving permission, the user is guided to point their phone to the object, for the engine to recognise the object and start the AR effect (screen 3).
When the AR effect is loaded the visitor can walk around and interact in different ways, here: press the start button of the GameBoy to start a game (screen 4)

landing page
(screen 1)



allow permission
(screen 2)

point camera
(screen 3)

in AR experience
use-interaction
(screen 4)

Part 1 Zoomed-in; circle-circle

The second AR element is video, e.g. watching a GameBoy commercial(screen 5), see a 3D exploded view of all the internal components (screen 6) and finally view a timeline of the object's impact on more contemporary devices(screen 7).
After having fully walked around the object, a pop-up shows the user completed this part and can go to the next if they would like (screen 8). Especially if they are interested in the story of the GameBoy.

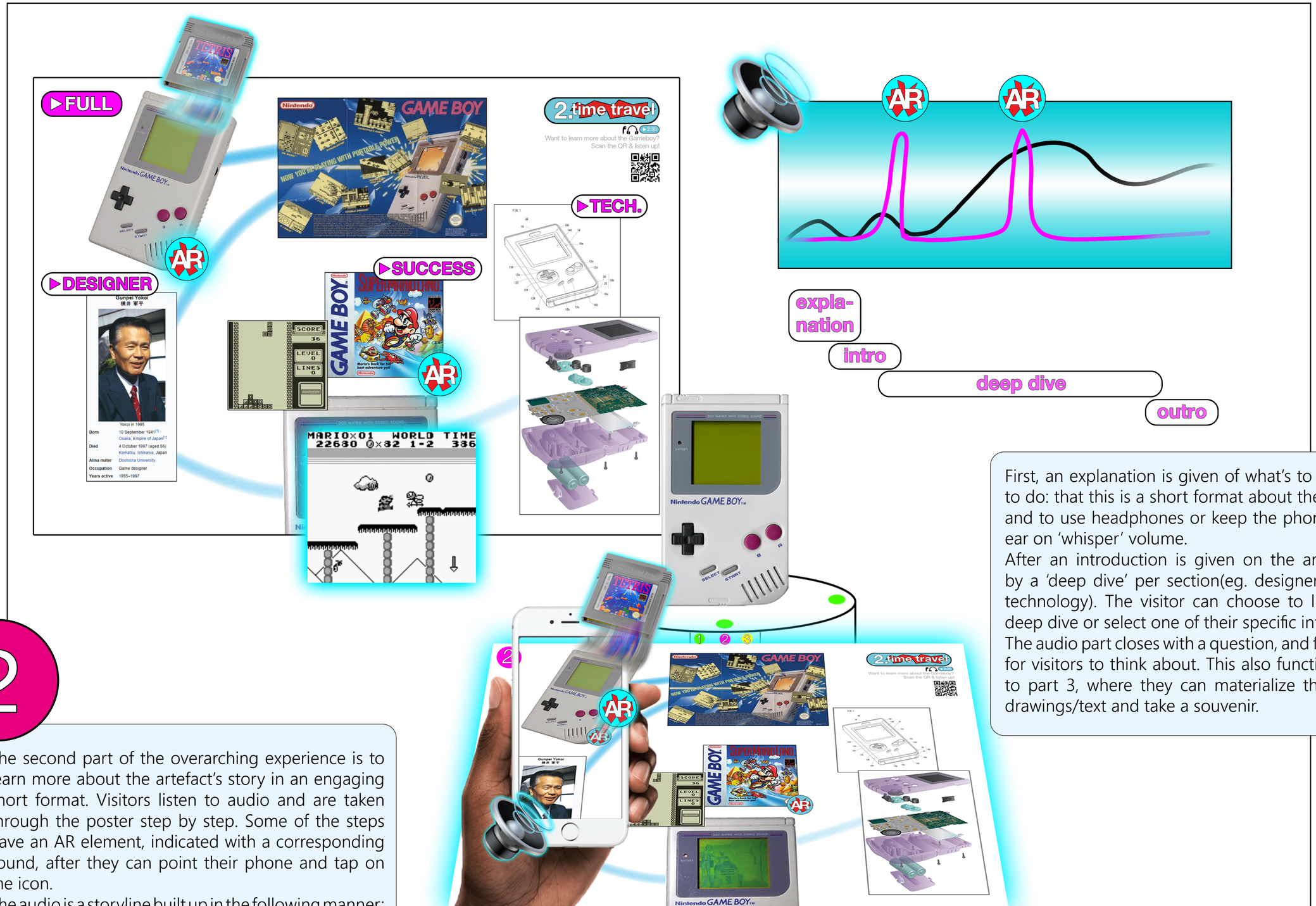
landing page
(screen 5)

3D effect
(screen 6)

image (timeline)
(screen 7)

guiding pop-up
(screen 8)

Part 2 Zoomed-in; time travel



2

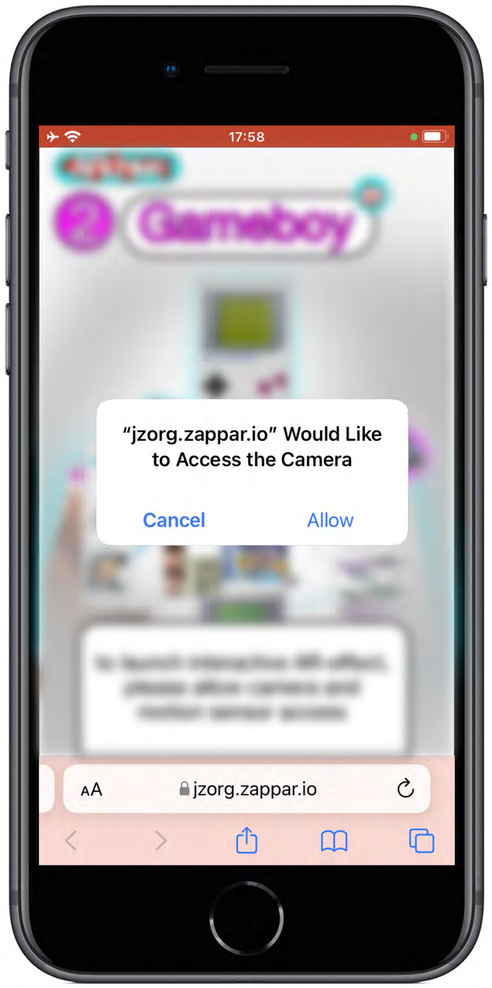
The second part of the overarching experience is to learn more about the artefact's story in an engaging short format. Visitors listen to audio and are taken through the poster step by step. Some of the steps have an AR element, indicated with a corresponding sound, after they can point their phone and tap on the icon.
The audio is a storyline built up in the following manner; explanation, introduction, deep dive and outro.

First, an explanation is given of what's to come and what to do: that this is a short format about the artefact's story and to use headphones or keep the phone close to their ear on 'whisper' volume.
After an introduction is given on the artefact, followed by a 'deep dive' per section(eg. designer, successes and technology). The visitor can choose to listen to the full deep dive or select one of their specific interest.
The audio part closes with a question, and food for thought for visitors to think about. This also functions as a bridge to part 3, where they can materialize their thoughts as drawings/text and take a souvenir.

Part 2 Zoomed-in; time travel

Here there are two ways the user can enter, through scanning the QR code, or when pressing [2] from the screen of the previous circle-circle screen.
If they choose to scan the QR code, say skipping step one, they again are welcomed by the landing page and asked for permission(screens 1 & 2). If visitors directly come from the circle-circle experience, they start at screen 3, where they are asked to point their device toward the poster. From here the audio queues, and an AR effect can be revealed when tapped (screen4).

landing page
(screen 1)



allow permission
(screen 2)

point camera
(screen 3)

AR effect 1
(screen 4)

Part 2 Zoomed-in; time travel

The audio continues to play and another Ar effects can be revealed, here gameplay of Supermarioland (screen 5). It was one of the first games that came out with the GameBoy, and one of the reasons of its success, since it is a console-exclusive game.
Finally when finished the now familiar pop-up is shown, users can choose to stick around, go to the next part or even the next object by walking towards it.

AR effect 2
(screen 5)

guiding pop-up
(screen 6)

Part 3 Zoomed-in; thought & disc

If the visitor chose to have the full experience, they arrive at this final part. Here users can draw and write down their ideas regarding the topic and question posed. For example;
What do you think the future of handheld gaming will look like?
Visitors can grab a non-permanent marker and draw or write on the whiteboard section. Or read to see what other visitors before them have written down.

3

3. Thought tower

What do you think the future of handheld gaming will look like?

description

handheld console

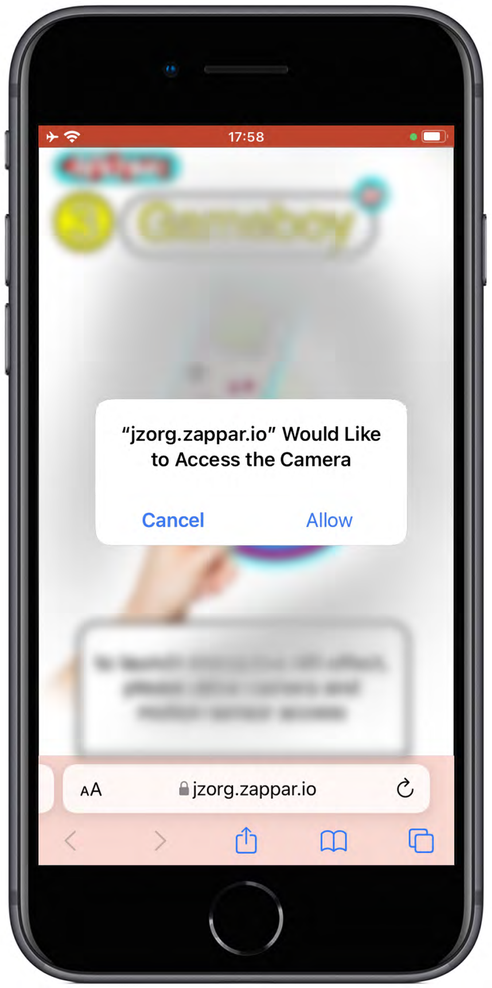
scan & flip for AR effect

As a souvenir and reminder, visitors can grab an ARdisc. This shows the object, with short supplementary text on the back. On the rear, there also is a QR, when scanned spawning the object comes to life even when they are not at the museum.

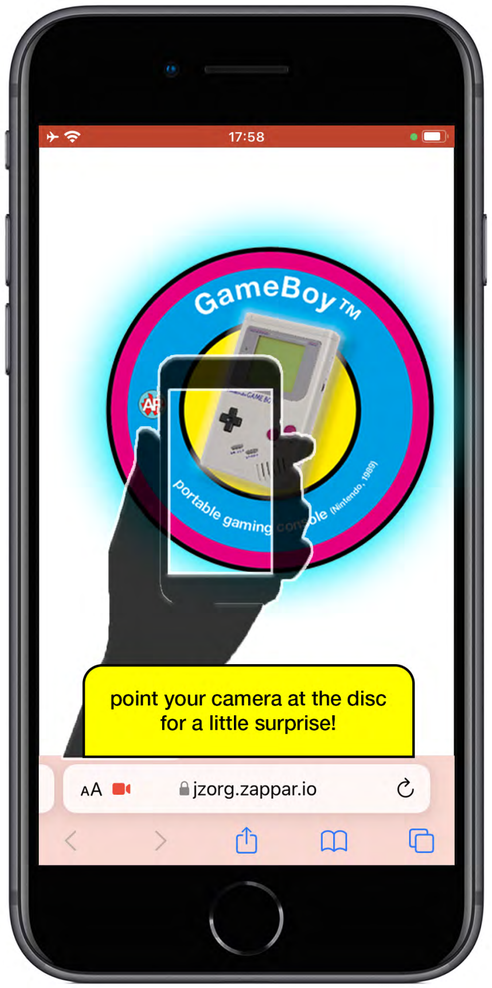
Part 3 Zoomed-in; disc

For the screens of part 3, again, depending on the users' flow enter by scanning the QR and are asked for permission (screens 1 &2) or directly start the experience. First, the user is shown the target image, disc, that will be recognised and tracked to spawn the effect(screen 3). After detection, the object spawns and animates above the physical disc (screen 4). Visitors can move it around or place it on a table.

landing page
(screen 1)



allow permission
(screen 2)



point camera
(screen 3)

object spawns
(screen 4)

Part 3 Zoomed-in; disc

The effects also has two ‘easter eggs’, here:
One that plays the GameBoy’s startup sound when the speaker is pressed (screen 5)
And a rainfall of Pikachu’s when the other button is pressed (screen 6). A reference to the now-iconic character, playable in the very first Pokémon game on the GameBoy.
This concludes the full experience, and a matching pop-up to inform the user (screen 7).
From here visitors can choose to go back and re-experience bits or go to the next artefacts.

easter egg 1
(screen 5)

easter egg 2
(screen 6)

final guiding pop-up
(screen 7)

ARchive physical elements

As seen before, the concept has two physical elements that play a role;
the AR disc and time travel poster.

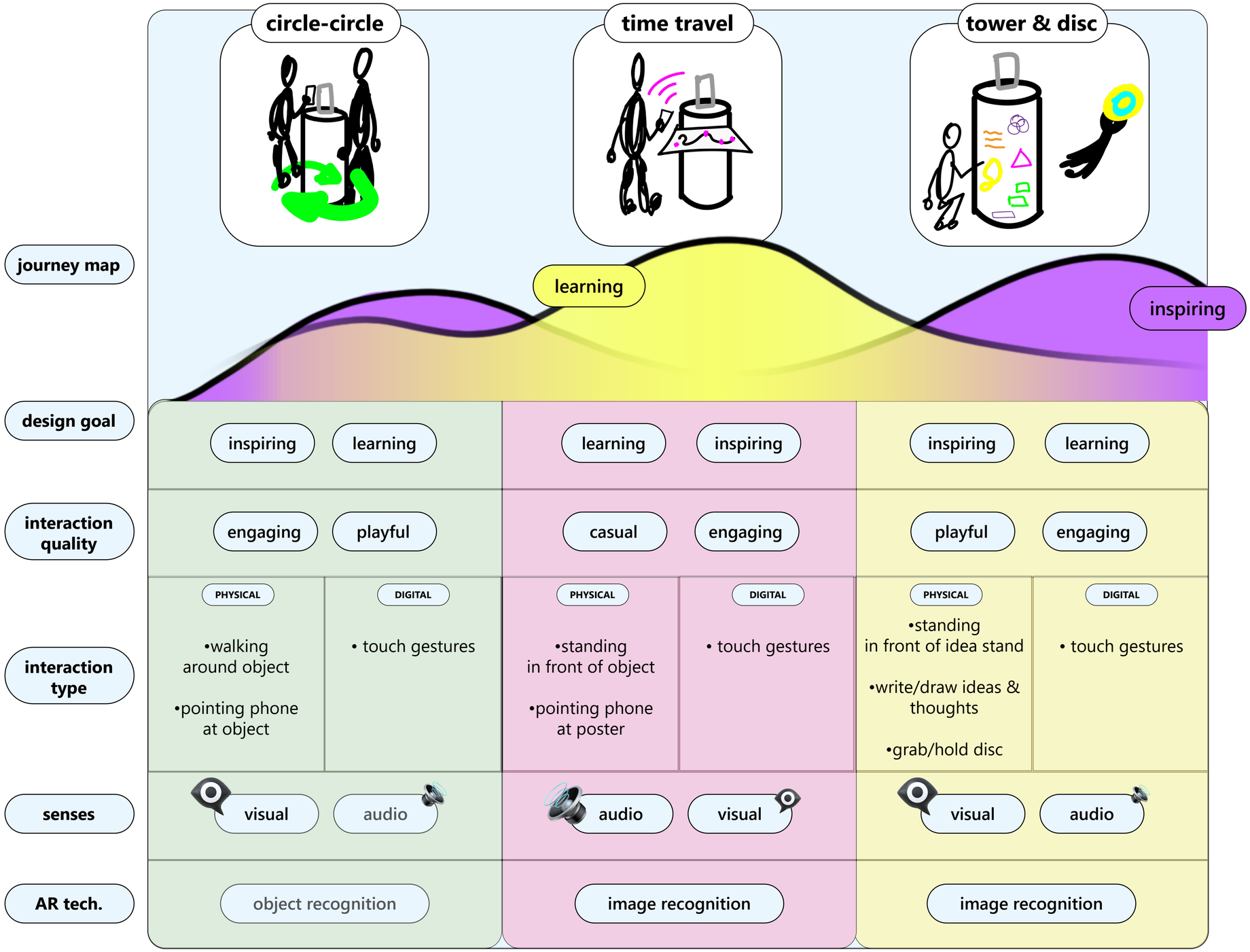
Disc
On the right concept images of the disc element can be seen. On the front the Design Heritage product is seen, with some generic information and AR icon. On its backside a short description of the artefact and its relevance can be read, along with the year of release and product category.
The disc acts as the physical key to a (final) AR moment for the whole experience, that can be done in or post the exhibition setting.
The user scans the QR, flips the disc and points their phone at it. Through image recognition the product comes to life digitally, by popping up in 3D and animating, and a few minor interactions can be had.
This is a way for visitors to take their favourite artefact with them, in their pockets, and reflect on it.

Time travel
During the time travel part of the experience users are told the back story of the artefact in a short and engaging manner. The physical poster(on the right) has a few points the story goes through, which are based on the research findings(students' interest): think of why the design was a success, the designer and technology.
The poster purposely was designed with little to no text, to keep the interaction simple and for the story to be revealed sonically.
Especially since there are AR elements, again recognisable through the icons. For example a cartridge spawning, seeing video gameplay on the Gameboy's screen and an exploded view during the technology section of the story.

ARchive storyboard map

To communicate the intent behind the ARchive experience a storyboard map was made. This map shows each part of the experience, its dedicated strengths in relation to the Design Goal and interaction vision. Also per part the physical and digital interactions ,stimulated senses and used AR technology are displayed.

The circle-circle experience is envisioned to be engaging and playful, being somewhat an equal blend of inspiring and educational for the user.
Time travel is designed to be strong in the educational aspect, being a casual and engaging experience.
Lastly the tower and disc parts are high in inspirational value, due to seeing the thoughts and drawings of others. This experience part has the playful and engaging interaction qualities on its forefront.



8.2 WebAR & Production

In this section some implications, and things to keep in mind for the practical materializiaiton of the design to take place;

WebAR and Object recognition
The design is built upon WebAR, specifically using the 8thwall platform, which allows the biggest accessibility. Currently, object recognition through webAR is not available, this is only available for stand-alone developed apps. However this is the next step for webAR, this also being the only 'big gap' between developed applications and webAR experiences in terms of features. The technology needs to innovate and catch up, however, this seems very possible. A small team of developers actually already created a WebAR object recognition tool, built upon the three.js framework (Xavier, 2022).

Production
The design and storyboard also have certain implications, things that should be taken care of by the institution from a production standpoint, below a few guidelines;

1. Duos should be given an iPad, or other tablet, to maximally enjoy the AR elements, with bluetooth headphones.
Visitors without a wireless headset should be able to borrow one before entering.

2. Visitors without a wireless headset should be able to borrow one before entering.

3. For visitors without smartphones, or older or partly functioning devices, they should be able to also lend a device from the institution, this can also be an iPad or smaller device.

3. WebAR uses internet connection, thus the institution should take measures to supply (temporary) fast wifi inside or near the AR experience spaces.
During the evaluation and iterative user tests the faculty's 'eduroam' wifi was used, which worked fine.

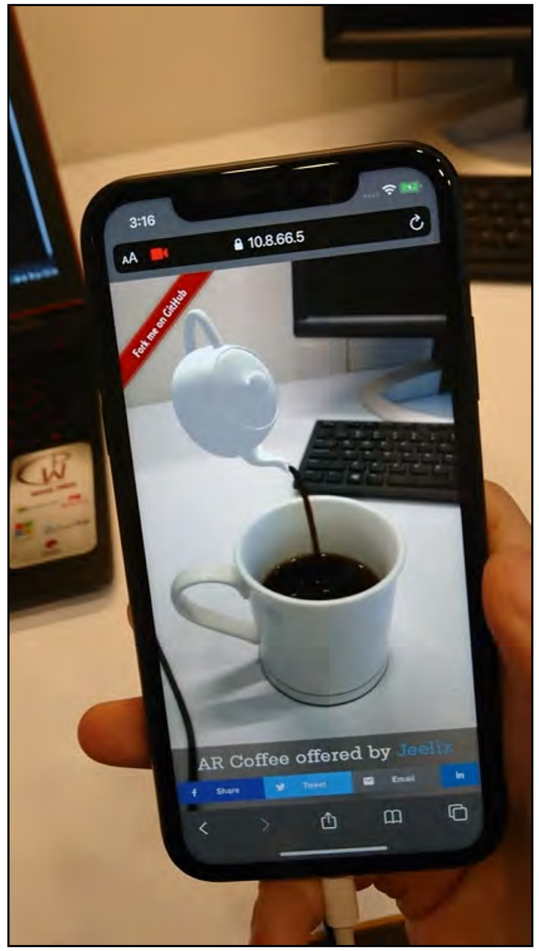


Figure 67: WebAR object recognition by Github user 'Jeeliz' (Xavier, 2019)

8.3 Implementation concept

The ARchive concept, aside from an experience, could be seen as a structure or system. Most of the experience is compromised of content, tailored to the artefact. Meaning the circle-circle AR effects, time travel poster and disc, for example, would change based on the object.
Figure 68 shows all of the components of the ARchive concept, a distinction being made between rigid components, non-changeable, and changeable elements.

The concept and concept part of course are non-changeable. This simply means the storyboard sequence is followed, with the elements.
What is changeable however are the contents in the concepts.
Think of the AR effects used in circle-circle, time travel and disc. Especially for another object this needs to be tailored.

However what would stay the same is the circling around the object and different assets being revealed, for the circle-circle part as an example.

Other elements that need to be tailored to an artefact are the time travel digital contents(audio story & AR effects, and the physical poster that goes with it.
Same goed for the Disc part.

Finally the stand can be adapted too, to cater to specific exhibition or visitors needs. It should still invite encircling however.
Finally the thought tower element can be changed too, in an exhibition being a large wall instead of on the stands themselves.

Figures 69 and 70 show mockups of the concept for another artefact, the classic Braun T3 domino lighter designed by Dieter Rams.
This gives an impression of how the experience would be tailored to another artefact.

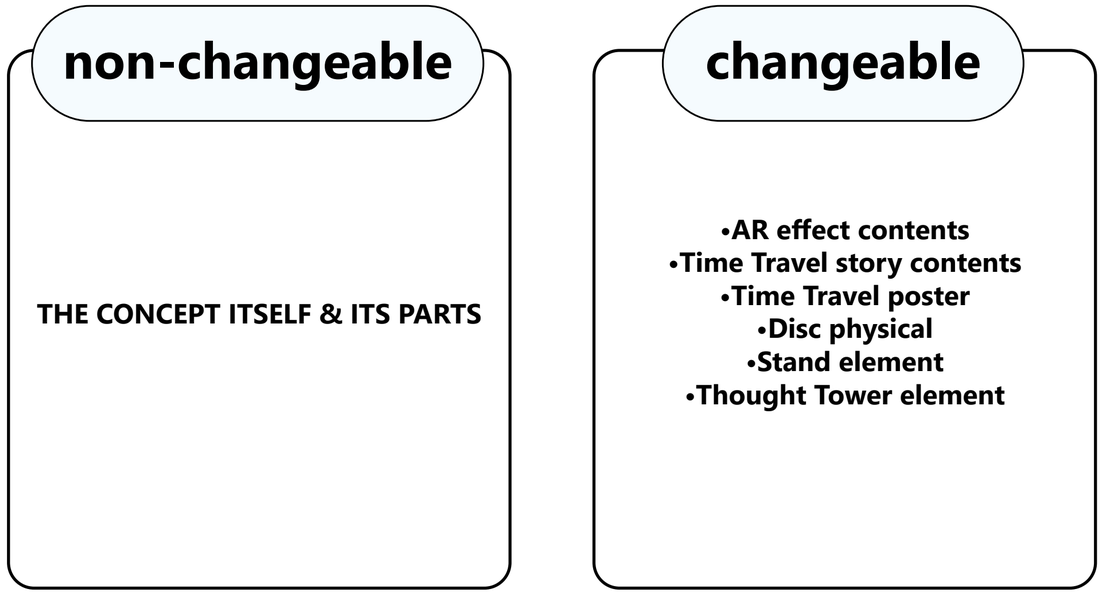


Figure 68: non-changeable vs. changeable concept elements

8.3.1 Example

An example of another product, that was the runner-up to the chosen Gameboy example, was the Braun T3 lighter. This product is also part of the HBI's archival collection.

Figure 69 shows how the circle-circle concept change for example.
Now highlighting the functionality of the lighter for the use-interaction.
Pressing the button in AR would play the real-life click and gas sound, also prompting a fire animation above the lighter.
The Disc mockups for the Domino T3 is seen on Figure 70.

The upcoming section dives into the implementation of the concept on a spatial level, for the IDE faculty and exhbition setting.

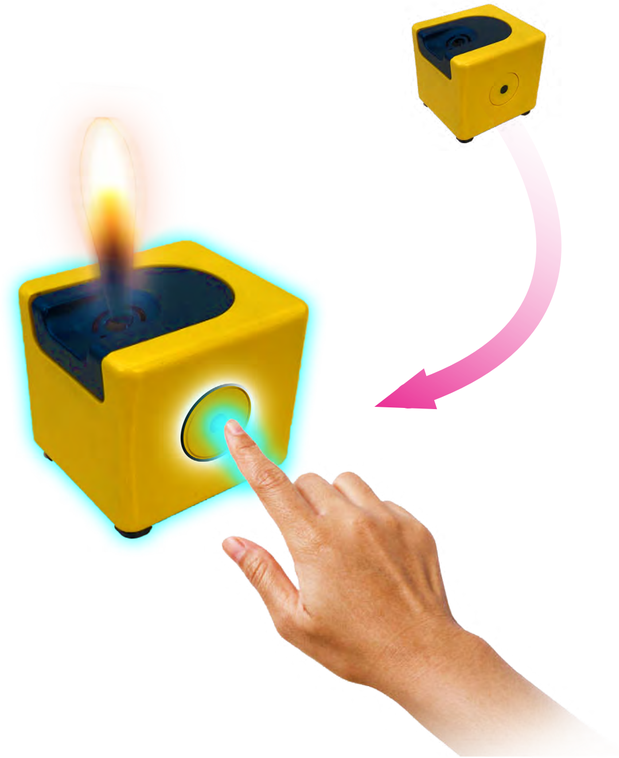


Figure 69: circle-circle AR experience mockups for the Domino T3 lighter

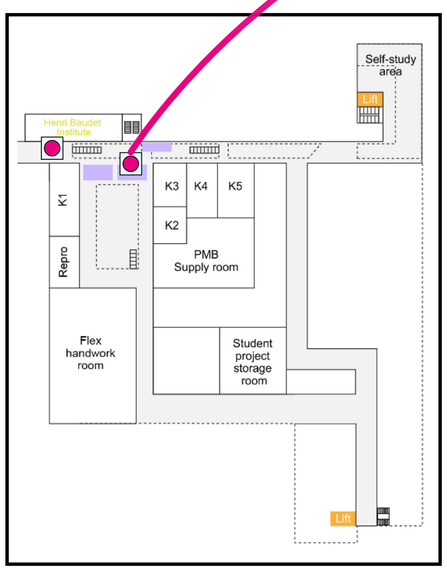
Figure 70: Disc mockups of Braun Domino T3 lighter

8.3.2 Implementation - IDE faculty

Implementation spatial level - IDE faculty
The earlier propsed concept showcases the design on an individual, singular level. How would this design be implemented to the IDE faculty?

For the context specific case of IDE and students taking breaks, the implementation would be in line in how students would like ti get inspired and learn(insights in section 5.4).

Figure 71 shows a floor plan of how the stands can be setup. They are setup in such a way to invoke discovery and exploration, with one hub with multiple artefacts on display in the main hall..
The idea is for these artefacts to change over time, making it a dynamic installation. This was an important point, since a while the artifacts got ignored in the current state.



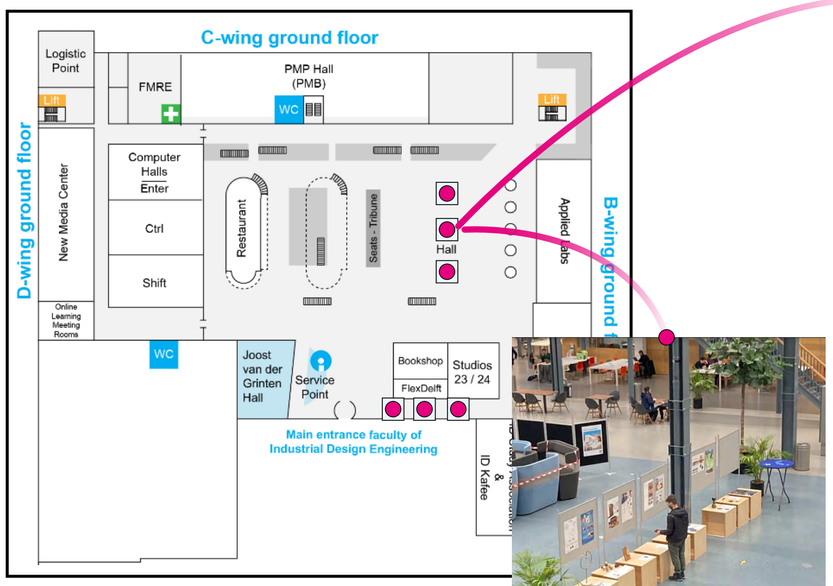


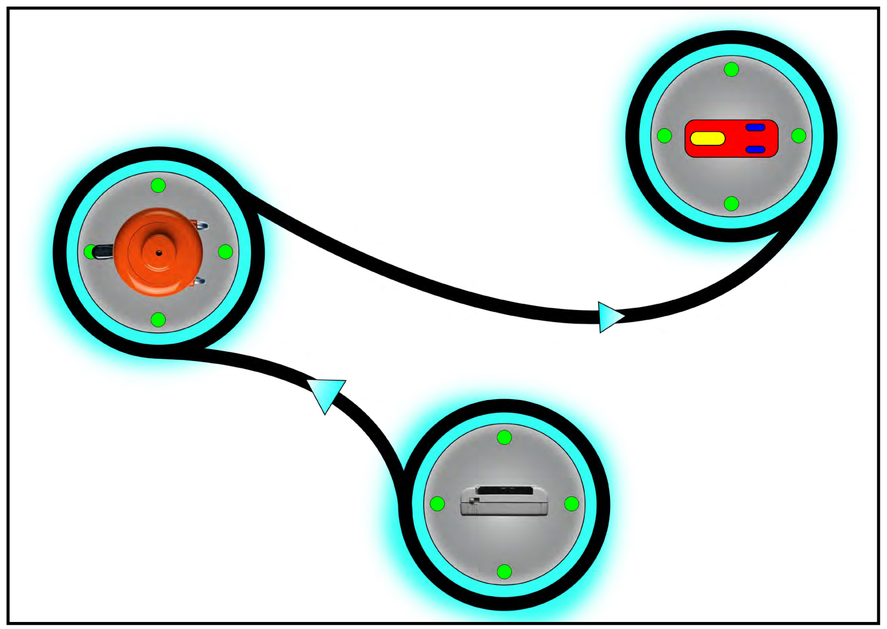
Figure 71: Implementation of concept at IDE hall & 'Kuil'(basement)

8.3 Implementation - Museum setting

In a museum or exhibition setting the setup would be similar, however this can entail more freedom in configuration of course.

Figure 73 shows a floor plan of a white cube museum space and the stand setup. You can see they are setup in a way to create this walking flow between artefacts, to make it easier to jump from one to the next.

Similar to every exhibition the setup depends on the space, but also the curatorial team and budget. Lots of configurations could be made regarding the artefacts their formation in the space.
An example of a configuration on the next page, having the thought towers as a big collective wall instead of per product and stand.



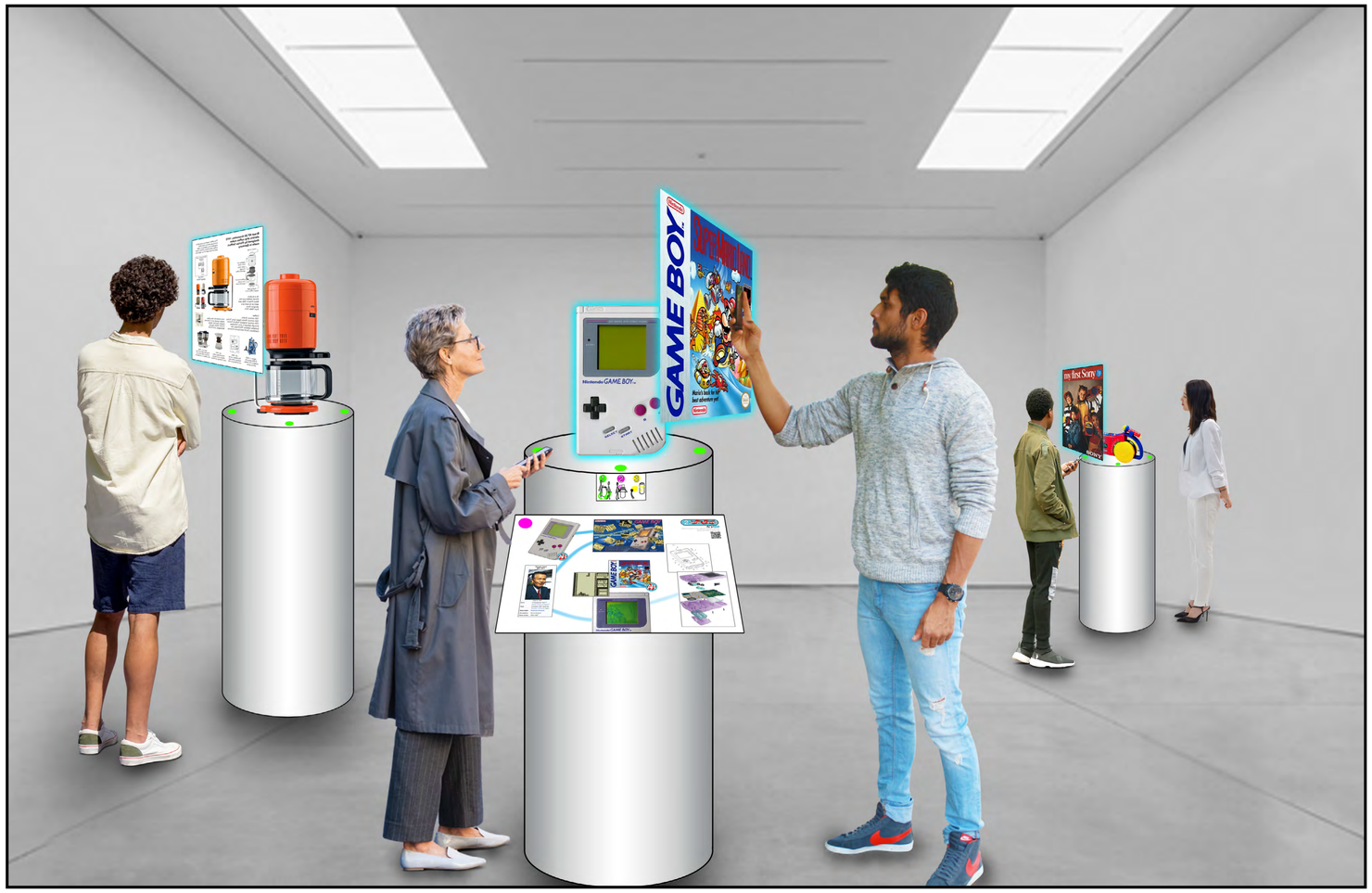


Figure 72: Concept mockup for museum setting

Figure 73: Walking flow between stands

Figure 74 Visualisation thought tower part as big wall in exhibition setting.

CH9: Evaluation

In this chapter the final design is put to the test and evaluated by the target group. First the test setup is discussed, followed by the final prototype, the evaluation results and conclusion. The chapter closes with final recommendations based on the evaluation insights.

This chapter is dedicated to the evaluation of the final prototype, functioning as a shadow of the final design. The validation test was performed in context with the target group.
First, the research setup and intention are discussed, followed by the final prototype, which aims to approximate the final concept. After, the evaluation results and insights are discussed in section 9.3. The chapter closes with an evaluation in section 9.4 and final recommendations in 9.5.

Chapter spine

9.1 Research Setup

In this section, the research setup is presented. First the overarching goal and paired research questions are discussed. Followed by the participants, methodology, the test setup and structure.

9.1. Evaluation goal

The goal of the user test is for the target group to evaluate the final proposed concept. This is done through the final prototype, which tries to mimic the final design as closely as possible. The final prototype is extensively discussed in section 9.2.
The evaluation was set up in such a way that it validates the design goal and interaction vision qualities. Also, importance is given to the intuitiveness of the prototype and meaning created post-experience.
With that the following research questions were set up for the research, seen on the right.

research questions

Design Goal
• To what extent did the participants learn, about Design Heritage, from the experience?
• To what extent was the experience inspiring for participants?

Interaction Vision
• How playful do participants find the overall experience?
• How engaging do participants find the overall experience?
• How casual do participants find the overall experience?

Design
• What is the overall opinion on the experience, and of each part?
• Which parts would need further development and in what way?

Project Approach
•If so, how do students view the artefact differently post-experience?

Individual vs. duo
•Is the experience as enjoyable for a duo, as for individuals?

Figure 75: Research questions overview

9.1.2 Test Setup

The testing context was the IDE building during the day, in the open hall of the faculty. Figure 76 show the floor plan and prototype in purple, and an image of the prototype in context.
Individual participants were asked to use their own smartphones and (wireless) headphones for the WebAR experience. Duos were given an iPad to experience the AR effects jointly. As a backup if the participant did not have a charged, partly functional or dated phone, the research host's phone was given.

test setup

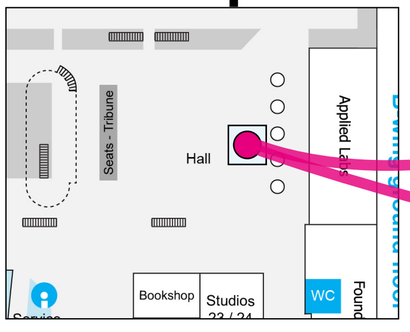


Figure 76: Test setup floor plan & proto in situ

The structure of the evaluation participants follow is the following, se Figure 78.

Firstly participants were presented the full concept storyboard and explained the scenario: They are visiting a museum and are approaching the pillar for the first time. Participants were asked if they knew how to scan a QR-code on their phone, and explained if needed. No further instructions were given, except for participants to do what feels right.

Part of the introduction is also filling in the pre-experience form, see Appendix H, where they fill in generic information and are asked their expectation having briefly seen the prototype. The final part of the introduction is signing a form, where students can consent to be recorded visually and sonically.

9.1.3 The experience

Now the participants approach the physical prototype, equipped with a smart device and headphones, ready to start their experience. Specifically, the AR experience is tri-partly: the circle-circle(1), time-travel(2) and disc prototype(3).

9.1.4 Post- experience

Post-experience the participants are asked about their overall thoughts and how it went, this marks the start of the semi-structured interview which is audio-recorded. Briefly, each part is discussed and a notable moment during the experience. If it was a duo, an extra question was asked on how they found the experience as a duo.
After participants are asked to fill in the post-experience part of the form. In this form, they are, among other things, asked to rate their overall experience on the DG and IV qualities. Participants were also asked about their favourite and least favourite element of each experience step.

9.1.5 Methodology

The research is set up to mimic the steps 'in-the-water' from the concept storyboard, see Figure 44.
Below is visualized how each question is set out to be answered relating to each step of the test setup. The overarching structure for the test is the following: introduction, experience and evaluation. The research methods used respectively are: Questionnaire(introduction), observation(experience) and semi-structured interview and questionnaire(evaluation).

During the experience, three digital prototypes were used to approximate the design concept. The physical prototype consisted of the stand, that elevates the artefact on display. Also the explanatory guide, markers(circle-circle), poster(time-travel), and thought tower paper element with disc(part 3) are printed and part of the stand.
These prototypes, digital and physical, are extensively discussed in section 9.2.

Figure 77: methodology(right) & tools used(below)

experience digital prototype individual
participant's phone with headphones

experience digital prototype duo
iPad with headphones

record participant's behavior
photos & video

record (initial) thoughts participants
audio & filled in form

structure

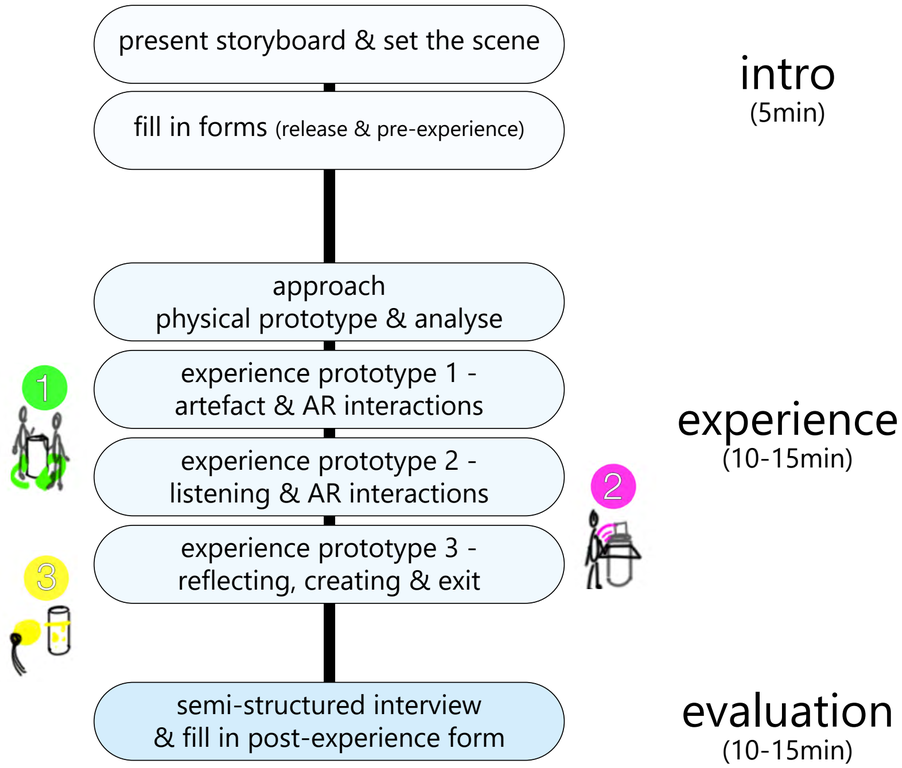


Figure 78: Evaluation structure

methodology

research aim
exploratory - evaluating design prototype in context with target group

research data
Qualitative: participant's opinion (interview & form)
Quantitave: participant's rating on form

research elements
Form
First given(intro) for generic information(age, study level, experience AR etc.) & prior knowledge on the artefact(GameBoy).
Post-experience used to rate the experience, and parts, on intented characteristic (learning, inspiring, engagement etc. & meaning post-experience)

Interview
Post-experience discussion to gauge how the experience was for the participants and reflect on it. As a start the overall experience is inquired and rated, after each part specifically.

9.2 Final Prototyping

This section uncovers the process toward the final prototype. First, the final prototype's link to the evaluation is discussed. After the final prototype, physical and digital parts are discussed. For the digital prototypes including, the process. The section closes with prototype limitations and expected/ potential effects on the evaluation.

9.2.1 Prototyping goal

The goal for the prototypes is to approximate the final concept as closely as possible. The final prototype also is based on the insights from the second iteration discussed in section 7..

Similarly to the first two iterations, these digital prototypes also used the same engines.

Storyboard & dedicated proto elements

The participants go through the experience, designed in a specific order. Figure 79 shows the intended order and dedicated prototyping elements. These elements, both physical and digital, are discussed more extensively after.

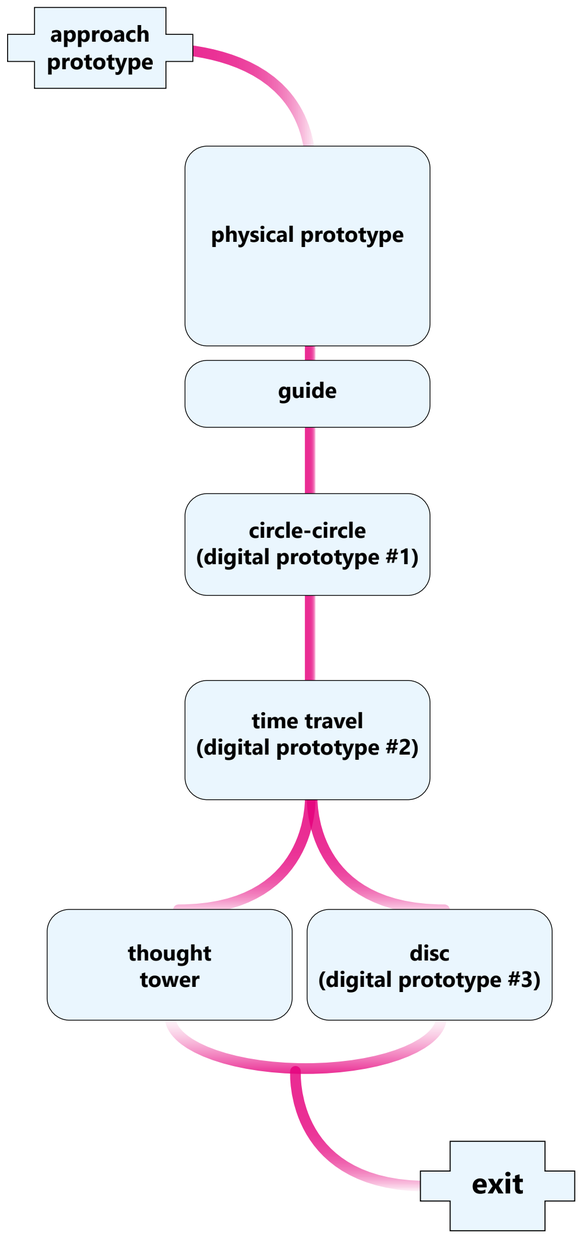


Figure 79: Participants prototype walkthrough

9.2.2 Physical prototype

The main physical prototype is the stand, that essentially is the spine of the physical elements. On top it, elevated the artefact, with other elements added onto it. Below a more detailed description of each element, top to bottom, see Figure 80 on the next page.

The stand is made from a aluminium bottom plate and three aluminum beams. The top surface is a spray-painted wooden MDF surface that was cut and sanded into a circle.

circle-circle markers: these markers are intented to communicate the augmented elements, and on which side they are (in front, on the left and right of the Gameboy). Also a small icon with circling arrows should nudge push the user to walk around the object.

guide: This guide is intended to be the first touch-point to guide the user through experience. It denotes the steps, with an explanatory visual and a dedicated QR-code to load the effects. Furthermore the steps are given a specific number and colour. These colors, green for part one, purple for part two and yellow for three, are repeated in the different elements on the stand. It also is intented to be the anchor, users being able to refer to it, after a part is completed.

Time travel poster: On the front of the stand the time travel poster is attached. This poster contains images regarding the backstory of the artefact, which the audio guides the participants through. The poster is attached to one of the aluminium tubes, angled for comfortable viewing and phone pointing for the AR elements.

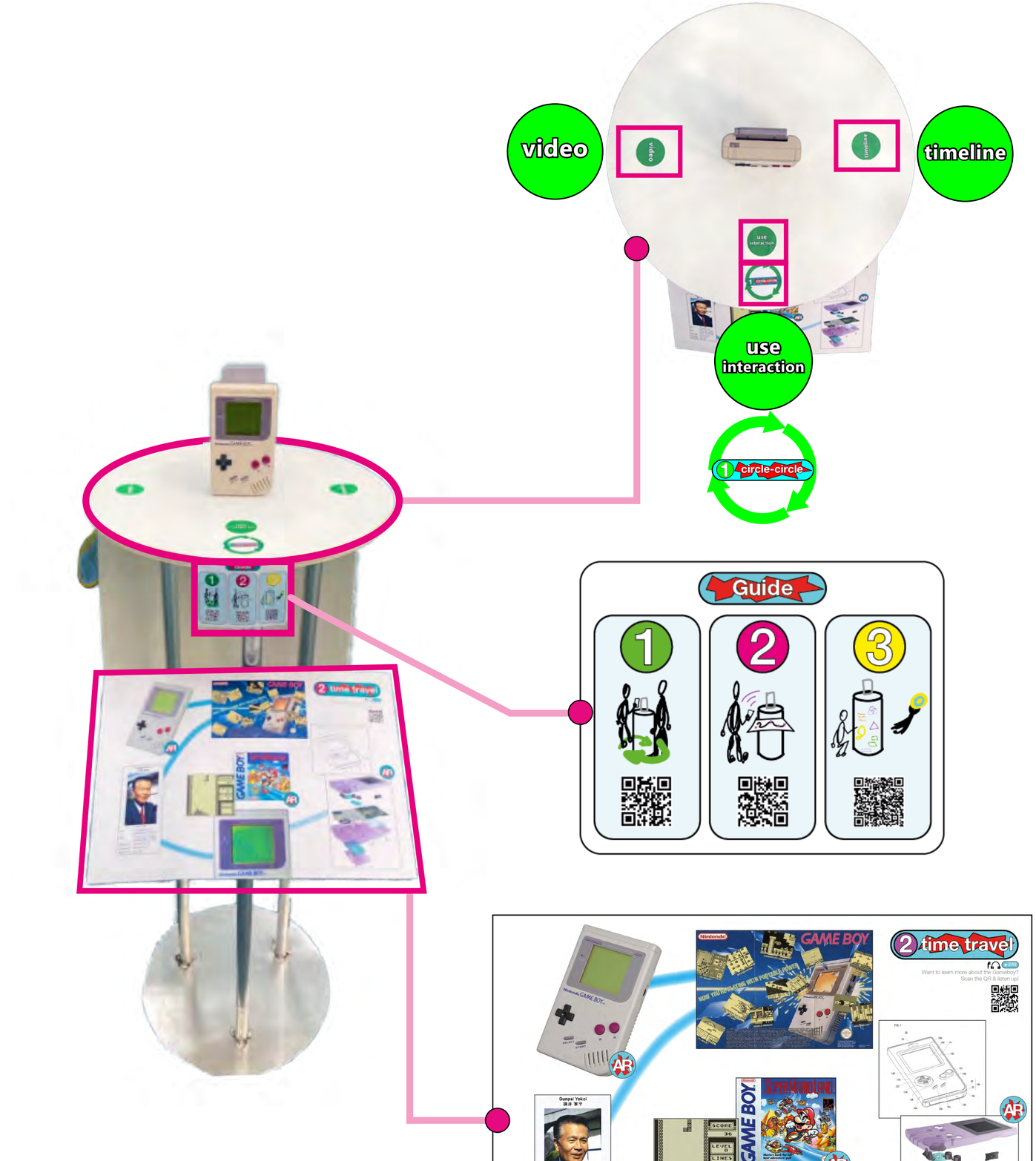


Figure 80: Annotated Physical protc (front)

Thought tower: This element is on the backside of the stand. it has a big number '3' in the yellow colour and title. Below thas is a short description of the element's intent and the posed question: for the participants to think reflect and create regarding the posed question.
The thought tower in the prototype is made out of a bent sheet of A1 paper, attached to the wooden surface on top via double-sided tape. On the top-left there are markers clipped to the paper sheet.

Disc: On the top-right, the disc souvenir is attached, via double-sided tape. The disc itself is printed and glued together to have the printed front and backside. The backside shows the information and QR code to load the effect, the front functions as the image target.
Next to the disc there also is written 'grab me' and 'souvenir' to hinge grabbing the disc.

9.2.3 Digital Prototypes

In the upcoming pages each digital prototype is described, followed by a making of process.

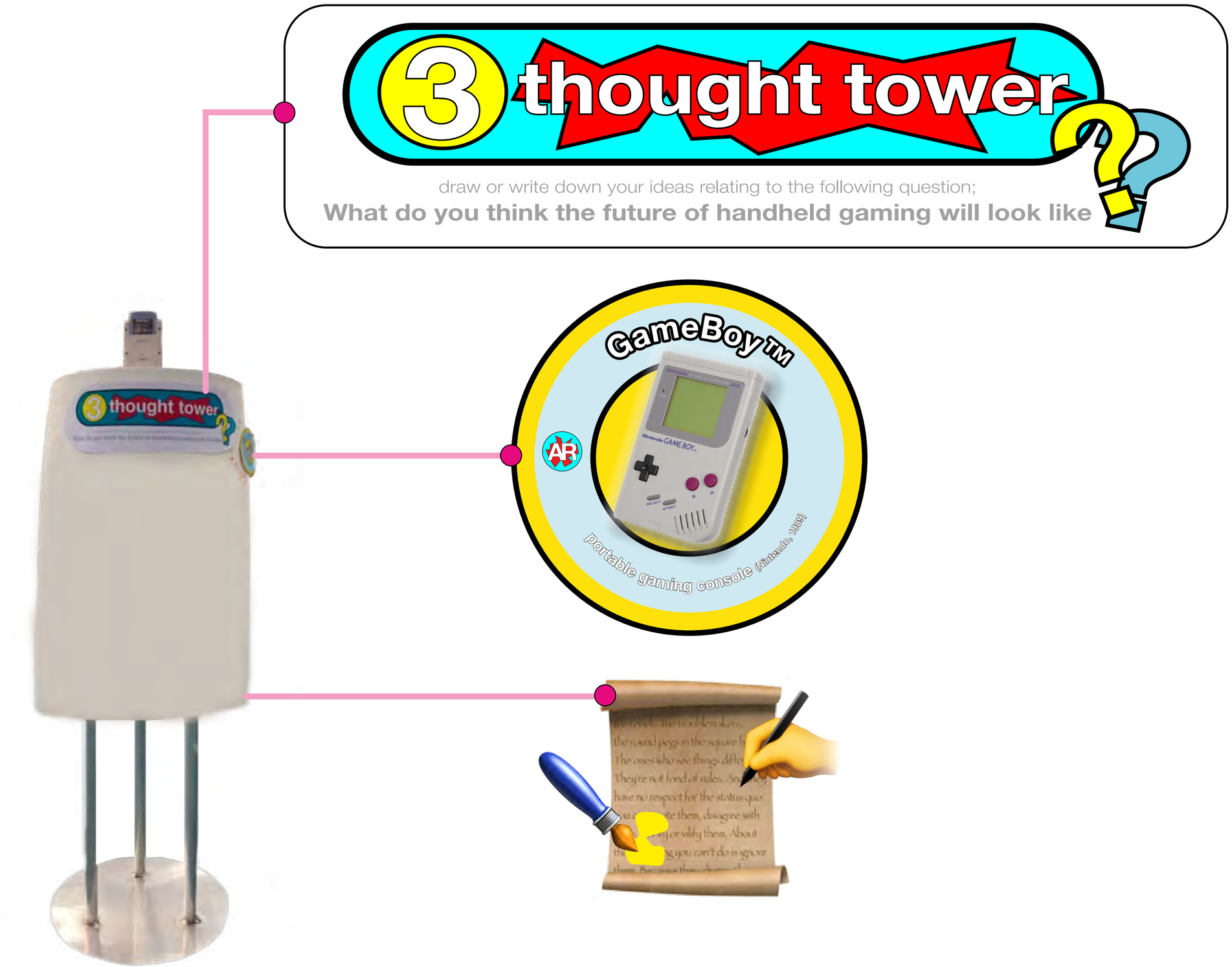
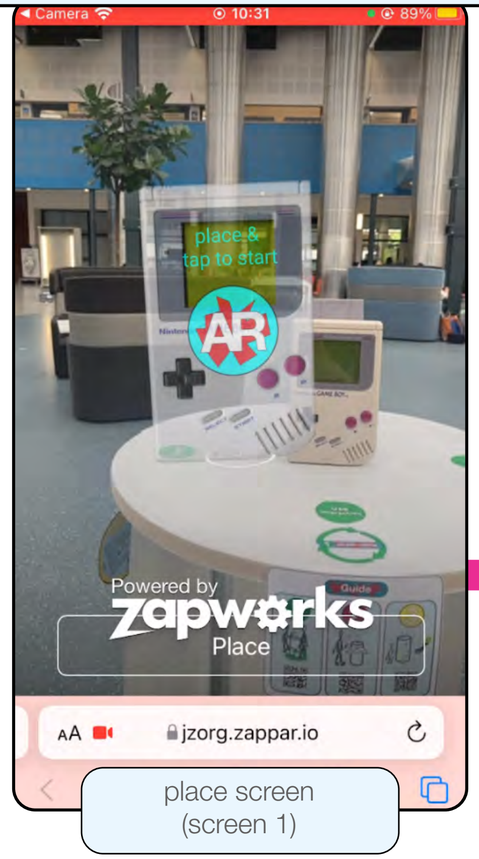


Figure 81: Annotated Physical protc (back)

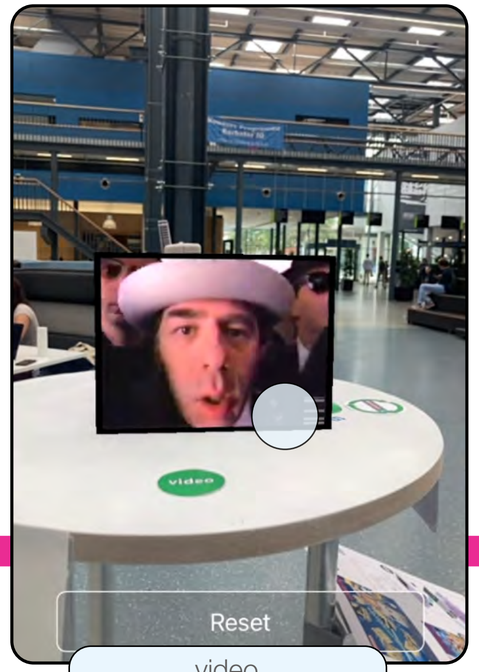
circle-circle prototype



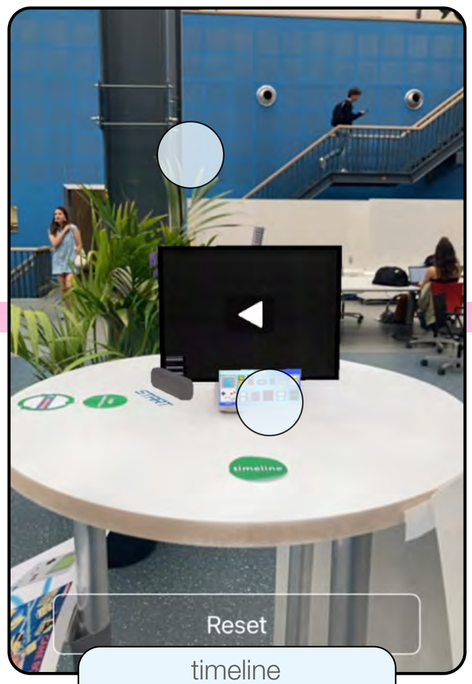
place screen
(screen 1)

effect loaded
(screen 2)

use-interaction
(screen 3)

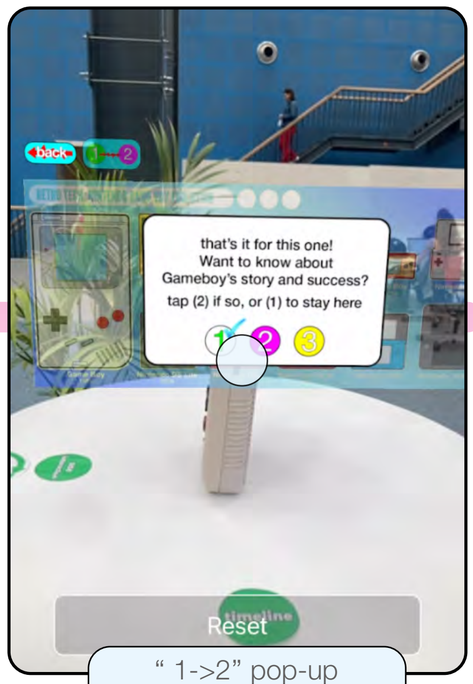


video
(screen 4)



timeline
(screen 5)

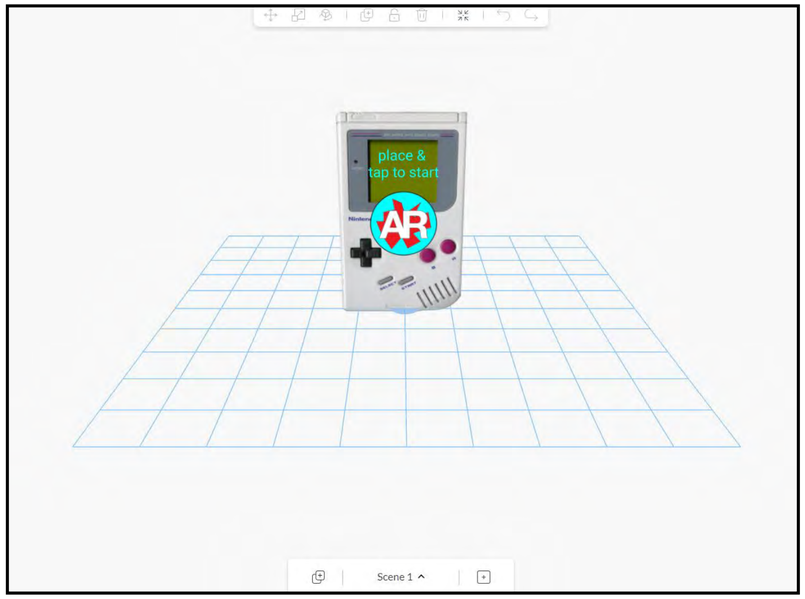
timeline post-tap
(screen 6)

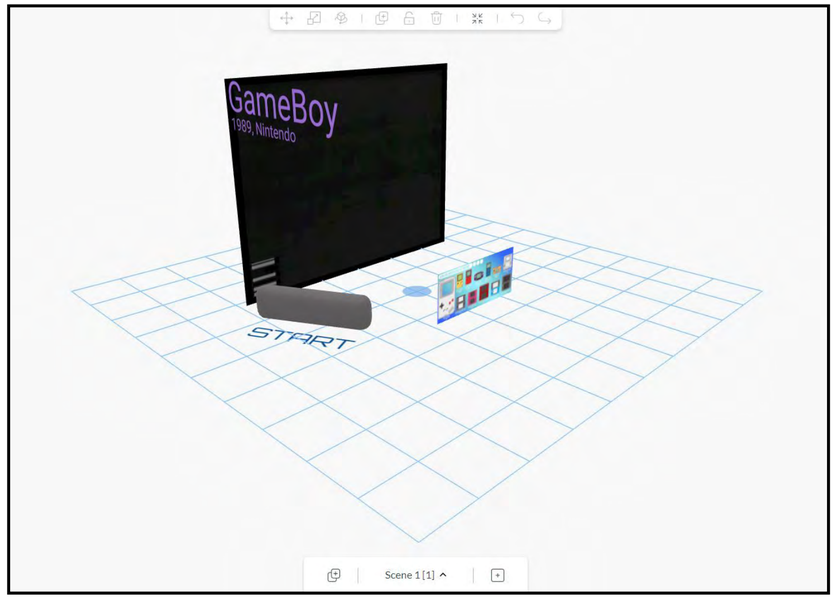


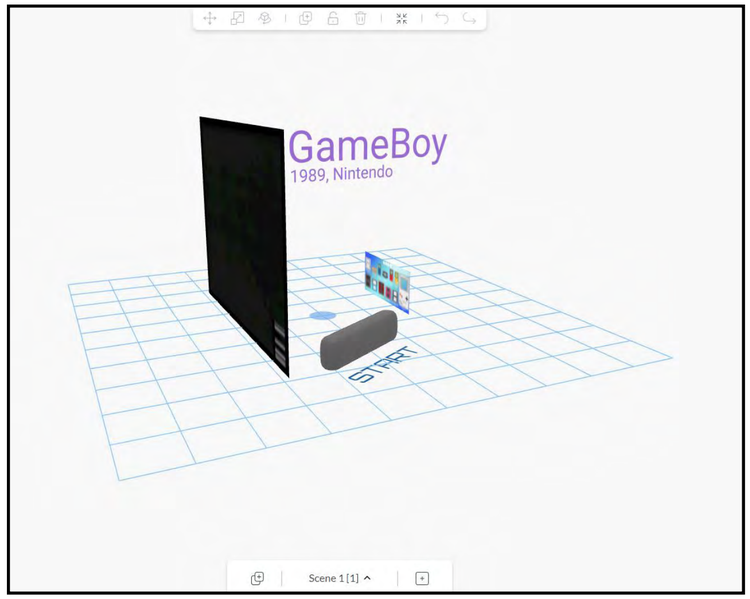
“ 1->2” pop-up
(screen 7)

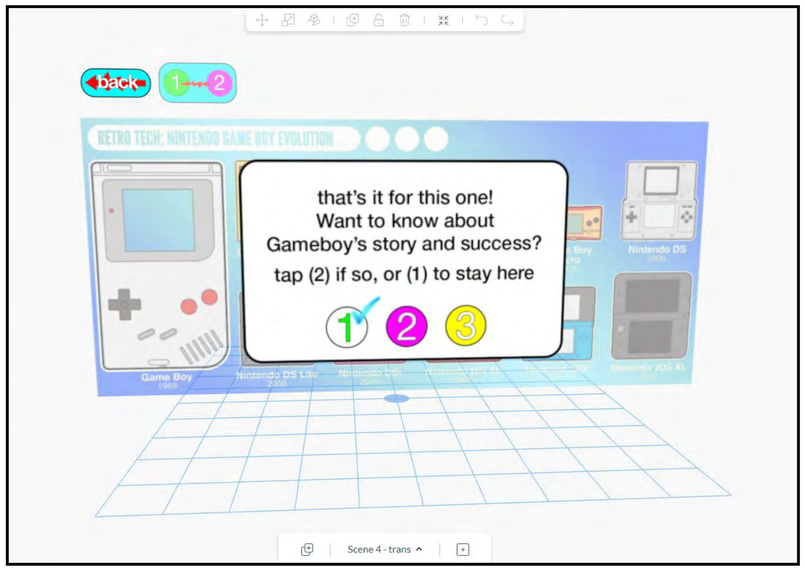
circle-circle
For part 1 of the AR experience, the same platform as before was used: ZapWorks.
Like the previous prototype versions, the same concept stands:
The augmentation of interactive elements over the object, which is done as a world object using plane tracking. The three main assets seen are the following:

1. **Use-interaction**: When pressing the start button, a Pokémon game starts to load like it would be in real life.
2. **Video**: On the left side from the object's front a video can be seen. An original commercial from the Gameboy's international release in 1989.
3. **Timeline**: On the right side, a timeline can be viewed. This shows the family of handheld consoles the Gameboy is the predecessor to and it sprung about.





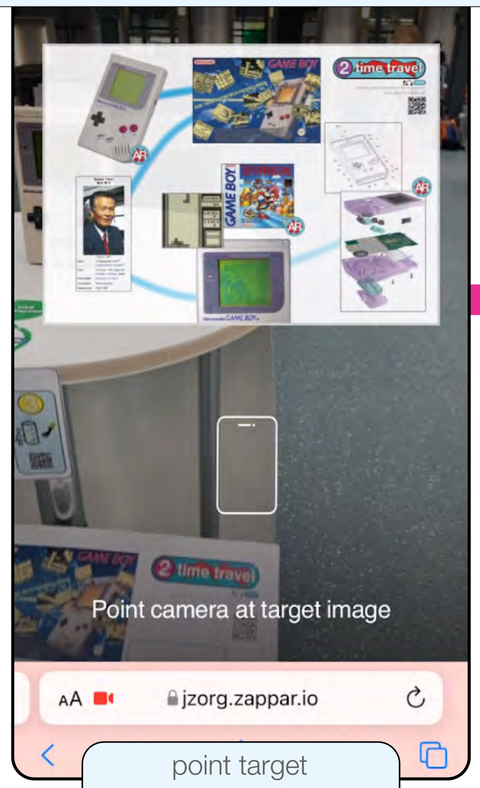




Prototyping in ZapWorks

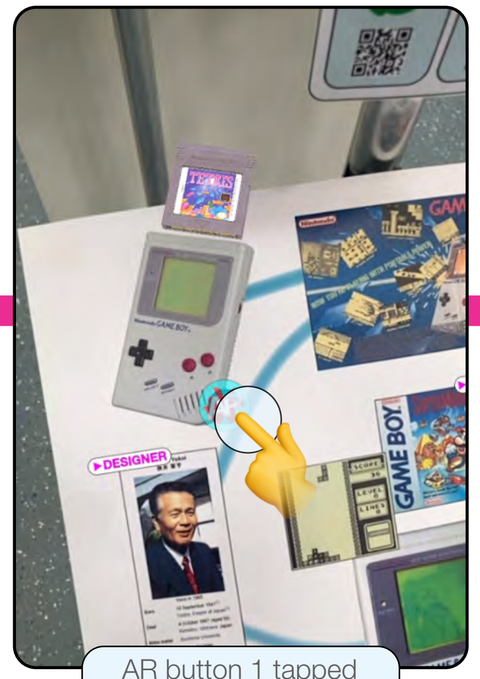
Timeline element used in AR, showing the
GameBoy & the (Nintentdo)products it influenced

time travel prototype



point target
(screen 1)

effect loaded
(screen 2)



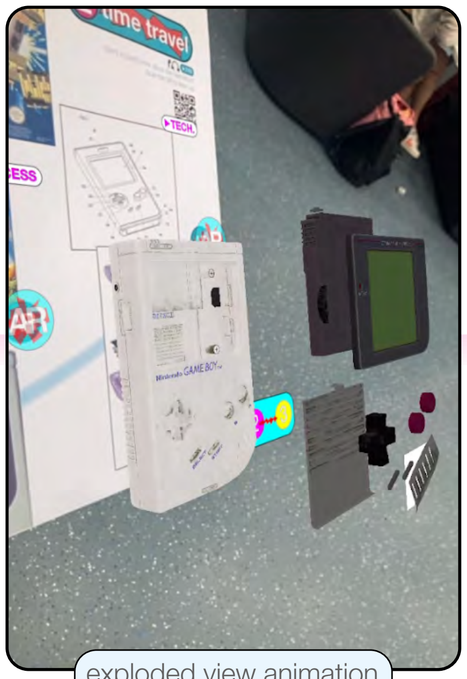
AR button 1 tapped
(screen 3)

AR button 2 tapped
(screen 4)

AR button 3 tapped
(screen 5)

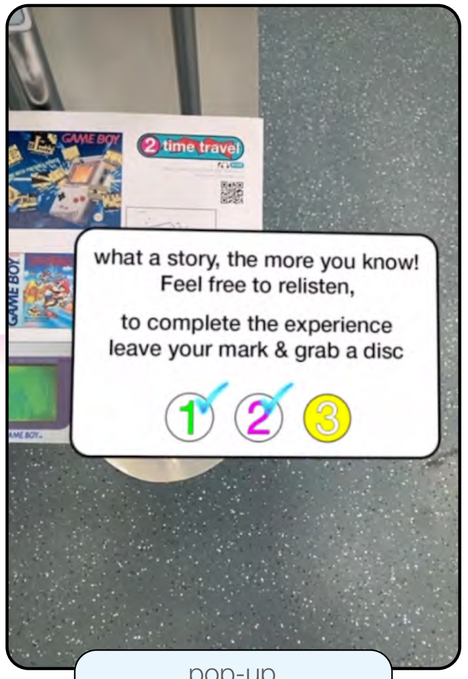
time travel
The time travel prototype similarly also is a third iteration, based on the two previous user tests. Again for the final prototype image recognition is used, to identify the physical poster and augment AR elements. This page shows the process in the ZapWorks designer tool. The second prototype can be loaded in two ways:
Scanning the QR on the guide or poster itself.
Directly after finishing part 1, by tapping the dedicated button.

This prototype's chronological sequence is the following;
1. **Start**: after the poster is recognized, the audio starts to play. Also the AR buttons are augmented and sections of the story(screen 1 &2)
2. **In story**: the audio first gives a brief explanation of the experience. Afterwards, the Gameboy's story is explained per category: introduction, designer, success and technology. These specific categories are selected based on the insights from the research phase.
3. **Augmentation**: During the audio explanation, users can press the digital AR button, which loads an AR effect. To guide when to press what, a specific sound is used to indicate when to press the button. This explanation is given in the beginning of the audio tour.
This time similar AR elements are viewable, see screens 3 through 6. A Tetris cartridge spawning and Mario gameplay on screen. Newly added, is an exploded view animation of the Gameboy during the technology explanation.

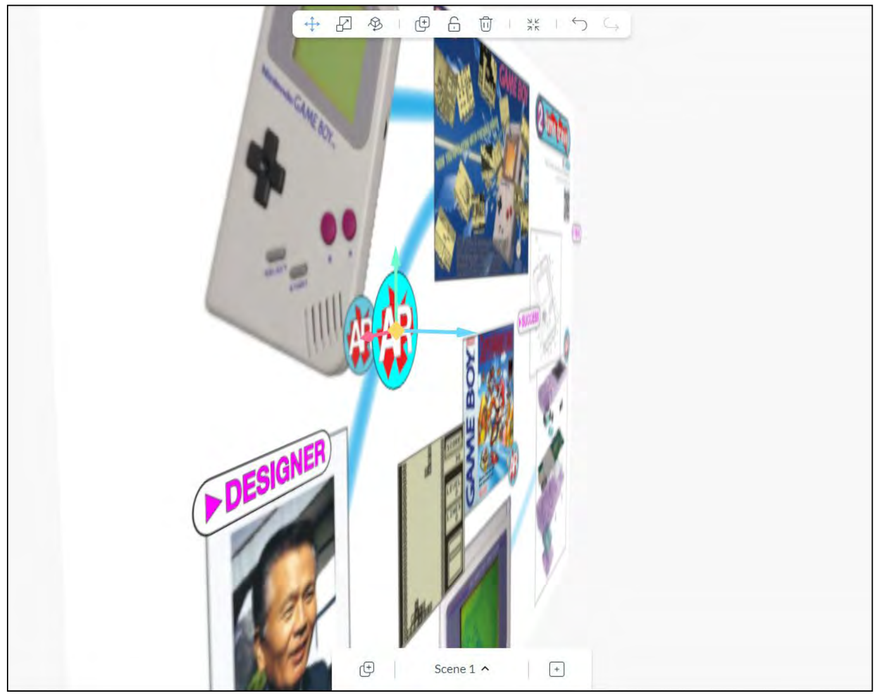


exploded view animation
(screen 6)

"2->3" button
(screen 7)

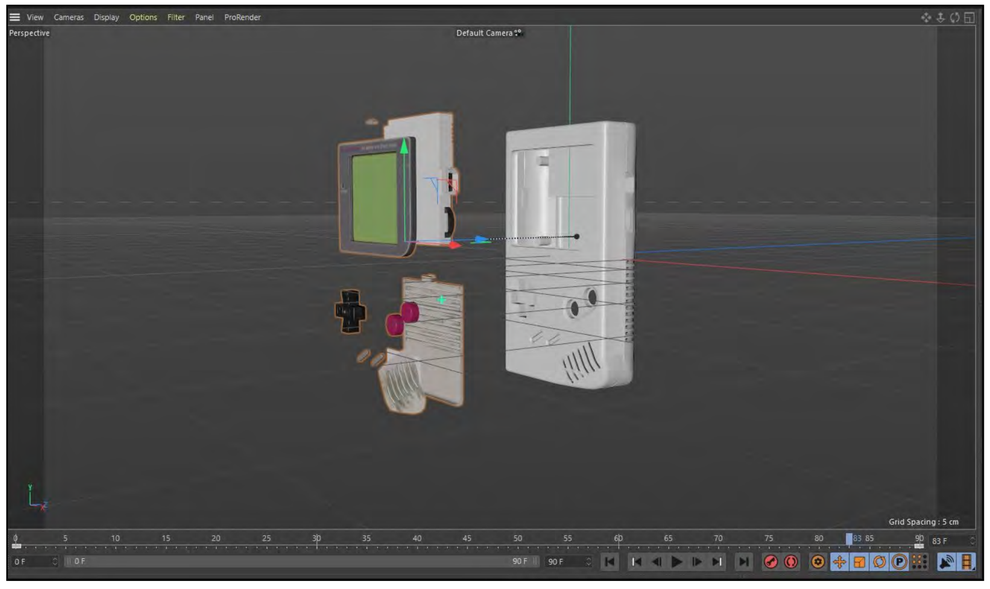


pop-up
(screen 8)



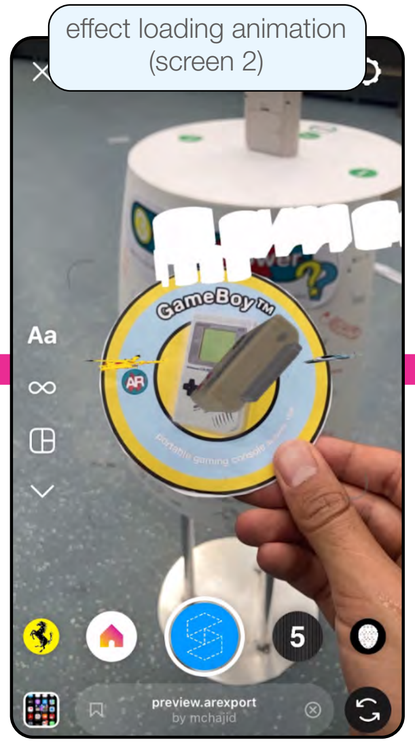
Prototyping in ZapWorks
Presseable AR button

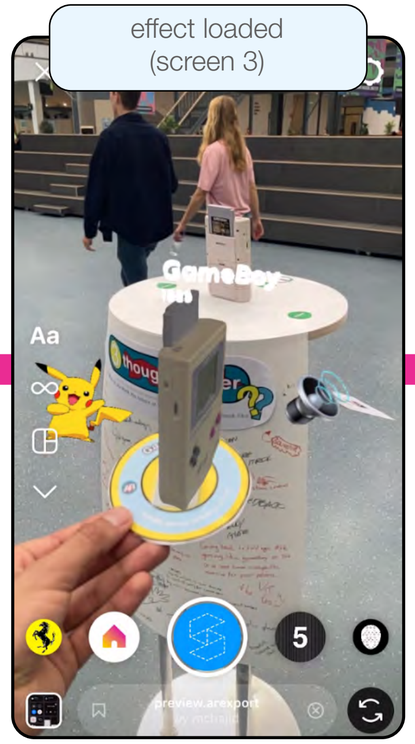
Prototyping in ZapWorks
Pop-up at the end of time travel



Exploded view animation made in Cinema4D,
used in time travel prototype

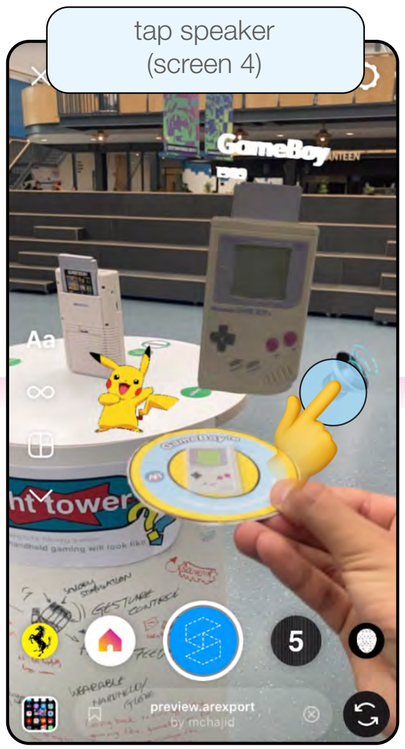
disc prototype

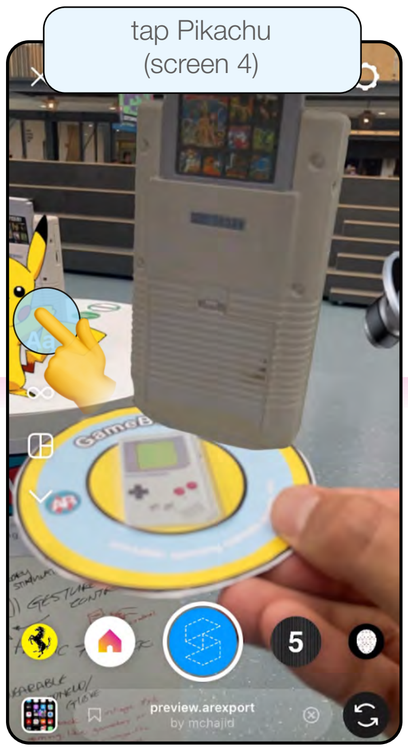


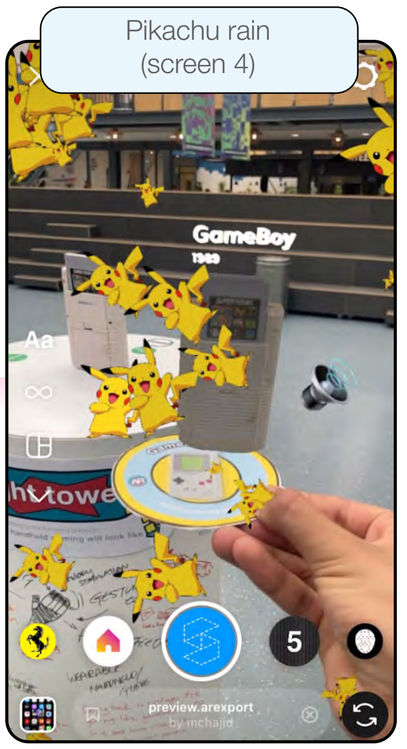


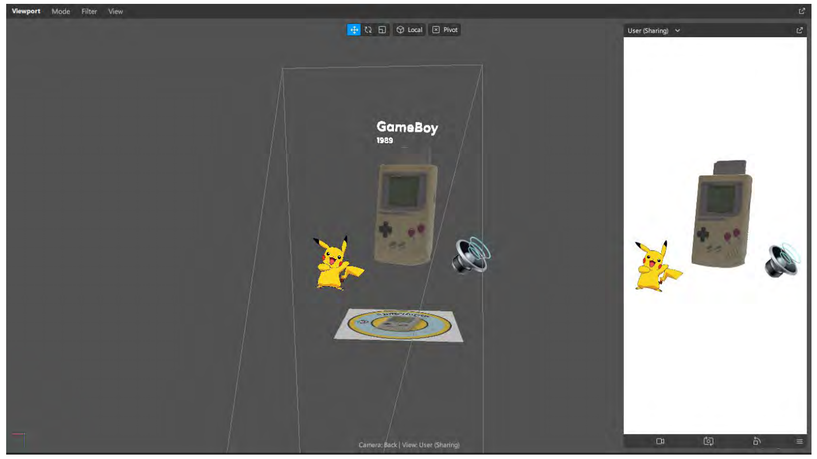
Disc
The third and final AR experience is with the Disc concept. This prototype is made up of the following chronological parts:

1. **Physical disc**: The physical disc has the photo of the object on the front, and a brief description on the back. On the back, the AR effect can be loaded also.
2. **Effect loading**: When the QR code is scanned, the AR effect is loaded inside the Instagram app. The first thing that loads is the image target and a phone animation, hinting the user to scan the target.
3. **In-effect**: After flipping the disc the image is recognized and the AR effect loads. A digital Gameboy spawns from the disc from small to big and is spinning and floating mid-air. Also with two buttons on either side.
(rescanning): If needed, say when the image target is not recognized anymore, the image target can be rescanned, pointing the phone at the disc again, and repeating steps 2 and 3.

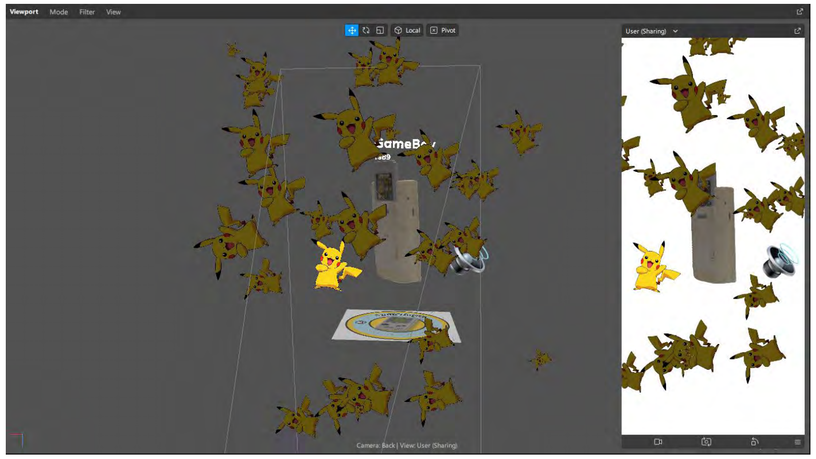




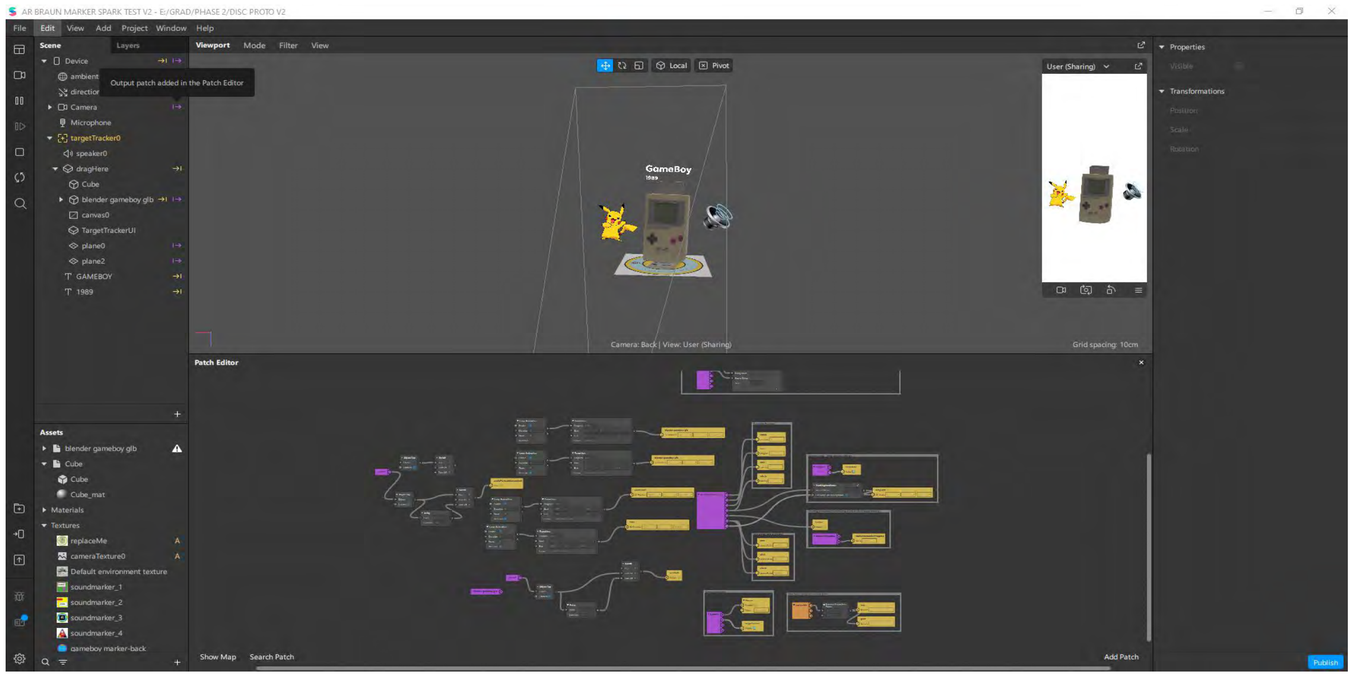




Prototyping in Spark AR
3D scanned Gameboy is in a loop animation,
with 2 interactive buttons on each side



Prototyping in Spark AR
Pikachu rain when the dedicated button is tapped



Prototyping in SparkAR:
The visual coding script that runs the effect
New script parts were added on a standard image tracking template,
for the looping Gameboy animation, and two buttons;
Pikachu rain (emitter effect)
sound tap (sound effect)

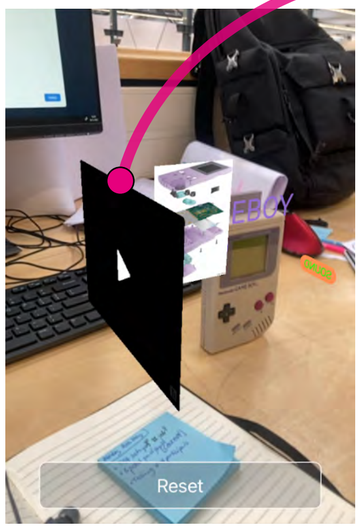
Disc fitting a pocket (excerpt from showcase video)

9.2.4 Design vs. Proto

There are some noteworthy limitations, and gaps between the proposed final concept(section 9.1) and the final prototype. On this page is an overview per prototype and the possible effect on the evaluation:

Physical prototype
Appearance: The appearance of the stand and paper prototypes is not high-quality. This can have a minor effect on the experiences, however very small.

Having explained each prototype's sequence, goals and intended use, the overarching goal is to evaluate the concept. The upcoming section dives into the performed evaluation results and insights.



Circle-circle

1. **Non-object recognition**: Due to the fact that object recognition is not possible yet through WebAR, plane tracking and the placement of objects was used. This makes the experience more complicated since the user now has to place the world object when loading. Also, they need to overlay the digital Gameboy image over the physical, for the assets to be in scale, see screen 1 in section 9.2.3. This is not part of the final design, however, needed to simulate the same effect.

2. **Plane tracking shift**: Due to the use of plane tracking, the phone tracks the pedestal's top surface. This surface is relatively small and can relatively easily distort or shift the augmented assets. Also, things like moving your finger in front of the camera often shift and distort the assets. The users however can hit reset and put the assets back in place again.

3. **overlap parts**: As mentioned before the augmented elements are overlayed over the Gameboy. The engine however does to recognize the object or other elements, this can create moments of overlay, see image on the left.

Possible effect on evaluation study

Due to the delicacy of the prototype, the factors above can have a negative influence on the evaluation, especially the extra steps needed to simulate object recognition(1a) and asset shift(1b). Unfortunately, this disregards the intuitiveness of the concept, essentially being point-and-go.
Also, the participants would have to reset the experience, possibly multiple times, which gets them out of their flow.

Time travel

1. **audio in one-take**: The audio segment used plays in full and one go. For the prototype, there is no other way. Different from the intent, where users can choose to listen to the entire mini-tour or specific parts.

2. **AR elements on tap**: AR elements need to be activated on tap, meaning the AR experience depends on whether the participants tap or not. In the design, the AR elements are revealed automatically over time and can be replayed by tapping the digital AR icon.

Possible effect on evaluation study
The effect the above can have on the evaluation is missing parts due to the audio playing in one go, leaving no room for relistening for better understanding.
The image tracking, however, is very close to the real deal and how it would be in the final concept: The engine recognises the poster and augments elements in place.

Disc

1. **instagram-app**: Different from the other prototypes this one was made using SparkAR and is a test-instagram filter. ideally this also would have been in webAR, however my skillset and intent were not able to be realized in AR, however possible using SparkAR experience.

2. **Image recognition**: The Spark AR image recognition works well, however can still be buggy at moments. This can lead to breaking of the AR effect, the participant having to point their phone above the target image closely again.

3. **digital button responsiveness**: The buttons augmented are not as responsive as desirable.

Possible effect on evaluation study
The effect the limitations above can have is breaking the flow, and having to scan the image multiple times for the effect to load. For the prototype this would be in higher frequency than the design, however, I expect no significant impact on evaluation.

9.3 Evaluation results & insights

The upcoming pages present the evaluation results from the user test evaluation held at the faculty.
18 participants experienced the prototype(s), of which 3 duos.

To evaluate the concept certain targets were set to gauge if the elements are good or need improvement and why. These are:

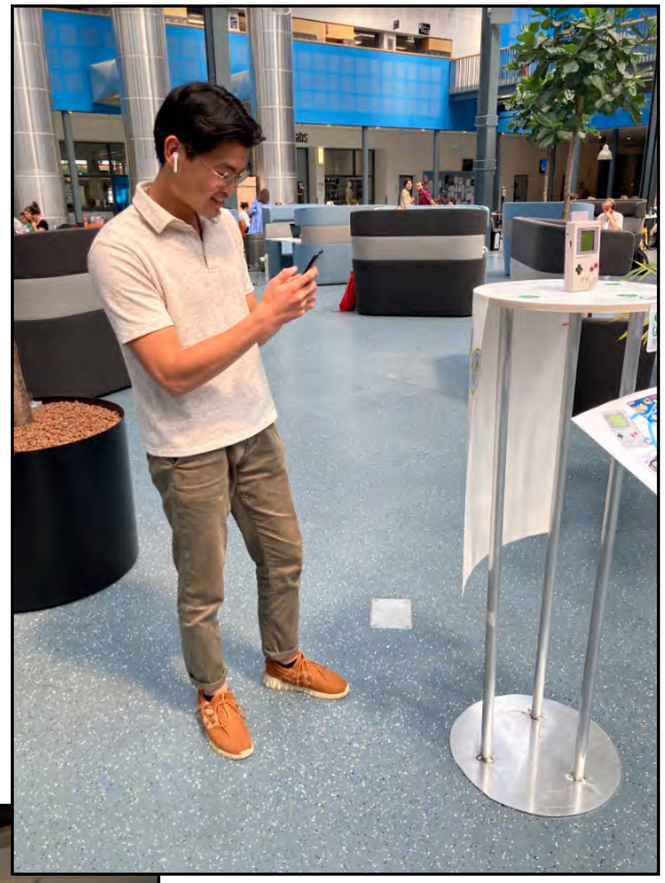
Design Goal
To what extent was the experience found;
•Inspiring
•Educational (Learning)

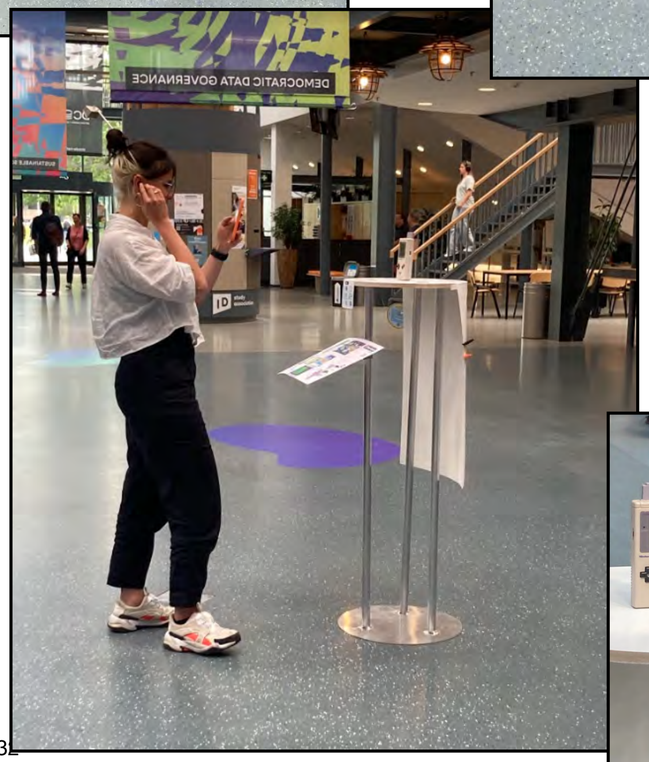
Interaction Vision Qualities
To what extent was the experience found;
•Engaging
•Playful
•Casual

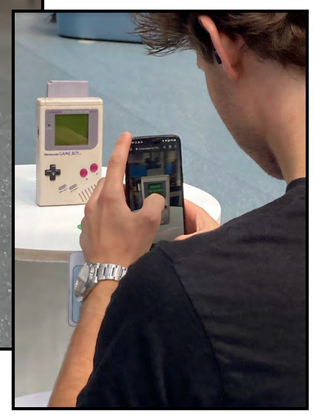
Intuitiveness (per part)
To what extent were the experience parts found;
•Intuitive

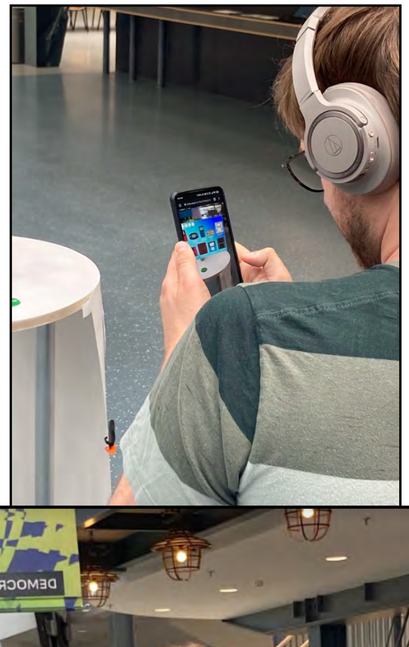
A score of at least 4 out of 5 average rating was set for the target to be achieved.

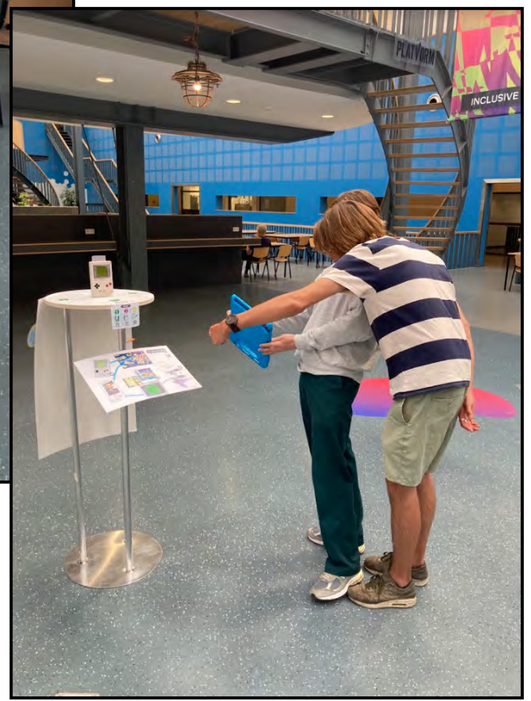
user test photos











9.3.1 overall results

PrEmo

quotes

"Good, feels like going on an adventure."

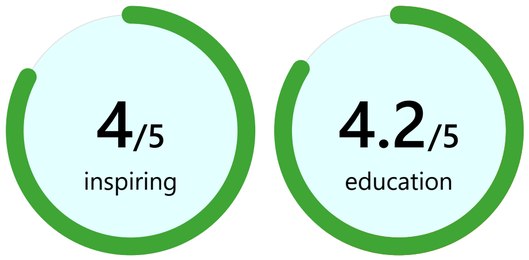
'' Light, fun, informing, nostalgic. It was short but sweet, which I liked. That kept me engaged. The information was presented in a casual way, light and fun. It made me laugh a few times. Nostalgic because it triggered childhood memories/experiences"

''It was more informative than I expected"

'' It was really nice to have something interactive around the Nintendo, otherwise, it is a static presented object, that is less engaging. I would just quickly stop to inspect it and walk further. However, with the AR you really want to explore and learn more about the Nintendo ''

ratings

design goal



interaction qualities

most enjoyed

'' The Gameboy 'unfolded' itself to show me its components in AR. ''

AR effects (13p.)

walking around & explore (2p.)

thought tower (2p.)

'' i read what others thought would be the future of handheld gaming ''

enjoyed least

" In the beginning I did not know what to do or look at"

uncertainty (10p.)

prototypes not working perfectly (3p.)

EXPLANATION

The overall impression of the full experience is found to be positive by participants.
Students found the experience to be: informative, interactive, surprising and engaging.'' On this page quotes from the participants. Two participants explicitly also mentioned partly being confused or not knowing what to do in regards to their overall impression.

Participants mentioned their favourite moments during the experience, the following form a top 3: the AR effects, walking around to explore and writing down and seeing other's ideas(thought tower)
Least liked during the experience was uncertainty at moments, regarding what to do is right or wrong and the digital prototypes not working perfectly.

Pre & post-experience meaning

Before starting the experience half of the participants noted to know basic information about the Gameboy, and a third only recognised the name. Also most participants had some prior AR experiences(Fig. 82)
Post-experience for the majority of participants their view on the Gameboyhas changed, mostly regarding increasing their knowledge on the artefact. Three categories were identified where participants' views fit in:

New/changed meaning: 9 participants found to view the object differently.

'' Yes, in the way that there is much more of a backstory to it than that it is just a product." (p.6)

'' Yes, appreciation. Simple but so strong. In the way it's designed and experienced. '' (p.12)

'' I have better understanding of the technical details due to the exploded view. '' (p.3)

(partly) changed meaning: 5 participants found to have a partly or slight change of meaning. These people mentioned having gained more knowledge about the object:

'' I have better understanding of the technical details due to the exploded view.''

'' Not significantly different, but it made me take a moment to look carefully at the object."

no new meaning: 4 participants found to have no meaning change towards the objects:

'' no because i did not touch it '' (p.11)

To recap on the overall experience, students werepraisingabouttheexperience.Validating all of the Design Goal elements, inspiring and learning and almost all interaction qualities. Every target was achieved, except the 'casual' target, being scored a 3.5 out of 5 instead of 4.
The upcoming pages discuss each experience part separately.

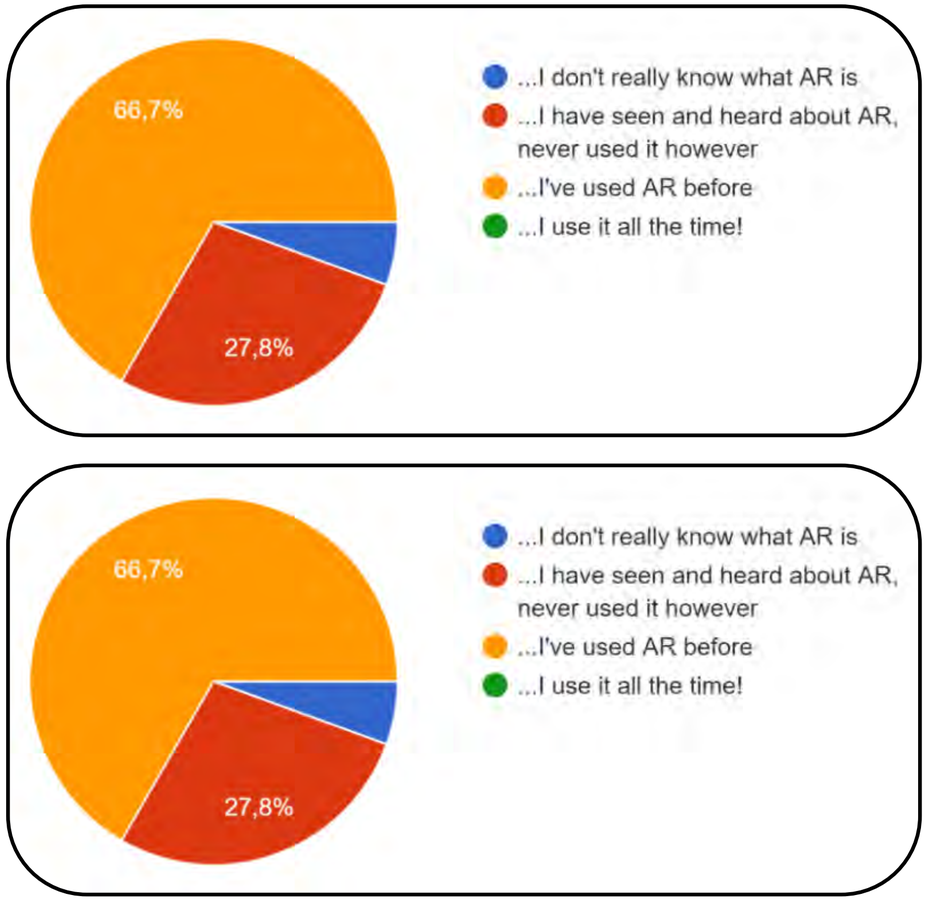


Figure 82: acquintance Gameboy(top)
level of prior AR experience of the participants(bottom)

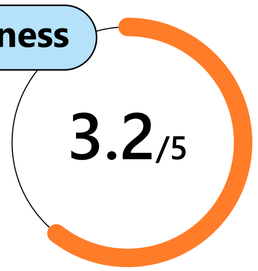
9.3.2 circle-circle results

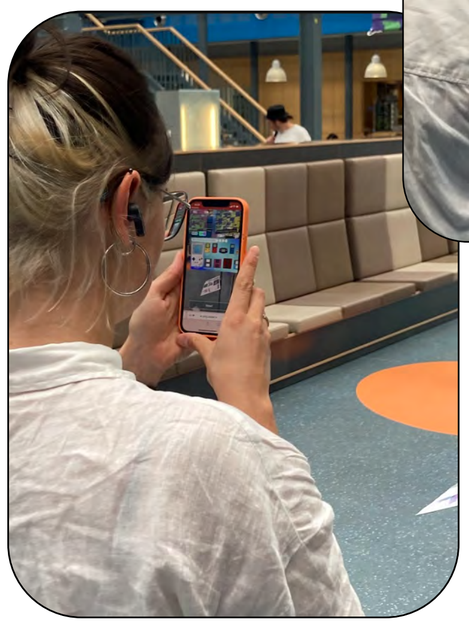
PrEmo

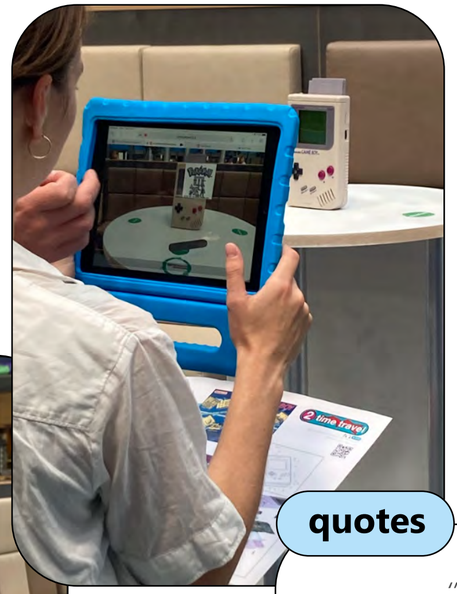
IV qualities

playful, surprising	#1
engaging	#2
educational	#3

intuitiveness







quotes

'' I liked the fact that you start with walking around it so you can really see the object, the things that appear enhance the experience and makes you more curious what is to come. I can imagine the process becomes smoother once the prototype fully works. '' (p.15)

'' Fun to see AR elements unfold when placing the Gameboy in the right spot '' (p.9)

'' Nice to walk around and discover '' (p.11)

'' Having to walk around is more intriguing than just standing in front of it '' (p.8)

most enjoyed

- **AR effects** (5p.)
- **walking around object** (5p.)
- **surprise/ discovery** (3p.)

enjoyed least

- **prototype not working perfectly** (9p.)
- **uncertainty** (7p.)

EXPLANATION

Part 1 of the full experience was circle-circle. Participants enjoyed the interactions in this part and walking around. Participants mentioned not exactly knowing what to do, especially at the start of the loaded AR effect.
Participants mentioned enjoying the most: walking around and the AR effects, on a shared first place. Second for the surprise elements.

Participants mentioned enjoying the least the prototype not working perfectly and not knowing what to do as the second least thing of this part.

Students chose different PrEmos to convey their feeling on the experience. Noteable the hope PrEmo was chosen, which could be the effect from the 'enjoyed least' elements. This part was rated a 3.2 intuitiveness on average

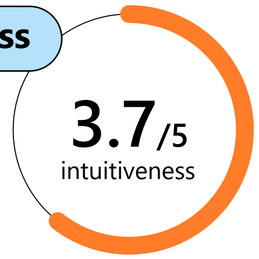
9.3.3 time travel results

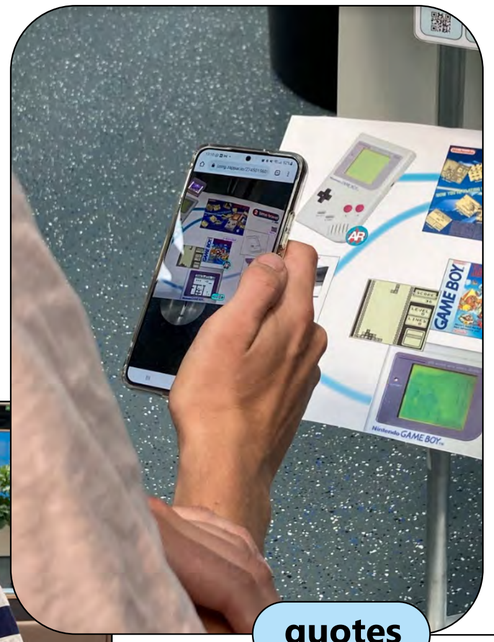
PrEmo

IV qualities

educational	#1
engaging	#2
playful	#3

intuitiveness





quotes

'' I didn't know what to expect, but it was quite funny! i really liked the interaction a lot in combination with the information you get about the gameboy '' (p.6)

'' Very intriguing and surprising. Loved this new way of experiencing a historical artefact. '' (p.10)

'' Really nice interactive by touching the buttons '' (p.16)

'' As I have very little AR experience, a bit confusing in the beginning (I also started with this section) '' (p.1)

most enjoyed

- **new things learnt** (4p.)
- **digital interaction** (4p.)
- **audio** (3p.)

enjoyed least

- **uncertainty** (5p.)
- **time, felt too long** (5p.)

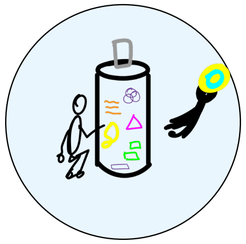
EXPLANATION

Part 2 of the experience was overall to be found educational-first. Participants enjoyed the combination of AR and audio. They also mentioned having enjoying listening to the story. Similar to circle-circle, but less often, a few participants mentioned not knowing what to do at moments, the average intuitiveness is rated a 3.7 out of 5.

Participants enjoyed the new things learnt, digital interactions and audio guide the most.
Least enjoyed were found to be uncertainty, not knowing what to do, and time for the time travel experience.

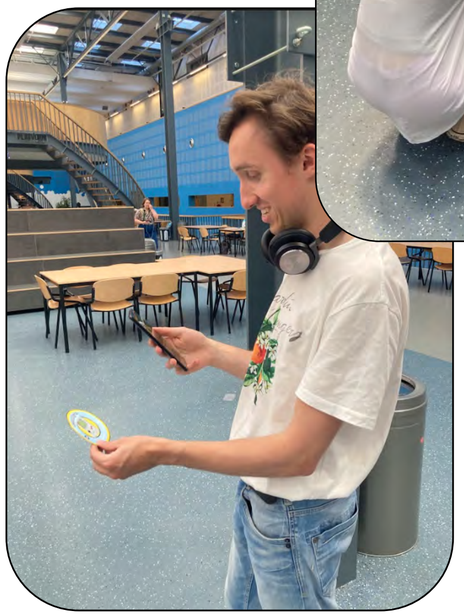
In terms of the Interaction Vision qualities, the students rated this part to be educational-first, secondly they found it engaging and third spot for playfulness.

9.3.4 tower & disc results



PrEmo

fascination | pride | joy



IV qualities

playful	#1
social	#2
casual	#3

intuitiveness

quotes

'' Nice, something analogue! A surprising combination with the super modern tech AR. it also got me thinking creatively. But I firstly always think: ohhh no I have to come up with an idea. I found the writing very intuitive but the disc less '' (p.14)

'' Nice to spark some creativity '' (p.8)

'' Engaging, made me think, sparked thoughts, ideas and creativity '' (p.12)

'' Very cool of way of contributing to the value of a historical artifact. '' (p.10)

'' the 3d model was surprising" (p.7)

most enjoyed

- **disc AR element** (4p.)
- **thought tower** (11p.)

enjoyed least

- **writing comfort** (2p.)
- **uncertainty** (6p.)

EXPLANATION

The final part of the experience was found to be fun and creative by the participants. They communicated to enjoy seeing what others thought of and creating themselves. Also, this is to be a contrast between 'high-tech' and analogue interactions.
Similar to the time travel part, students the fascination, pride and joy PrEmo's were picked most often.

The experience was rated to be playful-first, social and casual. The experience got an intuitiveness rating of 4.2 out of 5.

Students enjoyed the thought element the most, with 11 votes. The AR effect of Disc got the most votes after.
Students rated to enjoy the least 'uncertainty'. Lots of students mentioned 'nothing' , most noteable writing comfort was addressed twice in the Form.

9.3.5 Evaluation Recap

For the evaluation certain targets have been set, most of which were achieved and some are not fully met.

overall
The overall experience has achieved every target, except the rated 'casualness' was lower than the target, rated a 3.5 instead of 4. It is fair to say that the overall experience inspires and lets users gain in knowledge, to an extent of course. Furthermore, it was found to be engaging and playful, reaching those targets.
How to make the experience more casual now?
Part of the reason why the rating did not achieve the desired goal, could be the set pattern that should be followed by the participants.

Part 1 - circle-circle
Participants mentioned this part of the experience to be unique, by combining the physical movement and augmented elements. Most of these statements are regarding walking around the object, to in turn discover more about the artefact in Augmented Reality.
On intuitiveness however the concept was rated mediocre, with an average score of 3.2 out of 5.
The biggest obstacle mentioned by participants were:
the prototype not working perfectly(43% of the votes) and not knowing what to do(39%).
A notable, most disliked, factor was the prototype not working perfectly. As mentioned in section 9.3.4, this was expected to an extent since the prototype is quite delicate.

Participants mentioned the latter also during the semi-structured interview, some stating simply not knowing what was expected of them at the beginning and had to discover by trying. The intuitiveness is below the desired goal and therefore is discussed in the recommendations in section 9.4.

Part 2 - time travel
The time travel concept was found to be the most educational part of the experience. It was also rated the people's first choice in their top 3. Participants mentioned they enjoyed the combination of audio storytelling and AR effects, that can be started on-demand.
The intuitiveness target is not fully met, below the desired goal, being rated a 3.7 out of 5 instead of at least a 4.
Students mentioned being able to press the AR buttons from upcoming parts already as confusing. Also, some participants were unsure what is what is not a pressable button in the prototype.
From an audio standpoint, some users mentioned not picking up the first parts of the audio, or it going too quickly, especially in the explanation phase.
The first issue was a clear prototype limitation, mentioned earlier. As noted before in the final concept, the AR buttons would pop up synchronous to the AR indication sound being played, during the audio story. Due to the prototype limitation, all AR buttons were viewable and interactive from the start. This way people cannot try the AR effects of other parts already, while the audio still needs to catch up.

Not knowing what is and what is not a pressable button was also due to the prototype. The buttons used to refer to the categories, e.g. designer see section 9.2.3. It has a play icon next to it, however, is non-playable in the prototype. In the concept users have the freedom to press what part they like, that part playing, or listening to the full story.
Still, however, the desired rating was not fully met, and new interventions were imagined to further boost the intuitiveness of this experience part, discussed in the upcoming recommendation section.

part 3 - thought tower & disc
The experience ended with the thought tower and disc. Students found this part to be fun and creative, triggering them to go from consumption to creation for the thought tower element. Students also mentioned they enjoyed the AR disc element, through its animation and interactive button.
The desired intuitive rating of 4 out of 5 was achieved. However, a few students did not know whether the disc could be grabbed and brought along.

In this section, the overall experience, and per part, were evaluated based on the results. Qualitative input was used to understand what and why the participants enjoyed or disliked things. Their ratings on the design goal, interaction vision qualities and intuitiveness were used to see whether the experience as is, was satisfactory.
Certain elements still need improvement, especially regarding intuitiveness for the circle-circle and time travel parts. These improvements are discussed in the form of recommendations in the upcoming section.

9.4 Final Recommendations

In this section, recommendations are made based on the evaluation results and insights. First regarding the overall experience, increasing guidance to reduce feelings of uncertainty.
After recommendations were made to increase the intuitiveness of the circle-circle and time travel part. Also, a minor suggestion was given regarding the disc.
Lastly, a recommendation were given on the casual/freedom felt rating.

Overall - feeling unsure / uncertainty

Multiple participants felt like they needed reassurance on what to do. Most participants started at the guide, which is meant to direct the users throughout the full experience, which it did for most. However there were multiple participants who still did not feel sure about what to do at moments during the process.
Before diving into the moments, from a meta-level, a way to show the use stages and AR steps use would help.

A short video going through each step, seeing a user going through the experience, could help, especially since it shows the steps over time. Now the guide shows a static image per part of the intended use. Figure 83 on the next page shows a mockup of a few of that video's frames. This video would be played in a loop, with a progress bar and stage number visible. This way the user knows which step is being explained and where the video is in the process.

Watching it once should give enough guidance on what to do per step and what is expected, essentially it is a short tutorial seeing how it's done, to be repeated by the user. Monkey see monkey do ;)
Research has shown a video tutorial can increase self-efficacy, here in a task to be performed by students (University of Twente & Teng, 2015). Also, a few guidelines were given: to keep the video short and maintain a good pace (video speed).

As a side note, this part can fit well with step two of the initial concept storyboard (grabbing attention phase). This step was intended to give a glimpse of what is expected before fully going in the exhibition space.

Circle-circle part - intuitiveness

For the circle-circle concept, the main issue for the students who struggled in the beginning post-scanning was not knowing what to do. Eventually, they found out, however for some, it might have felt too scary.
The previously mentioned video, showing a person scanning from the guide, the effect of loading and walking around the object would obviate this issue.

As an extra use-cue on the top panel point were added, to indicate which asset was where and trigger walking around. Not everyone picked this up as quickly, however. A recommendation is to add these markers on the ground, with arrows in between, instead of on the top plate. This to have the intended effect, since it is enlarged and again to trigger walking around the object with which element(e.g. video, use-interaction, timeline) is where. This also keeps the top plate more simple and clean, leaving full space to the object, instead of marker stickers.

A final and recommended extra measure is to add a gif tutorial when the AR link is loaded.
This gif shows a preview of what is to come and most importantly: exploring the effect by circling around the object, see on the right for an initial visualization of the circling steps.
This also helps people who have not watched the video entirely beforehand.

Thinking this through: it would be annoying to have this tutorial spawn at every stand, so there needs to be a way that the website can distinguish first-time and repeat users. Instead of having to create an account, or selecting which user you are at each circle-circle experience, using cookies would be a simple solution(Hotjar, 2022)

This way the site can differentiate who visited the website before and who is a first-time user.
First-time users get shown the GIF tutorial and repeat users do not, since they now have ‘a history’ on the website. That history is the cookie they have, which the website detects.

Figure 83: excerpt of video frames of tutorial video & circle-circle GIF.

Final Recommendations

Time travel - intuitiveness

Certain issues were addressed from the time travel part evaluation, two of which were clear prototype limitations.
Some users, however, did not fully understand the explanation, post-explanation the audio quickly dives into the story. To improve that, a question can be posed to the user, acting as a brief pit stop between starting the story or replaying the explanation. A pop-up indicates the explanation is finished and whether the user wants to relisten or dive into the story. For the latter, they can choose to listen to the full story or specific categories. Also, note each has a time indication.

Disc - grabbing

Some participants initially did not think they could grab the disc and take it with them. This could be due to the fact only one disc was stuck to the stand, and it seemed semi-permanently stuck.
Something like a small basket with multiple discs on the side of the stand should trigger and allow grabbing if the visitors want to of course.
A foldable bag, that if cut and folded properly acts as a basket for the disks. Intentionally this recommendation does not contain any precious materials and DIY elements, to minimize the ecological footprint.

Overall - casual/freedom

The interaction quality ‘casual’ did not match the intended target of 4 out of 5, having been rated a 3.5.
To briefly reiterate, this quality was to direct the concept into a direction, that the user feels autonomous and free when interacting with the design. The opposite being having to follow specific steps.
The latter of course was more the case during the prototype testing. As mentioned earlier, the concept is not intended for users to repeat each step at each artefact. Visitors can choose how far they want to go, based on their interest level. This was not entirely the case for the prototype evaluation, even though a few participants, started at step two or three, instead of one.
A good way to re-iterate this, however, is to explicitly mention this in the video shown when just entering the exhibition space.

In this section, recommendations were given based on the insights from the final prototype evaluation. First, a recommendation was discussed to increase the overall guidance of the experience. The imagined intervention is a short tutorial video played, showing the intented steps, physical and digital interactions, of each part of the experience. This tutorial would be played on a screen in a loop, playing on a screen when entering the exhibition space.

Secondly, recommendations were given to increase the intuitiveness of the circle-circle part, since some participants felt unsure at the start, regarding what is right to do. The markers on the top plate, indicating where each element is in AR, now are moved and enlarged to the ground. Between markers, they have arrows to indicate how to walk.
A digital intervention is to add a GIF of the intended use, especially pointing the phone towards the object and moving around it. This is especially intended for first-time users.

Thirdly to boost intuitiveness for the time-travel experience the audio explanation now functions as a pit-stop. Instead of directly playing the story afterwards, an extra option is given to replay the explanation and from there choose which section they would like to go through.

Finally, to increase the level of freedom felt, how casual the experience is, the following recommendation was given:
Explicitly mentioning this at the end of the video which visitors view when arriving in the exhibition space. When the full sequence was shown, multiple use cases are shown, where users experience just one, two or the full parts and afterwards go to the next.

Personal Reflection

Wow, that's it already!
This graduation project was a roller coaster ride. I started the project very enthusiastic since it is a blend of two big interests of mine; museums and new digital technologies, especially AR.
Writing this reflection now at the end of the project I can say I am very much satisfied, also of the end result, but mainly with the things, I learned over the past months.

I set out on the project wanting to learn more about AR technology and did. I got more knowledge of Augmented Reality on a theoretical level. What I am most proud of is this learning done by doing. During the project I got the opportunity to do lots of prototyping, to further develop the ideas, but also to explore and see where the boundaries of (web)AR technology practically lie.

Another learning goal was learning more about design on an interaction design level. How could we create a series of interactions that feels natural and intuitive? Through iterations the concept and prototypes got more and more intuitive, however, I still am not satisfied with the result on that spectrum from the evaluation.
An important thing I will take away for my future design endeavors, is to always explain things multiple times and in different ways. This way there is little room for the users feeling uncertain.
Also, uncertainty in an (another) experience is not always bad, the user just has to know it is intended that way, for discovery for example, so they do not feel stupid or any other kind of way. Then again the point of having a transparent design.

Aside from learning goals I set beforehand, there are a few things I learned about myself, having the reins in such a big project.
Since primary school teachers would describe me as eager, 'ijverig' in dutch. Somehow I have this drive for doing things right and an obsession for details. This might sound great, however, it is a double-edged sword.
Wanting to do lots of things can take a toll on you mentally and even physically. Luckily I have been getting better in controlling this fire, yet it is too difficult.
What I noticed in this project is when you want to take on the world and do lots of stuff, it gets very tight in terms of deadlines and deliverables, 'even' if you work even harder. Fire is great, it can keep you and others warm, if not careful however you migh tburn yourself.

It sometimes feels like a high-risk high-reward situation, by going for that extra iterative testing round or user study. But needing to catch up with reporting for example.
During this project, I need to check myself to take it slower. Rome wasn't built in a day.

In terms of the project process, I thoroughly enjoyed the ideation and conceptualisation stage, like I expected. This is a school project where you finally get lots of freedom and responsibility to do it your way, especially now getting a better sense how you design in the last 5 years.
Another aspect I enjoyed was the User studies, in the beginning, and when evaluating. it is great to see people using your prototype and observing how they behave, regardless of the feedback. These social moments were very inspiring, and quite meta since that was one of the insights from the user study too.

What now?
What do you think the future of AR will be?
Does this project end here?
I like asking questions, I think they are a great source for reflection.
Do I have all the answers? Nope.
Either way, I am planning to further develop the project outcome, to see how it could be applied in a fitting setting, maybe even at IDE!
There are a few ideas I could not explore during this project, that I want to regarding the concept, for example to have more engaging and interactive stand, that draws users.

For now I feel very fortunate to have gotten these rich experiences. Before continuing the possible further development of the concept, and starting my 'design career' it is time to take a step away from the project and take in the 6 month rollercoaster ride.

References

8th Wall. (2021, December 13). Introducing the New 8th Wall Project Library Featuring Over 30+ Projects. Medium. Retrieved 15 June 2022, from https://medium.com/8th-wall/introducing-the-new-8th-wall-project-library-featuring-30-projects-2b29dcbbb1e5

Abitare. (2020). Katharina Grosse, a vortex of colours [Image]. https://www.abitare.it/en/events/2020/09/30/katharina-grosse-on-display-in-berlin/

Adobe, Smithsonian, & The Hydrous. (2021). Explore Coral Reefs in AR with the Smithsonian, The Hydrous, & Adobe Aero | Adobe Creative Cloud [Video]. https://www.youtube.com/watch?v=RDSSOW_uX1Y

ARLoopa. (2016). Augmented Reality Physics Book by ARLOOPA [Video]. https://www.youtube.com/watch?v=Qw7HJPol8ZQ

Bilbow, S., Kiefer, C., & Chevalier, C. (2021, March). The Value of Sound within a Multisensory Approach to AR in the Arts. University of Sussex. https://drive.google.com/file/d/1OJBSo5_vJoHoFYHSr1cgDaEsm7iGW3y2/view

BRDG Studios. (2022). Nike Play New [Image]. https://www.8thwall.com/playnewkids/playnew

Bulsyte, B. (2017). Story Structure [Image]. https://medium.muz.li/storytelling-in-design-6ca275068f32

C., R. (2021). Smartphone Gestures [Image]. https://mraberthon.com/smartphone-gestures/

Chen, W., Shan, Y., Wu, Y., Yan, Z., & Li, X. (2021). Design and Evaluation of a Distance-Driven User Interface for Asynchronous Collaborative Exhibit Browsing in an Augmented Reality Museum. IEEE Access, 9, 73948–73962. https://doi.org/10.1109/access.2021.3080286

Cianciarulo, D. (2015). From Local Traditions to "Augmented Reality". The MUVIG Museum of Viggiano (Italy). Procedia - Social and Behavioral Sciences, 188, 138–143. https://doi.org/10.1016/j.sbspro.2015.03.349

Cisco. (2016). Pokémon Go [Image]. https://blogs.cisco.com/innovation/pokemon-go-5-innovation-lessons-from-this-augmented-reality-check

CleverBooks. (2021). Augmented Classroom for STEM Education -CleverBooks Presentation [Video]. https://www.youtube.com/watch?v=oFPxyO3EQWk

CubicBrain. (2017). How to create Virtual buttons with Vuforia AR & Unity3D [Image]. https://www.youtube.com/watch?v=ElmzIq6stNI

de Graaf, E. (2022). Traditionele Jurken [Image]. https://nl.pinterest.com/pin/308918855667605960/

Design Council. (2019, May 17). Framework for Innovation: Design Council's evolved Double Diamond. Retrieved 4 July 2022, from https://www.designcouncil.org.uk/our-work/skills-learning/tools-frameworks/framework-for-innovation-design-councils-evolved-double-diamond/

Dewey, J. (1938). Experience and Education. Collier Books.

Dunleavy, M., & Dede, C. (2013). Augmented Reality Teaching and Learning. Handbook of Research on Educational Communications and Technology, 735–745. https://doi.org/10.1007/978-1-4614-3185-5_59

Dunleavy, M., Dede, C., & Mitchell, R. (2008). Affordances and Limitations of Immersive Participatory Augmented Reality Simulations for Teaching and Learning. Journal of Science Education and Technology, 18(1), 7–22. https://doi.org/10.1007/s10956-008-9119-1

EdGlossary Org. (2015, April 6). Scaffolding Definition. The Glossary of Education Reform. Retrieved 30 March 2022, from https://www.edglossary.org/scaffolding/

Edwards-Stewart, A., Hoyt, T., & Reger, G. (2016). Classifying different types of augmented reality technology. Annual Review of CyberTherapy and Telemedicine. https://www.researchgate.net/publication/315701832_Classifying_different_types_of_augmented_reality_technology

EPM. (2020, October 2). Kolb's Learning Cycle Explained with Example [Video]. YouTube. https://www.youtube.com/watch?v=rycjUldMl3k

Falk, J. H., & Dierking, L. D. (2004). Reinventing the museum: Historical and contemporary perspectives on the paradigm shift. AltaMira Press.

Fenu, C., & Pittarello, F. (2018). Svevo tour: The design and the experimentation of an augmented reality application for engaging visitors of a literary museum. International Journal of Human-Computer Studies, 114, 20–35. https://doi.org/10.1016/j.ijhcs.2018.01.009

FS Redactie. (2004). Henri Baudet: een bijzondere hoogleraar Designgeschiedenis. Trendalert. Retrieved 4 July 2022, from https://www.trendalert.nl/artikel/164962-henri-baudet-bijzondere-hoogleraar-designgeschiedenis

Fyfield, M. [Ed Theory]. (2018, July 24). Constructivism vs Positivism - a false debate? [Video]. YouTube. https://www.youtube.com/watch?v=gmeH2RJ-YpQ

Gartner. (2022). Definition of Augmented Reality (AR) - Gartner Information Technology Glossary. Retrieved 4 July 2022, from https://www.gartner.com/en/information-technology/glossary/augmented-reality-ar

Gatter, S., Hüttl-Maack, V., & Rauschnabel, P. A. (2021). Can augmented reality satisfy consumers' need for touch? Psychology & Marketing, 39(3), 508–523. https://doi.org/10.1002/mar.21618

Griffin, D. (2018). water base [Image]. https://slideplayer.com/slide/13239934/

Hasa, B. (2020, March 3). What is the Difference Between Positivism and Constructivism. Pediaa.Com. Retrieved 29 March 2022, from https://pediaa.com/what-is-the-difference-between-positivism-and-constructivism/#:%7E:text=Positivism%20is%20the%20theory%20that,and%20interactions%20with%20the%20world

He, Z., Wu, L., & Li, X. R. (2018). When art meets tech: The role of augmented reality in enhancing museum experiences and purchase intentions. Tourism Management, 68, 127–139. https://doi.org/10.1016/j.tourman.2018.03.003

Hotjar. (2022). Understanding New vs Returning Users in Google Analytics | Hotjar. Retrieved 28 June 2022, from https://www.hotjar.com/google-analytics/glossary/users/

References

Hyper Reality. (2018). Hyper Raality. Hyper Reality Co. Retrieved 2022, from http://hyper-reality.co/

ICOM. (2022, May 9). Museum Definition. International Council of Museums. Retrieved 4 July 2022, from https://icom.museum/en/resources/standards-guidelines/museum-definition/

Islam, A. (2018, December 15). The Ins and Outs of Augmented Reality - Predict. Medium. Retrieved 16 June 2022, from https://medium.com/predict/the-ins-and-outs-of-augmented-reality-44c45cdf2312

Ismanalijev, I. (2022). Learn how to vibrate your mobile phone on the web using the vibration API. Illyism. Retrieved 16 June 2022, from https://il.ly/journal/vibrate-mobile-phone-web-vibration-api/

Jeon, S., Choi, S., & Harders, M. (2012). Rendering Virtual Tumors in Real Tissue Mock-Ups Using Haptic Augmented Reality. IEEE Transactions on Haptics, 5(1), 77–84. https://doi.org/10.1109/toh.2011.40

Jung, T., Tom Dieck, M. C., Lee, H., & Chung, N. (2016). Effects of Virtual Reality and Augmented Reality on Visitor Experiences in Museum. Information and Communication Technologies in Tourism 2016, 621–635. https://doi.org/10.1007/978-3-319-28231-2_45

Keil, J., Pujol, L., Roussou, M., Engelke, T., Schmitt, M., Bockholt, U., & Eleftheratou, S. (2013). A digital look at physical museum exhibits: Designing personalized stories with handheld Augmented Reality in museums. 2013 Digital Heritage International Congress (DigitalHeritage). https://doi.org/10.1109/digitalheritage.2013.6744836

Kelly, L. (2003). Understanding Museum Learning from the Visitor's Perspective. Curator: The Museum Journal, 46(4), 4–5. https://doi.org/10.1111/j.2151-6952.2003.tb00102.x
Kolb, D. A. (1984). Experiential Learning. Prentice Hall.

Kurt, S. (2020, December 28). Kolb's Experiential Learning Theory & Learning Styles. Educational Technology. Retrieved 18 May 2022, from https://educationaltechnology.net/kolbs-experiential-learning-theory-learning-styles/

Ma, N. (2021). Research on the Design of Mobile Guiding in Art Museum Based on Augmented Reality. 2021 International Conference on Digital Society and Intelligent Systems (DSInS). https://doi.org/10.1109/dsins54396.2021.9670596

MAMUR, N., ÖZSOY, V., & KARAGÖZ, B. (2020). Digital Learning Experience in Museums: Cultural Readings in a Virtual Environment. International Journal of Contemporary Educational Research. https://doi.org/10.33200/ijcer.799643

Marr, B. (2021, December 10). Future Predictions Of How Virtual Reality And Augmented Reality Will Reshape Our Lives. Forbes. Retrieved 4 July 2022, from https://www.forbes.com/sites/bernardmarr/2021/06/04/future-predictions-of-how-virtual-reality-and-augmented-reality-will-reshape-our-lives/

Marto, A., Melo, M., Goncalves, A., & Bessa, M. (2020). Multisensory Augmented Reality in Cultural Heritage: Impact of Different Stimuli on Presence, Enjoyment, Knowledge and Value of the Experience. IEEE Access, 8, 193744–193756. https://doi.org/10.1109/access.2020.3032379

Matsuda, K. (2015). HYPER-REALITY [Video]. https://www.youtube.com/watch?v=YJg02ivYzSs

Mayhew, R. (2017). ReBlink Trailer [Video]. https://www.youtube.com/watch?v=mHFzkV20lwQ

Mcleod, S. A. (2019, July 17). Constructivism as a Theory for Teaching and Learning. Simply Psychology. Retrieved 13 April 2022, from https://www.simplypsychology.org/constructivism.html

MET museum. (2022). audio tour guide [Image]. https://www.metmuseum.org/visit/audio-content

Milgram, P., Takemura, H., Utsumi, A., & Kishino, F. (1995). Augmented reality: a class of displays on the reality-virtuality continuum. SPIE Proceedings. https://doi.org/10.1117/12.197321

Moorhouse, N., Tom Dieck, M. C., & Jung, T. (2019). An experiential view to children learning in museums with Augmented Reality. Museum Management and Curatorship, 34(4), 402–418. https://doi.org/10.1080/09647775.2019.1578991

Morrison, A., Oulasvirta, A., Peltonen, P., Lemmela, S., Jacucci, G., Reitmayr, G., Näsänen, J., & Juustila, A. (2009). Like bees around the hive. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. https://doi.org/10.1145/1518701.1518991
Nejc Prah. (2022). [Graphic]. https://www.nejcprah.com/

Neuburger, L., & Egger, R. (2017). An Afternoon at the Museum: Through the Lens of Augmented Reality. Information and Communication Technologies in Tourism 2017, 241–254. https://doi.org/10.1007/978-3-319-51168-9_18

Onirix. (2018). Augmented Reality for Museums and Art Exhibitions |Onirix [Video]. https://www.youtube.com/watch?v=wMsUs5nBS-4
Orb Amsterdam. (2022). Adidas Checkboost [Graphic]. https://orbamsterdam.com/checkboost-ar

O'Shea, P., Mitchell, R., Johnston, C., & Dede, C. (2009). Lessons Learned about Designing Augmented Realities. International Journal of Gaming and Computer-Mediated Simulations, 1(1), 1–15. https://doi.org/10.4018/jgcms.2009010101

PEDIAA. (2020). What is the Difference Between Positivism and Constructivism [Figure]. (Hasa, 2020). https://pediaa.com/what-is-the-difference-between-positivism-and-constructivism/#:~:text=Positivism%20is%20the%20theory%20that,and%20interactions%20with%20the%20world

Perry, J., Klopfer, E., Norton, M., Sandford, R., Facer, K., & Sutch, D. (2008). AR gone wild: two approaches to using augmented reality learning games in Zoos. ICLS, 2008(3), 322–329. https://www.researchgate.net/publication/220934269_

References

AR_gone_wild_two_approaches_to_using_augmented_reality_learning_games_in_Zoos

Pokémon GO app. (2018). Pokémon GO [Image]. https://twitter.com/pokemongoapp/status/975462386877509635

Prodigy. (2020). 6 Proven Strategies for Scaffolding in Education and 8 Benefits for Learning. Prodigy Education. Retrieved 18 May 2022, from https://www.prodigygame.com/main-en/blog/scaffolding-in-education/

Radu, I. (2014). Augmented reality in education: a meta-review and cross-media analysis. Personal and Ubiquitous Computing, 18(6), 1533–1543. https://doi.org/10.1007/s00779-013-0747-y

Roberts, G. (2006). Kolb's Learning cycle graphic [Image]. http://dx.doi.org/10.5032/jae.2006.01017

Scheffler, A. (2022, June 1). Artec Eva vs. Scoobe3D - Which 3D scanner to invest in? Scoobe3D. Retrieved 29 June 2022, from https://scoobe3d.com/en/artec-eva-vs-scoobe3d/

ShutterStock. (2022). water rippling in sun reflection [Image]. https://www.shutterstock.com/nl/video/clip-4924979-sea-waves-sunlight-reflection-water-star-reflections

Singulart. (2022). Kazimir Malevich [Painting]. https://cdn.singulart.com/famous/artworks/v2/cropped/691/a_691_08301f249d8e99a3cae9d513e82a6036.jpeg

Skarbez, R., Smith, M., & Whitton, M. C. (2021). Revisiting Milgram and Kishino's Reality-Virtuality Continuum. Frontiers in Virtual Reality, 2. https://doi.org/10.3389/frvir.2021.647997

Sleeswijk Visser, F., Stappers, P. J., van der Lugt, R., & Sanders, E. B. N. (2005). Knowledge Pyramids [Image]. http://contextmapping.com/basics/

Smithsonian. (2015). Skin & Bones promotional video [Video]. https://www.youtube.com/watch?v=7agVb4IG16M

Sullivan, M. A. (2003). La Grand Vitesse, 1969 [Photo]. https://returnonart.com/blog/alexander-calder

Techpulse. (2017). Snapchat AR face effects example [Photo]. https://techpulse.be/achtergrond/213882/zijn-snapchats-gezichtsfilters-een-schending-van-je-privacy/

Tillon, A. B., Marchal, I., & Houlier, P. (2011). Mobile augmented reality in the museum: Can a lace-like technology take you closer to works of art? 2011 IEEE International Symposium on Mixed and Augmented Reality - Arts, Media, and Humanities. https://doi.org/10.1109/ismar-amh.2011.6093655

TU DELFT. (2022). IDE floor plans [Floor plan]. https://www.tudelft.nl/io/over-io/contact/plattegronden

Tucker, B. G., Kazmer, D. O., Bielefeldt, A. R., Paterson, K., Pierrakos, O., Soisson, A., & Swan, C. (2014). The Reflective Learner: Perspectives of Engineering Faculty Engaged In Learning through Service. International Journal for Service Learning in Engineering, Humanitarian Engineering and Social Entrepreneurship, 9(2), 29–46. https://doi.org/10.24908/ijsle.v9i2.5448

University of Twente, & Teng, J. (2015). https://essay.utwente.nl/69309/1/Teng%20J.%20-%20S1559206%20-%20masterscriptie.pdf. https://essay.utwente.nl/69309/1/Teng%20J.%20-%20S1559206%20-%20masterscriptie.pdf

van Huystee, M. (2022). IDE main hall [Image]. https://www.huystee.com/nl/onderwijs.html

Venkatasubramanian, N., Getov, V., & Steglich, S. (Eds.). (2012). Mobile Wireless Middleware, Operating Systems, and Applications. Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering. https://doi.org/10.1007/978-3-642-30607-5

Vermeeren, A. P., & Calvi, L. (2019). Relevance by Play. Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems. https://doi.org/10.1145/3290607.3312960

Victoria University. (2022). Scaffolding for learning. Victoria University, Australia. Retrieved 18 May 2022, from https://www.vu.edu.au/learning-teaching/teaching-for-learning-at-vu/guides-for-learning-teaching-in-block-mode/scaffolding-for-learning

Vincenzi, D. A., Valimont, B., Macchiarella, N., Opalenik, C., Gangadharan, S. N., & Majoros, A. E. (2003). The Effectiveness of Cognitive Elaboration Using Augmented Reality as a Training and Learning Paradigm. Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 47(19), 2054–2058. https://doi.org/10.1177/154193120304701909

Volkskrant. (2011). Pootjebaden [Image]. https://www.volkskrant.nl/mensen/aan-belgische-kust-voorlopig-alleen-pootjebaden~b64c1d90/

Vuforia. (2022). How to Create a Model Target | VuforiaLibrary. Https://Library.Vuforia.Com/Model-Targets/How-Create-Model-Target. Retrieved 17 June 2022, from https://library.vuforia.com/model-targets/how-create-model-target

Wojciechowski, R., Walczak, K., White, M., & Cellary, W. (2004). Building Virtual and Augmented Reality museum exhibitions. Proceedings of the Ninth International Conference on 3D Web Technology - Web3D '04. https://doi.org/10.1145/985040.985060

WSJ. (2016). 'Pokémon Go' Surged by Building Community [Image]. https://www.wsj.com/articles/pokemon-go-surged-by-building-community-1469419260

Wu, H. K., Lee, S. W. Y., Chang, H. Y., & Liang, J. C. (2013). Current status, opportunities and challenges of augmented reality in education. Computers & Education, 62, 41–49. https://doi.org/10.1016/j.compedu.2012.10.024

Xavier, B. (2019). AR Coffee - Free Coffee offered by Jeeliz [Video]. https://www.youtube.com/watch?v=a09NSXp_ENU

Xavier, B. (2022, February). GitHub - jeeliz/jeelizAR: JavaScript object detection lightweight library for augmented reality (WebXR demos included). It uses convolutional neural networks running on the GPU with WebGL. GitHub. Retrieved 12 June 2022, from https://github.com/jeeliz/jeelizAR

Appendices

Appendix A: Signed Project Brief

DESIGN FOR our future

TU Delft

IDE Master Graduation

Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT

Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

STUDENT DATA & MASTER PROGRAMME

Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy".
Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !

family name: CHAJID

initials: M given name: MOHAMED

student number: ----

street & no.:

zipcode & city:

country:

phone:

email:

Your master programme (only select the options that apply to you):

IDE master(s): ( ) IPD ( ) Dfl ( ) SPD

2nd non-IDE master:

individual programme: - - (give date of approval)

honours programme: ( ) Honours Programme Master

specialisation / annotation: ( ) Medisign ( ) Tech. in Sustainable Design ( ) Entrepeneurship

SUPERVISORY TEAM **

Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair: ELKHUIZEN, W.S. dept. / section: SDE/MD

** mentor: VERMEEREN, A.P.O.S. dept. / section: HCD/HCID

2nd mentor:

organisation:

city: country:

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v..

Second mentor only applies in case the assignment is hosted by an external organisation.

comments (optional)

Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

Procedural Checks - IDE Master Graduation

TU Delft

APPROVAL PROJECT BRIEF

To be filled in by the chair of the supervisory team.

chair ELKHUIZEN, W.S. date 11 - 03 - 2022 signature

Digitally signed by tudelft.protect Jamf Protect CSR Identity Date: 2022.03.11 09:28:12 +01'00'

CHECK STUDY PROGRESS

To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair.
The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: _____ EC

Of which, taking the conditional requirements into account, can be part of the exam programme _____ EC

List of electives obtained before the third semester without approval of the BoE

YES all 1st year master courses passed

NO missing 1st year master courses are:

name _____ date - - signature _____

FORMAL APPROVAL GRADUATION PROJECT

To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **.
Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks ?
- Does the composition of the supervisory team comply with the regulations and fit the assignment ?

Content: APPROVED NOT APPROVED

Procedure: APPROVED NOT APPROVED

comments

name _____ date - - signature _____

Personal Project Brief - IDE Master Graduation

TU Delft

ARchive; Unlocking design archives through an interactive AR experience project title

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

start date 14 - 02 - 2022 08 - 07 - 2022 end date

INTRODUCTION **

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

Museums are institutes dedicated to showcasing the past, present or future of different fields. That is why a plethora of museums have vast archives of objects, each holding a story of their own. However for some visitors the experience only goes so far, e.g. : A classic Braun shaver under a glass display, with a few supplementary sentences attempting to summarize its story. Is this satisfactory, or is there more to be uncovered? What if we could unlock the rest of its (hi)story? Say at Design Museum Den Bosch or Boijmans' Depot in Rotterdam.

Scope
The scope of this project are institutes with a (product) design archive, with different degree of accessibility. These institutes are often targeted towards virtually anyone, from tourist to purist. For this graduation project however, specifically IDE's collection and its students are taken as the context and target group. This collection will be used to explore the potential of telling stories around (design) artefacts, by using novel technologies (eg. AR & 3D scanning).

Stakeholders
The main stakeholders are the collection owner and the students. Less directly involved are the teaching staff and recent graduates.

Context
The physical context is at the IDE faculty, for example the allocated exhibition areas.

Opportunities & limitations
A problem creates room for improvement, opportunities;

1. Currently the products are behind glass at the faculty, with little to no interaction possible.
The interaction is mainly one-way --> make this a real interaction, more of a dialogue, between product and visitor.

2. Augmented Reality(AR) can facilitate interactions in an accessible and engaging manner, by overlaying information over the real-world using your phone for example.

3. Go from a one/two-dimensional experience to a layered(multi-sensory) one. Right now the experience is solely visual(static), objects in display without text. What if dynamic visuals and sound are added? How could this create a more engaging and thought-provoking experience?

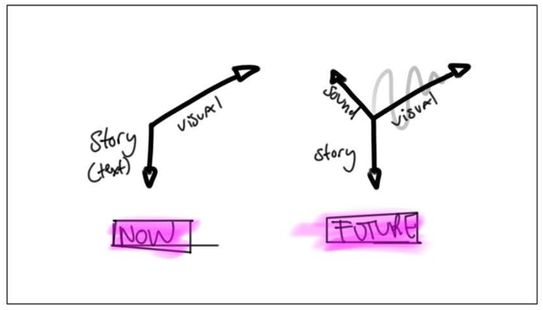
Limitations
1. External touch-points; For AR there are touch-points needed for it to recognize an object, this is bound to the physical location of the device (eg. QR-codes). How to minimize the amount of these type of points needed?

2. Bridge; For AR there is a 'bridge' needed to go from the real to the digital world and in between. E.g. your smartphone, a tablet or a HoloLens. This could take away too much attention from the artefact itself.

3. Stance on tech; Certain heritage museums can be less forward thinking when it comes towards technology. How to convince said parties of its potential? The aim of this project is to provide that convincing example.

space available for images / figures on next page

introduction (continued): space for images



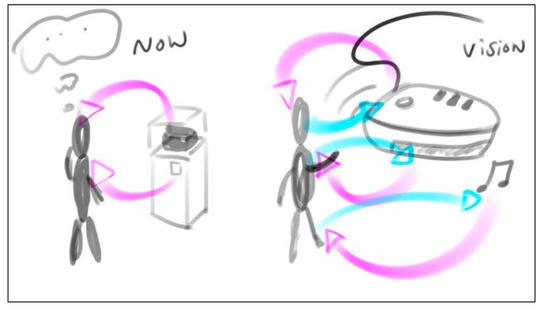
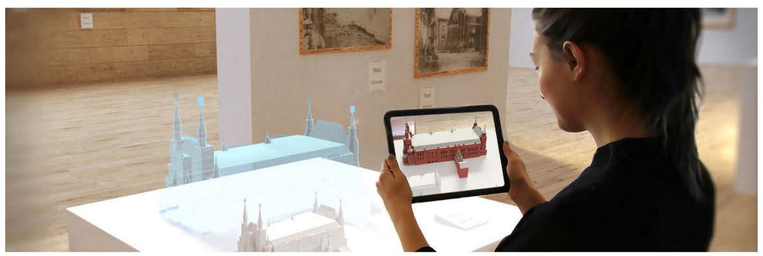


image / figure 1: initial vision sketches; experience/interaction now vs. future

(Sandu,2020)



(AR-Go Lab,2021)

(MET museum,2019)

(MT Sprout,2017)

image / figure 2: references of museum context <-> AR concepts

PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

A visit to a design museum archive is interesting for the design fanatic and ones casually interested, however it is difficult to convey the richness of the stories about the objects through the static object and text labels.
Essentially this museum-visit can be quite one-dimensional, staying on the surface level, whilst the object/stories offer a lot more to tell. The focus for this project is the IDE collection at the faculty and its students.

Industrial design students have little connection to the IDE product history and the archive at the faculty. As mentioned before, there is a superficial(one-way) interaction. The goal is to create a layered (multi-sensory) experience to get a deeper insight regarding these design artifacts, and their stories, in an accessible and casual manner.
Ultimately inspiring the students, and educating them about product design history.

Target group
For this project the focus is on IDE students, representing the explorers & expert/hobbyist categories within Falk's museum visitor framework.

Solution Space/Design Challenges
1. How can we use AR technology to create more depth in the interactions with archival products, for learning & inspiration?
2. How can the intervention be intuitive to learn, having a low learning curve, whilst being a series of short interactions (eg. < 10 min per interaction) ?
3. How can we create a multi-sensory experience that balances digital interactions and real-world engagement? Thus creating an experience complementary to the artefact(s), rather than a substituting one.
4. How can we incorporate the physical space around the artefacts in the experience? (Eg. marker placement)

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

Design an interactive multi-sensory experience for museum visitors, using AR, that ultimately inspires them, adding depth to the stories currently told about product design objects at archival institutes. For this assignment the IDE product archive, its students and faculty are taken as the context.

1. Research phase;
 -Explore context, understand the current experience user journey (eg. observations & contexmapping)
 -Obtain understanding needs stakeholders, context & limitations (eg. interviews, observations and personas)
 -Gain understanding of AR tech. & principles relating to context + learning theories/frameworks (eg. lit. research)
2. Design phase;
 -Ideate & conceptualize
 -Representation of the artifacts digitally (e.g. 3D-scanning)
 -Leaning about and prototyping using existing AR engines
 -Iterative small user tests to gain insights effectively
3. Evaluation phase;
 -Final prototype & user study in context to evaluate design --> final recommendations

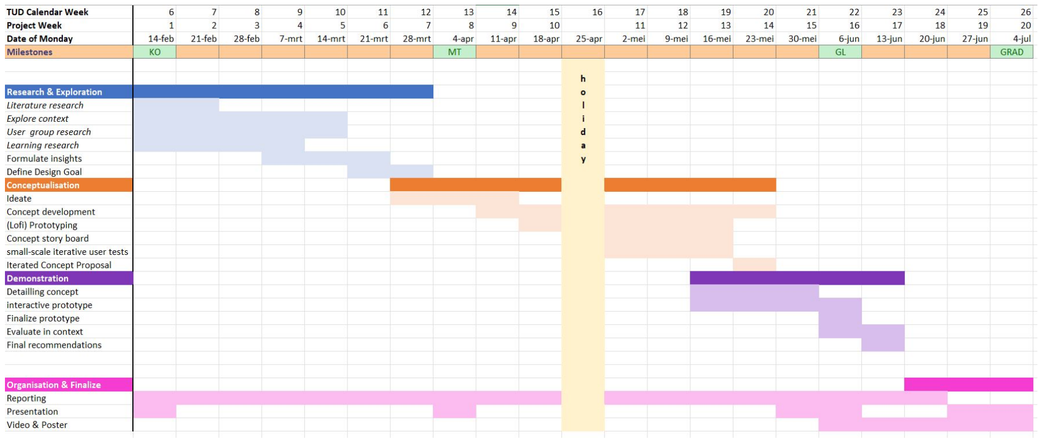
Expected deliverables;
 -Visualizations of the final design (eg. storyboard)
 -Demonstrator; interactive prototype using Augmented Reality, demonstrating part(s) of the concept.
 -Concept video; brief video to grasp the proposed concept
 -Graduation report

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 14 - 2 - 2022

8 - 7 - 2022 end date



META planning activities divided in 3 main design phases; Research & Exploration, Conceptualisation & Demonstration.

Anchor points;

Kick-off: week of February 14th

Mid-Term: week of April 4th

Green-Light: week of June 6th

Graduation: day 100, July 8th

MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

As a kid I had a strong interest in the arts, which grew to design. Also I was very fascinated with the world of tech and what it could offer in the far and near future. Hence my choice to study IDE.
In my teens I visited and worked at museums in Rotterdam and experimented with digital technology in my free time. Playing around in Photoshop and 3D software.

This grew possibilities, being fortunate to have some freelance gigs. Doing 3D animations and small AR-experiences for example.

All in all this brief resonates with my past experiences and interests, but more importantly where I see my future self and the world of design/art headed.

Learning goals

1. Interaction design level; How to design a series of interactions that feel natural/intuitive yet engaging to the set target group? This is what one of the things I want to explore and get better at on an interaction design level.
Eg. by exploring UI norms on handheld devices(iPhone/iPad), think of pinch to zoom for example.

2. AR-tech; Learn more about principles of AR and how this could be implemented to solve this specific problem.

3. Rapid prototyping; I want to get better at quick prototyping and using mock-ups to effectively iterate towards a better design. To test parts of the design through wizard-of-oz prototyping for example.

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.

Appendix B:
Full Interview with IDE's educationalist

Q1: Who are you & what do you do?
Nel is the education advisor, focusing on maintining and improving education quality at the faculty eg. through Learning evaluation and direct improvements new bsc courses.

Q2: What does learning, in relation to IDE students, mean to you?
'difficult question'
'A lot what we do stems from different learning frameworks, for example behaviorism. Eg. giving students a reward when they attend a work-shop'
creating some sort of incentive for their efforts

Q3: How does one promote learning?
'through a mix of frameworks, trying to combine elements from each, depending on your goal'
constructivism comes back @ IDE through the project based approach for example.
'we try to engage students to learn through promoting the social context'
'Autonomous learning is the didactic concept for the IDE bsc.'

Q4: Why these particularly?
'It stems from prepping students for the real-world, desinging is becoming more and more complex, where taking initiative and being self-reliant are important for example.'

Prep students for post-grad, having the needed skill-set

Q5: Which learning scaffolds to implement in design intervention?
'keep in mind social context'
'most likely you'll need to pick certain elements, not use a whole scaffold/learning theory'

Q6: How & when is 'design heritage' taught @ the faculty?
'Mainly during Understanding Design'
Students than touch on design history during the course.

Q7: any feedback/evaluation on students wanting to learn more about design heritage?
'Yes, actually that's the reason it was taken in the goal list for the new Bachelor. '
'Students really wanted to learn more about the history of design'

Q8: In which ways does the faculty try to inspire students during their design proces?
'Giving new students a feeling they are real designers is important and inspiring. '
'For example through inviting designers in the fields. However they often only tell the success stories, not the failures, where the students could learn more from even. '

Q9:Why is this important when learning?
In the design process this gives students the 'hooks' to be able to come up with a solution.

Q10: What role do inspiration & self-motivation play when learning?
'self-motivation is essential and important'
self motiviation is key, it is the intrinsic drive, without it you can't get very far.
'the game-industry is interesting, where people are motivated to keep on playing and lured to play more often. to keep on pushing to reach a certain goal'

misc.
Nel really liked her visit to the 9/11 memorial museum in NY, 'it was impressive'
Mainly because there were stories, from the pov of the survivors, family, bystanders, Emergency team etc.
'The stories were engaging,which made it human, instead of facts, numbers or politics. '

Appendix C: Full Interview with HBI director

Q1: What is the HB Institute?
Set up in 2004 to collect and archive the progression of Industrial products over time. To show and display at the faculty and its students.

Q2: Does it have any goals in relation to students & faculty?
Showing the progression of consumer products
Highlight materials, their use and manufacturing processes that had in impact on products.
Essentially for to students to learn from the past and be inspired.

Q3: How are students able to interact with the archive collection currently?
Mainly through the displays at the faculty, downstairs, and upstairs have permanent displays.
And every once in a while in the hall there is a small exhibit.
Most of the archive is hidden in the dedicated space, very few students know of it. 'They light up when they enter the institute'

Q4: How satisfactory do you find the current interaction between students & the collection?
'It doesn't exist' There is close to no interaction.
'They don't know the collection exists.'

Q5: Is there a catalog with all the products the Institute owns?
There isn't an accessible one, it's a simple excel with the name, date and designer.
'Have been wanting to create a more intricate and accesible one, with materials and more specific info about the products.'

Q6: Having done exhibits and installations for years at the faculty, what has worked to engage and inspire students?
'The way you set it up is very important'
'The pit(kuil) doesn't work, students used to just stare from above and not go downstairs'
'In the hall, near the tribune worked often'
'Information with the products helps a lot to create some sort of context and story.'
'Products and just QR-codes don't work, or at least I don't like. Than it's just people behind their phones. '

Q7: What do you take into account when setting up an installation/display? (limitations)
Visibility
Being able to walk around it well
'the way it's setup is important again, so people respect it'

Q8: What would you say your favourite part of the archive as a whole is?
'The wide array of products. It's easy to see the progression throughout time and we purposely have some quirky products. Those tried to push the status-quo/had a unique design language '

Q9:And what would be your least favourite elemnt about the collection as a whole?
'it's a shame that students aren't able to interact with the artefacts more often, now they're hidden.

Q10: How could we improve this do you think?
-Better vitrines, dust them of more often etc.
-more information about the products displayed, currently you have no idea what it;s about or why it is relevant.
-involve the students more , 'make the collection 'open' and accesible for their education.'
-more frequent rotation of products in the display

Appendix D:
Questionnaire
Context Interview

results;

https://docs.google.com/spread-sheets/d/1a2WYEHO1c2j9myqifCUDN5V-dO0iZwvHLnGy-VC97ZdQ/edit?usp=sharing

the Questionnaire

(filled in manually by interviewer & answered verbally by interviewees)

next pages-->

REAL Context Field study

Field study of current context & users interview

1. hey! I saw you walking by the displays. What do you think of them?

2. how come, why?

3. how does having seen it before play a role do you think?

4. For during a product design project, how inspiring would you rate the display & products? (you can be honest ;)

Markeer slechts één ovaal.

1	2	3	4	5	6	7	8	9	10
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

5. For during a product design project, how educational would you rate the display & the products within? (you can be honest ;)

Markeer slechts één ovaal.

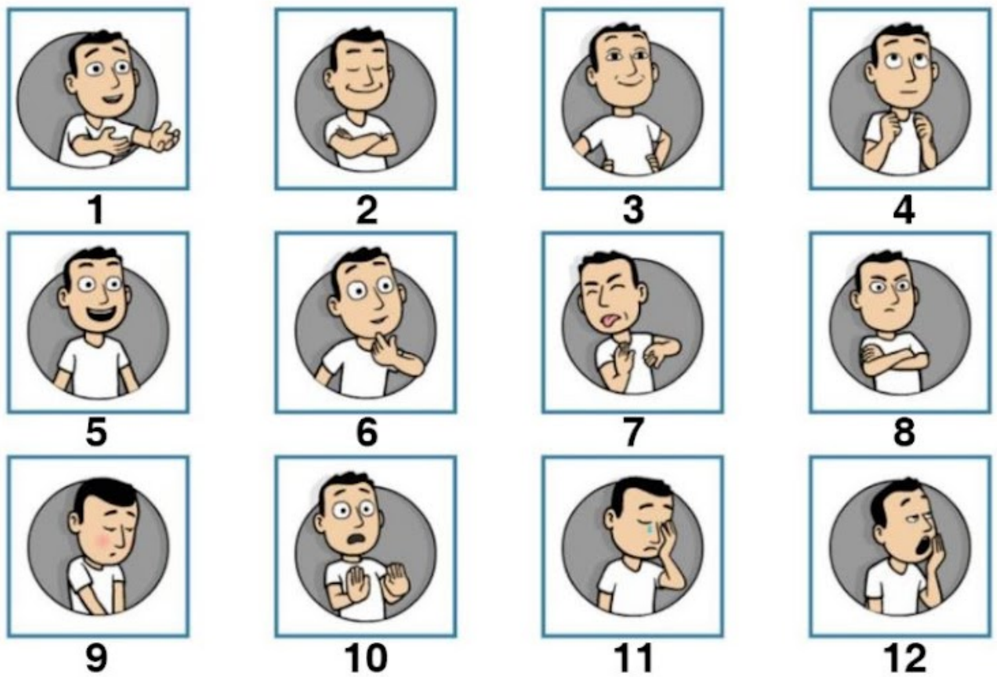
1	2	3	4	5	6	7	8	9	10
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

6. Did you before ever go by and got inspired or go here to get inspired? (be honest)

Markeer slechts één ovaal.

- ◯ yes
- ◯ no
- ◯ Anders: _____

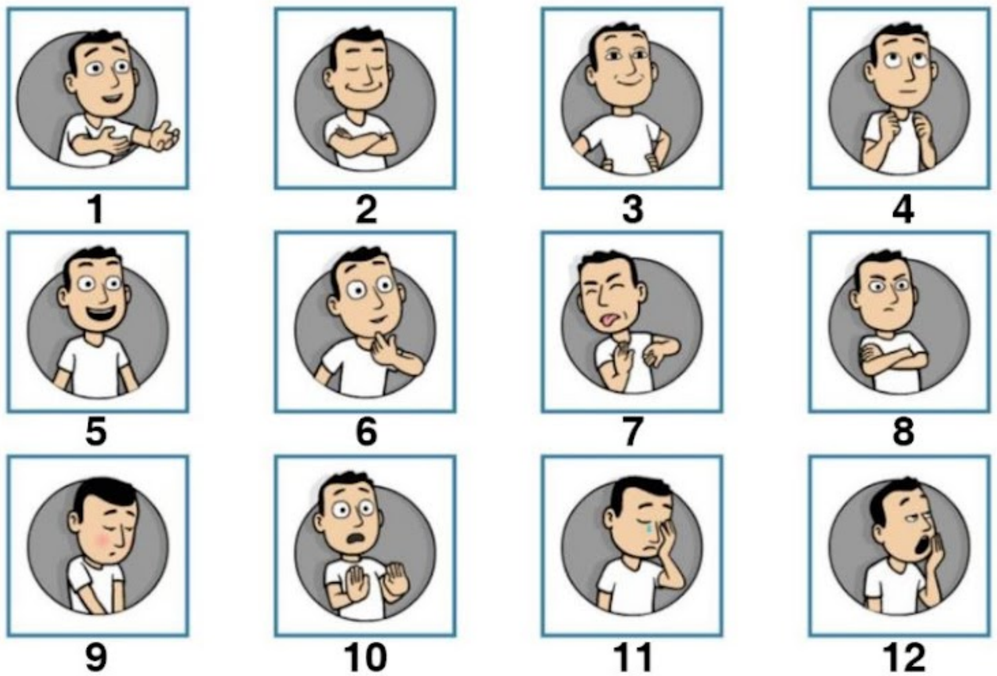
7. From the following 12 pictures, what would describe your feeling best when you are looking for inspiration?



Markeer slechts één ovaal.

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12

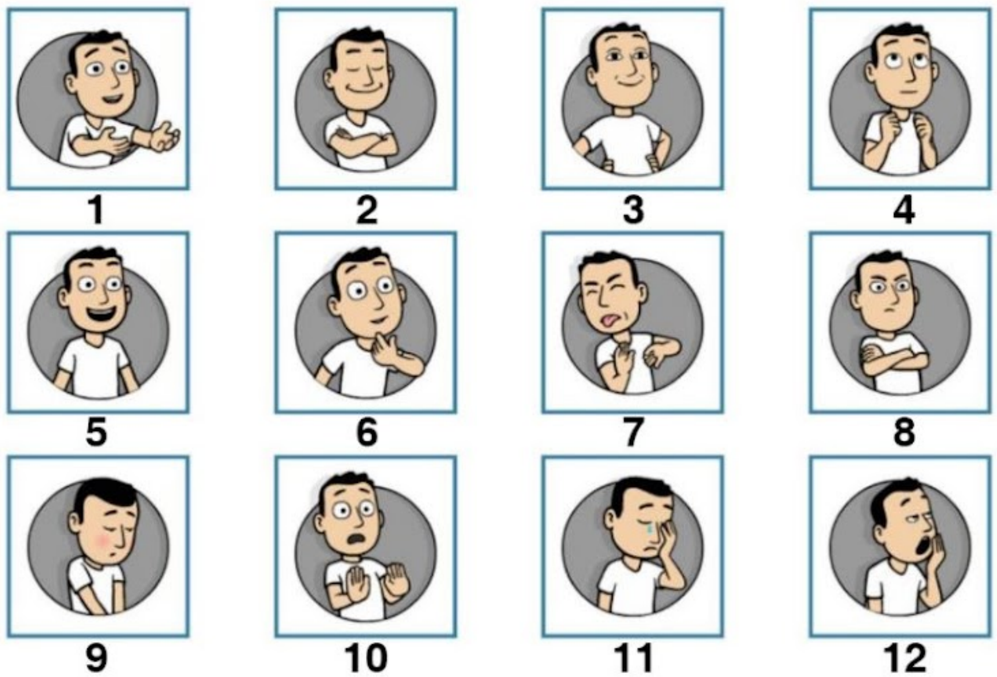
8. From the following 12 pictures, what would describe your feeling best when looking at the display?



Markeer slechts één ovaal.

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12

9. From the following 12 pictures, what would describe your feeling best after looking at the display? >is there a change or same?



Markeer slechts één ovaal.

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12

10. So how do you usually get inspired/inspiration when designing? What do you do, use, seek out etc.

11. Did you know our faculty has a collection of heritage design products?

Markeer slechts één ovaal.

- yes
- no
- Anders: _____

12. 1. Would you like to interact with these products of the collection in a particular way(how)? 2. What do you feel like is lacking currently?

13. 1. Do you know much about product design heritage/history? 2. Would you like to learn more?

14. 3. What would you like to learn about 'design heritage' ? & why

15. room for extra + info: name, age, year, gender etc.

16. further details interested participate rest of research, number/email

17. LOCATION

Markeer slechts één ovaal.

- 1E VERDIEPING
- KUIL
- Anders: _____

18. intervention?

Markeer slechts één ovaal.

- none
- 1 flyer
- 2 tape
- 3 overlay
- Anders: _____

Appendix E:
Sensitizing booklets

visit;

https://miro.com/app/board/uXjVONMin-6w=/?share_link_id=266237549694

Appendix F:
Generative session Materials

visit;

https://miro.com/app/board/uXjVONMin-6w=/?share_link_id=266237549694

Appendix G:
Plan of Requirements

results;

Plan of Requirements

LEARNING
1. The design needs to communicate information about the DH objects, adding more depth to them.
2. The design offers learning scaffolds for visitors.
3. The design facilitates learning through, at least half, of Kolb's experiential learning cycle.
4. The design supports interactions in the social context, to boost learning.
5. The design is in line with the visitors' wants, needs and interests, in order to ensure self-motivation.

CONTENT
6. The content of the design is able to provide information about the following subjects regarding DH [based on User Research]
7. The design communicates the information in a short and engaging manner. This could be in the form of storytelling.
8. The content is not text-heavy, to prevent cognitive overload, the AR experience mainly being via visual or auditory ways.

INSPIRATION
9. The design inspires the visitors.
10. The design caitors to at least 3 of the ways users(students) like and want get inspired
11. The design scores a ranking higher than the current displays regarding inspiration. e.g. ranking of 8/10 inspiring for a product design project [comparison base lvl test current displays]

TECHNOLOGY
12. The design leverages AR's strengths
13. The design minimizes AR's risks
14. The AR part of the experience is designed context-specific
15. The design is able to be used on both IOS and Android platforms (multi-platform)
16. If the design fails technologically, there still is a learning and experiential element. E.g. through analogue elements. So there is a backup plan, plan B. The experience is not fully reliant upon the digital elements.
17. The digital experience can start instantly, the user not needing to install any apps or programmes on their device. Either that OR: the preloaded devices are accessible, to the users

EXPERIENCE
18. The design promotes regular discovery, preventing the experience from getting boring in the long run.
19. The design needs to frame the objects in such a way that they are seen as part of IDE's design history.
20. The design has a strong visual component in the experience, communicating mainly visually.
21. The experience is multi-sensory, with at least 1, sonic component.

PRE
22. The design should attract the attention of passersby, in such a way that they take a moment to stop or remember/recognize it when they are on their way somewhere in the space the next time
23. The passerby can get a sense of what the experience would entail, and is about, before fully experiencing it (have a clear intent, be transparent)

DURING
24. The experience engages users.
25. The experience is casual, meaning the user is in charge when they step in and/or out of it.
26. The experience is inspiring for the visitors. Inspiring them through highlighting Design Heritage.
27. The experience does not (solely) provide plain and dull information, but rather communicates materials for visitors to learn through.
28. The experience offers the user the autonomy on how 'deep' they want to go in terms of information and knowledge. Meaning the experience is layered and caters to both explorers and experts.
29. The design can be used in a social manner, e.g. by 2 visitors at a time.
30. The experience can be both enjoyed individually or socially in small groups (flexible)
31. The experience adds to the physical object and real-life experience, rather than trying to replace it with the digital. E.i the experience is complementary rather than trying to be substituting.
32. The experience is holistic: part of an overarching whole of learning about DH and getting inspired. Meaning no loose interactions with each object with no clear overarching purpose or binding theme.

POST
33. The experience gives visitors food for thought, so they can reflect on the newly gained knowledge and apply it to their practice for example.
34. The experience is deemed enjoyable by visitors and stimulates return visits after first use

INTERACTION
35. The interaction between design and visitors is not one way, going both ways, like a dialogue almost. meaning the design or experience changes based on the users' input, there is a back and forth.
36. The interactions are casual, fun and engaging. [IV qualities]
37. The interactions [per object] can be both short and sweet or long and deep depending on the user. The user has autonomy over their experience.
38. The digital interactions needed to be performed are familiar to the users. E.i. in line with Apple's UI and actions (e.g.pinch-to-zoom. swipe gesture etc.). The interactions are self-explanatory/ intuitive(Apple,2022)
39. There is a balance between real-world and digital interactions

CONTEXT SPECIFIC [IDE FACULTY]
40. The design does not obstruct existing walking paths in the faculty
41. The design does not take more than 10 m2 surface area.
42. The design is accessible to passersby
43. It should not take longer than 2 minutes walking to reach the experience from the first-floor studios.

Appendix H:
Form Final Evaluation
& Results

Results;

https://docs.google.com/spreadsheets/d/1p9BIq1d90cuNcKv7PzDX-0VHl36IQjWZG6LXnt-MKZ9E/edit?usp=sharing

Form Final Evaluation
(next pages) -->

ARchive Graduation Evaluation

*Vereist

1. My name is... *

_____

2. I am... *

Markeer slechts één ovaal.

- male
- female
- others
- Anders: _____

3. I'm going into the experience as... *

Markeer slechts één ovaal.

- an indidividual
- a duo
- a small group (2+)

4. I am a... *

Markeer slechts één ovaal.

- 1st year Bsc. student
- 2nd year Bsc. student
- 3rd year Bsc. student
- Msc. SPD student
- Msc. DFI student
- Msc. IPD student
- IDE staff
- Anders: _____

5. I fit in the following age group; *

Markeer slechts één ovaal.

- <18
- 18-23 years old
- 24-28 years old
- 29-35 years old
- 36-40 years old
- 41-50 years old
- 50+ years old

6. Pick a statement that fits you... *

Markeer slechts één ovaal.

- ...I don't really know what the object on display is.
- ...I know it's a GameBoy, but nothing really more than that
- ...I know some basic stuff about it
- ...Ahh yes, I'm a geek! I know everything about the GameBoy
- Anders: _____

7. Pick a statement that fits you... *

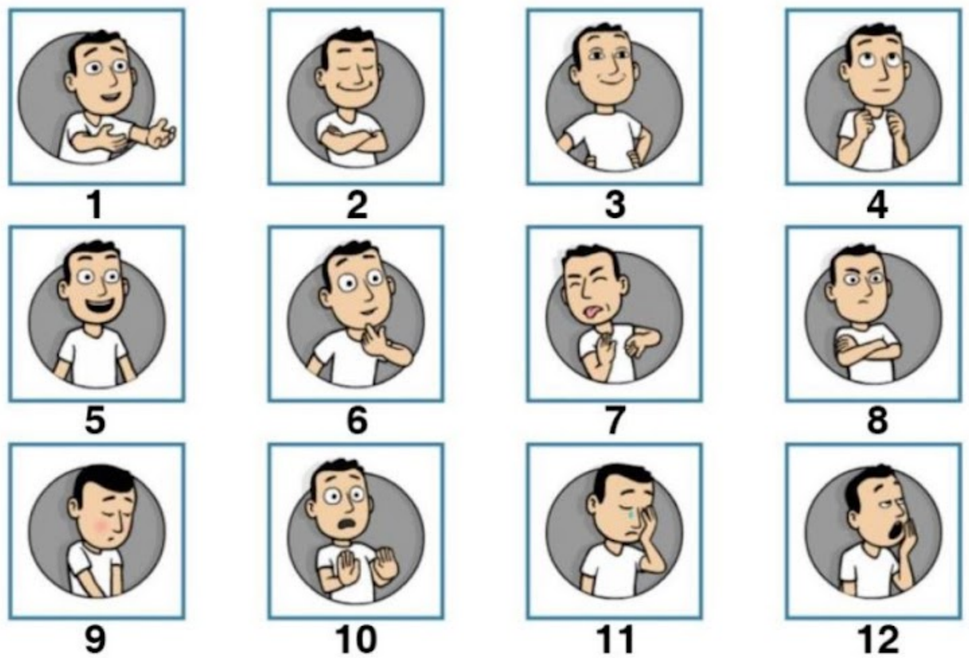
Markeer slechts één ovaal.

- ...I don't really know what AR is
- ...I have seen and heard about AR, never used it however
- ...I've used AR before
- ...I use it all the time!
- Anders: _____

8. Before the experience I expect...

_____

9. The following emotion represents my current state best... *



Markeer slechts één ovaal.

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12

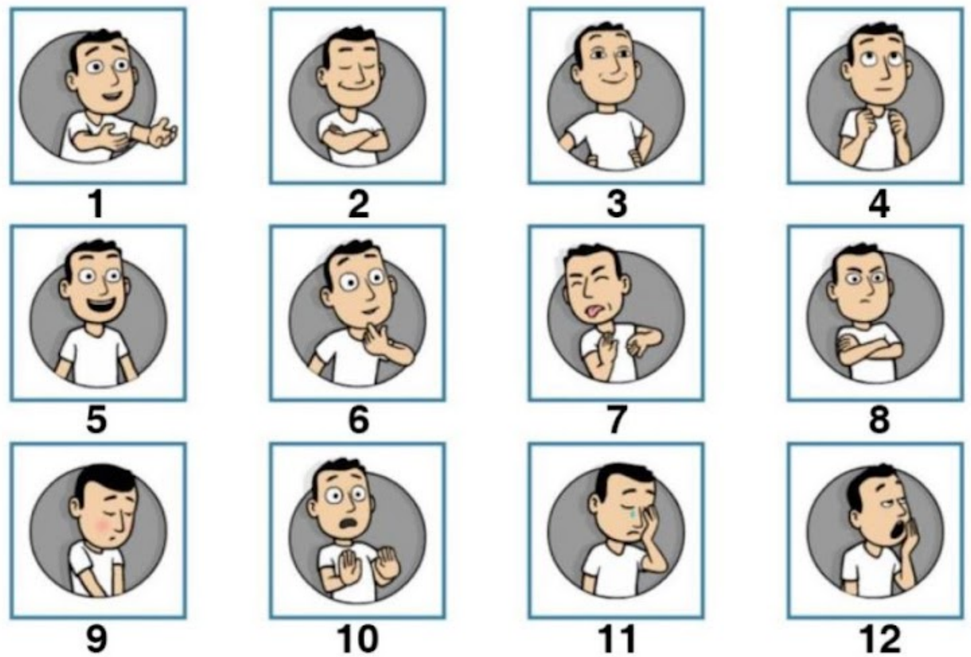
Post-experience - overall

10. What is your overall first impression on the overall experience? & how come? *

11. Do you view the artefact(GameBoy) differently now, if so in what way? *

12. My overall favorite moment was when... *

13. The following PrEmo represents feeling towards the overall experience the best: *



Markeer slechts één ovaal.

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12

14. To what extent did you find the overall experience inspiring? *

Markeer slechts één ovaal.

	1	2	3	4	5	
zero inspirational value	◯	◯	◯	◯	◯	very inspiring

15. To what extent did you find the overall experience educational? *

Markeer slechts één ovaal.

	1	2	3	4	5	
I did not learn anything at all	◯	◯	◯	◯	◯	I learnt lots of new things

16. To what extent did you find the overall experience playful? *

Markeer slechts één ovaal.

	1	2	3	4	5	
very serious	◯	◯	◯	◯	◯	very playful

17. To what extent did you find the overall experience engaging? *

Markeer slechts één ovaal.

	1	2	3	4	5	
very boring	◯	◯	◯	◯	◯	very engaging

18. To what extent did you find the overall experience casual? *

Markeer slechts één ovaal.

	1	2	3	4	5	
very formal	◯	◯	◯	◯	◯	very casual

Part 1: circle-circle

This section specifically is about the first part of the prototype experience

Part 1: circle-circle

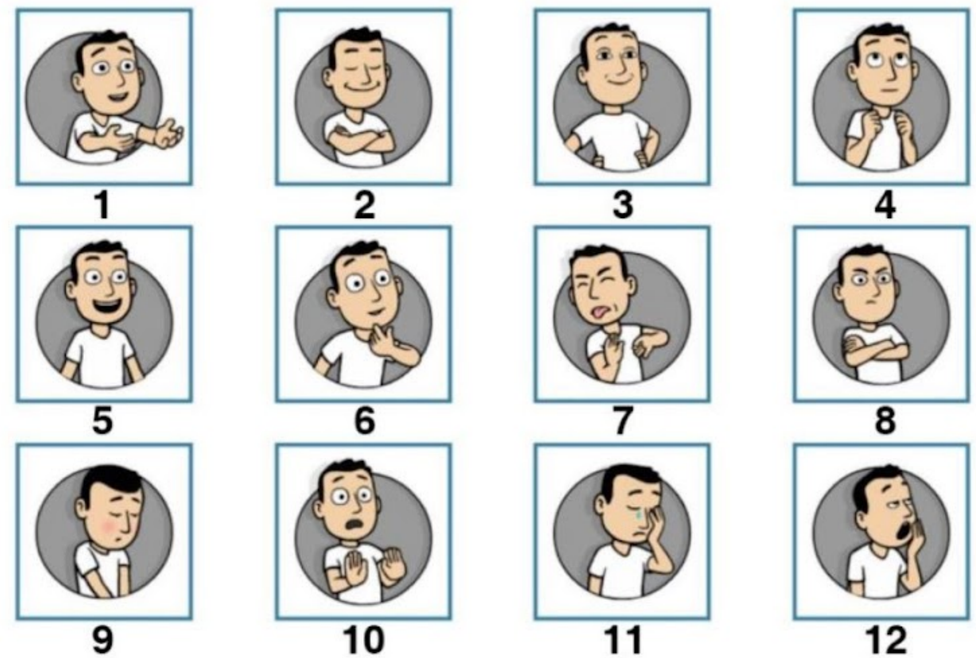
19. What are your thoughts on the first part of the experience? *

20. I would characterise this part as (top 3)... *

Markeer slechts één ovaal per rij.

	playful	engaging	educational	free	surprising	casual	social
#1							
#2							
#3							

21. The following PrEmo represents my feeling towards Part 1 best: *



Markeer slechts één ovaal.

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12

22. I rate this part... *

Markeer slechts één ovaal.

	1	2	3	4	5	
not intuitive at all	◯	◯	◯	◯	◯	very intuitive

23. During this part I enjoyed the most... *

Markeer slechts één ovaal.

- ◯ the digital interaction
- ◯ the walking around the object
- ◯ the AR effects
- ◯ the surprise elements
- ◯ the new things i learned
- ◯ Anders: _____

24. During this part I disliked the most... *

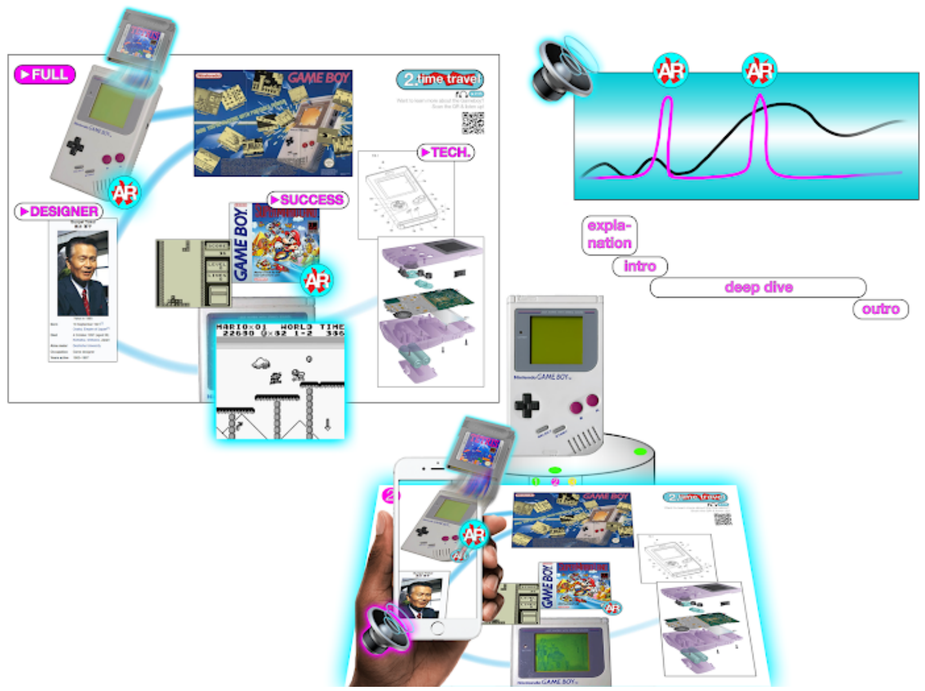
Markeer slechts één ovaal.

- ◯ the prototype was not working perfectly
- ◯ time, it felt like it took too long
- ◯ I did not understand what to do
- ◯ It was too difficult to use
- ◯ Anders: _____

Part 2: time travel

This section specifically is about the second part of the prototype experience

Part 2: time travel



25. What are your thoughts on the second part of the experience? *

_____

_____

_____

_____

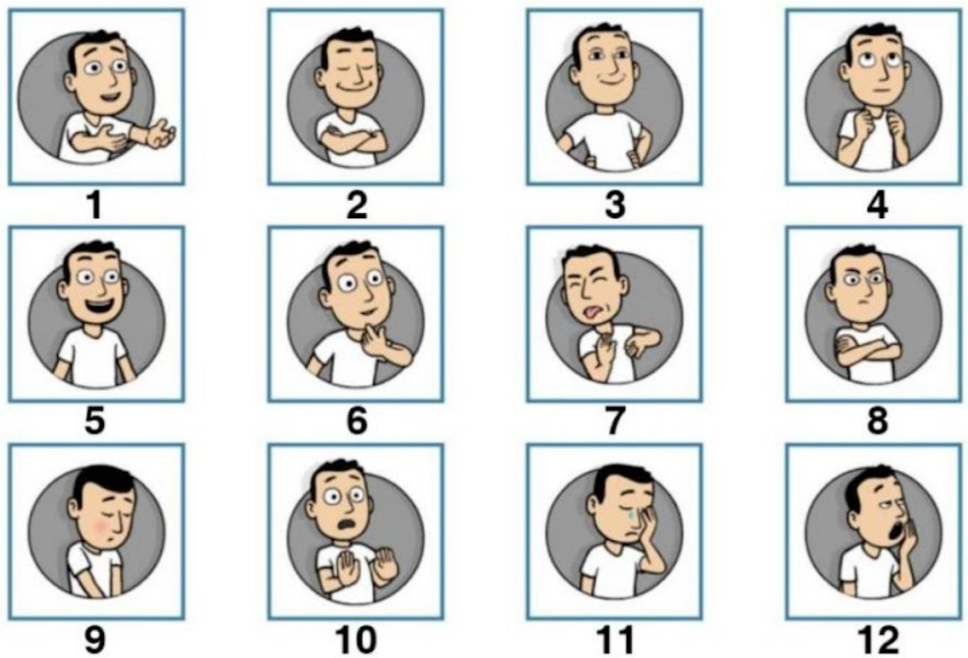
_____

26. I would characterise this part as (top 3)... *

Markeer slechts één ovaal per rij.

	playful	engaging	educational	free	surprising	casual	social
#1	◯	◯	◯	◯	◯	◯	◯
#2	◯	◯	◯	◯	◯	◯	◯
#3	◯	◯	◯	◯	◯	◯	◯

27. The following PrEmo represents my feeling towards Part 2 best: *



Markeer slechts één ovaal.

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12

28. I rate this part... *

Markeer slechts één ovaal.

	1	2	3	4	5	
not intuitive at all						very intuitive

29. During this part I enjoyed the most... *

Markeer slechts één ovaal.

- the digital interaction
- the audio
- the AR effects
- the surprise elements
- the new things i learned
- Anders: _____

30. During this part I disliked the most... *

Markeer slechts één ovaal.

- the prototype was not working perfectly
- time, it felt like it took too long
- I did not understand what to do
- It was too difficult to use
- Anders: _____

Part 3: tought tower & disc

This section specifically is about the third part of the prototype experience

Part 3: tought tower & disc

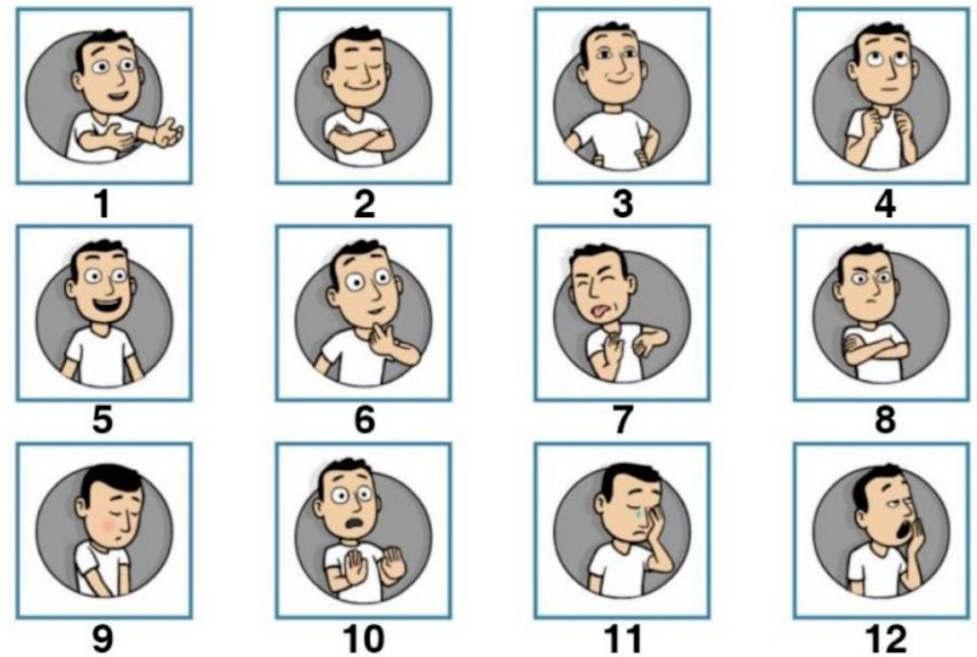
31. What are your thoughts on the third part of the experience? *

32. I would characterise this part as (top 3)... *

Markeer slechts één ovaal per rij.

	playful	engaging	educational	free	surprising	casual	social
#1							
#2							
#3							

33. The following PrEmo represents my feeling towards Part 3 best: *



Markeer slechts één ovaal.

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12

34. I rate this part... *

Markeer slechts één ovaal.

	1	2	3	4	5	
not intuitive at all	◯	◯	◯	◯	◯	very intuitive

35. During this part I enjoyed the most... *

Markeer slechts één ovaal.

- ◯ the digital interaction
- ◯ the tought tower part, writing/drawing
- ◯ the disc AR effects
- ◯ the surprise elements
- ◯ the new things i learned
- ◯ Anders: _____

36. During this part I disliked the most... *

Markeer slechts één ovaal.

- ◯ the prototype was not working perfectly
- ◯ time, it felt like it took too long
- ◯ I did not understand what to do
- ◯ It was too difficult to use
- ◯ Anders: _____

Wrapping it up

37. My top 3 of the parts is... *

Markeer slechts één ovaal per rij.

	Part 1:circle-circle	Part 2: time travel	Part 3: tower & disc
#1	◯	◯	◯
#2	◯	◯	◯
#3	◯	◯	◯

38. I am... *

Markeer slechts één ovaal.

- ◯ a cool person
- ◯ a very cool person
- ◯ super-ultra-crazy cool person

39. If you have any ideas to add, improve or change. I would...

_____

_____

_____

_____

_____

THANK YOU :) !!

don't forget to hit send ;)

you did it!!

http://youtube.com/watch?v=JveEvjddOpA