ENHANCING MUSEUM EXPERIENCES

A conceptual design framework
for tech-enabled visitor experience
enhancement of museum exhibitions

Bas Leferink

Thesis
Enhancing museum experiences: A conceptual design framework for tech-enabled visitor experience enhancement of museum exhibitions.

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MSc Strategic Product Design
Faculty of Industrial Design Engineering
Delft University of Technology

Author
Bas Leferink

Supervisory team
Dr. Cankurtaran, P.
Dr. ir. Elkhuizen, W.S.

Current Obsession (partner organisation)

Executive summary

Visiting a museum is not only about the unique collection or the information available. Visiting a museum is about the visitor. Without them, what would be the point of putting a collection on display? Exhibitions are only as relevant as they are experienced to be.

In line with this thought, the graduation project presented in this thesis centres on design for museum visitor experience enhancement. Specifically, the usefulness of digital technologies in allowing visitors to experience a museum in new valuable ways is focused on as an emerging key driver for museum experience design. A conceptual framework was proposed for (re-)designing museum exhibitions to expand the visitor experience, enabled by technological add-on features. The applicability of this guiding framework by exhibition designers in the field was illustrated with a proof of concept, developed for the case of a fictional museum exhibition on pre-Columbian adornment artefacts.

These results were achieved through a design process consisting of phases of contextual research, practical research, development, evaluation and discussion.
In the contextual research phase, the involved stakeholders were identified and described, and studies were conducted on the principles of museum experience, the potential uses for digital technologies in enhancement, the role of gamification in effectuating visitor participation in tech-enabled learning interactions, the state of the art of digital technologies considered for the development of add-on features, and finally the financial confines and dependencies to development typical for the museum sector.
The practical research activities, these being an observational study in a museum and a generative session with museum visitors, served to validate prior findings and complement these with additional insights gathered.
The proposed conceptual design framework and corresponding proof of concept would be developed through a bottom-up 'Research through Design' process, iteratively building upon knowledge acquired through progressive development.
The proposed designs would be evaluated with the involvement of target stakeholders, contributing to further validation of the proposed designs as well as additional considerations for concept design processes. Further recommendations for development of the proposed designs and for exhibition design more generally, as well as the limitations of the study presented in the thesis, are presented as a follow-up.
The project was concluded by stating the need for the proposed framework to be used by exhibition makers in real-life design settings in order to learn more about potential adjustments to the framework to better support exhibition design processes.

Contents

1. Introduction

Ideally, visiting a museum is an activity for young and old, for people with a casual interest or a big fascination. Countless different museums exist to cater to countless different interests. While recent decades have seen the function of museums develop "from being about something to being for somebody" (Weil, 1999), the general reputation of museums may not reflect that. If you were to ask a random person on the street what they think about museums, would you consider "boring" to be a surprising answer?
While it is also not hard to imagine there being a museum out there for anybody with content that has the potential to interest or even 'wow' them, not all museums exhibit their content in a manner that fully captures that potential. A historical artefact behind glass accompanied by a descriptive sign simply cannot capture the full extent of the object's original function and meaning in the society that made and used it.

This design project is focused on finding ways to improve how visitors can experience a museum and its contents, addressing the traditional elements of exhibition design that may still embody the persistent legacy of the "boring" museums of the twentieth century. Especially the role that modern-day digital technologies may play in unlocking museum exhibits' potential to interest people is explored.

The goal of answering the question of how tech-enhanced museum experience enhancement might be served by the field of design was established in dialogue with the collaborating partner involved in this project: Current Obsession.
Current Obsession (CO), a jewellery magazine and platform based out of Amsterdam, is dedicated to contemporary adornment. In their own words, “the word ‘adornment’ is used as a larger concept to describe key cultural and personal signifiers that include jewellery, fashion artefacts, digital means of self-enhancement, body modifications, make-up and drag art — constantly expanding and upgrading the perception of what jewellery is, currently”. CO had singled out pre-Columbian adornment artefacts as an interesting and suitable case for the development of a novel experience product.
With regards to this project, CO was interested in finding new ways to have exhibitions tell the stories of historical jewellery and the cultural heritage it represents. Their vision is to build connections between historical jewellery and contemporary functions of adornment; to influence modern adornment practices, put the legacy of cultural heritage into perspective and add to historical artefacts’ contemporary relevance.

1.1 - Assignment

From the outset of this project, the museum sector's need to create more value for museum visitors in how they experience exhibited content was recognised, and an opportunity was identified in establishing how digital technologies might be effectively leveraged to enhance visitors' experience of a museum and its exhibitions. For this opportunity space to be exploited across the museum sector, a generally applicable design approach would be required.
As such, a conceptual design framework for tech-enabled museum experience enhancement was to be delivered in this project, supplemented with a showcase of applied concept development.

1.2 - Scope

Though this project’s aim was to propose a conceptual design framework that might support improved practices in museum and exhibition experience design sector-wide, the full extent to which the framework might support different scenarios of exhibition design could not be validated, due to the limited duration and scale of the project.
Applied concept development, simulation and evaluation remain limited to the case of a fictional museum exhibition within the realm of adornment artefacts from the pre-Columbian Americas. Though ideally the conceptual design framework would have been validated optimally by implementing multiple museum experience concepts in corresponding real-life exhibition settings, there were too many limiting constraints for this to fit within the scope of this graduation project. For the sake of feasibility this project remained confined to demonstrating a proof of concept.

2. Contextual research

To illustrate the design context of this project, this thesis chapter presents the involved stakeholders that were identified, as well as the resulting outcomes of studies conducted on the principles of museum experience, the potential uses for digital technologies in enhancement, the role of gamification in effectuating visitor participation in tech-enabled learning interactions, the state of the art of digital technologies considered for the development of add-on features, and finally the financial confines and dependencies to development typical for the museum sector

2.1 - Stakeholders

This section serves to introduce the different parties involved or impacted by the project and its outcomes, and explain to what extent and in which manner they were important to the design process.

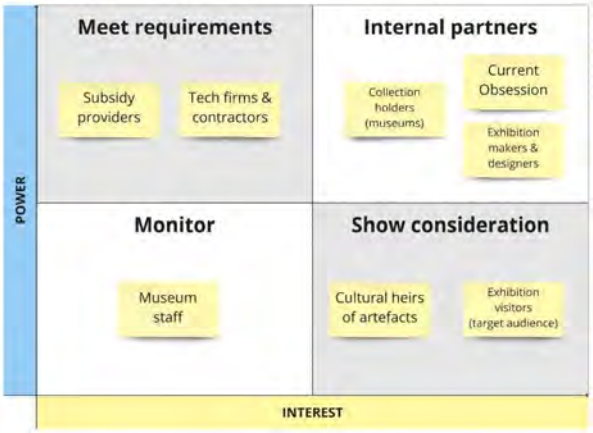


Figure 1: the key stakeholders mapped out on a power-interest matrix (as introduced by Newcombe, 2003), showing their role and stake in relation to the product.

Current Obsession & other exhibition makers/designers

The first stakeholder to mention is the partner of this project, Current Obsession (CO), envisioned in the role of exhibition designer. The proposed strategic design framework is to be exploited by CO as a service-product; implementing this model for client partners is to be part of their (semi-)commercial activities. For this reason, an important precondition for this project was to hold dialogues with CO, making sure to steer the direction of the project as mutually determined, and to inspire and enable the further development of their vision for (pre-Columbian) exhibitions.

The conceptual design framework would also be intended for potential adoption by other exhibition makers across the museum sector. In order to deliver a framework that would in fact cater to the needs and desires of this stakeholder for exhibition design, close involvement in the development process would be necessary.

However, any opportunities for CO, or any exhibition designer for that matter, to apply the proposed strategic design framework are largely dependent on another stakeholder: the holders of artefact collections, and the business they operate in.

Collection holders (museums)

Not having access to original artefacts that constitute the subject-matter of an exhibition complicates efforts to design an enhanced exhibition experience around that subject-matter, so in practice a collaborative partnership between collection holders and CO seems necessary for the implementation of the value creation strategy. With a few exceptions, the

holders of artefact collections are almost always museums. Since CO's service-product would be aimed at enhancing the visitor experience of exhibitions and museums are in the business of selling access to their exhibitions to visitors, a partnership would make sense for both stakeholders, but it is important to ensure both parties' commercial interests stay aligned. Naturally, similarly constraining circumstances concerning budgets and permissions may apply for a museum's own exhibition design staff as well as for independent exhibition makers.

Exhibition visitors (target audience)

Arguably the most central stakeholder to the design of the product are the visitors of the museum experience that is to be enhanced with CO's product; the 'end experiencers'. It is these people on which a museum in turn depends for their commercial activities, private donations and their general raison d'être as a contemporary, partially publicly funded institution (see also section 2.5)

Thus, the proposed framework revolves around creating a more valuable experience for museum visitors. However, what adds value to a visitor's experience can differ depending on which type of visitor audience is considered. The most critical audience for museums to appeal to in the present and looking towards the future, and thus the most logical target audience, are young adult museum enthusiasts (aged around 20 to 30).

This demographic is often highly educated, as is typically the general majority of museum visitors (Daskalaki et al., 2020). Notably though, young people are commonly a minor demographic of museum visitors (Brida et al., 2016), while less so of the general population; this means museums could effectively add a large percentage of visitors to their count if they were to attract more (potential) young museum enthusiasts. Moreover, Brida et al. (2016) point out that higher levels of investment directed specifically to young people are likely to increase visitor flows, implying a higher return on the museum's commercial activities. Besides, capturing a larger share of young people as visitors is not only a sound commercial focus in the present, but also in the future, as the young people of now will remain an important demographic in decades to come (Farrell & Medvedeva, 2010). Generally visiting as experience seekers and explorers (Falk, 2016), they are also key to attract as part of many museums' present-day mission to serve a broader purpose than only serving as a centre for collecting, preserving and exhibiting knowledge (Brida et al., 2016; Farrell & Medvedeva, 2010).

Considering the relatively small share of young visitors, young people have thus proven difficult for museums to attract and satisfy. They generally prefer highly participatory forms of cultural engagement (Farrell & Medvedeva, 2010) and expect to be able to interact with and be part of exhibitions, while they also tend to cherry pick from everything on offer at the museum (Brida et al., 2016). Besides, as general early adopters of technological innovations (Farrell & Medvedeva, 2010), young people can be considered the most critical benchmark demographic to focus on when implementing novel technologies to enhance an exhibition experience.

The elderly demographic meanwhile, from which one might expect to see the most aversion towards a shift to interactive digital technology, also perceives its implementation

as a factor that contributes positively to an enjoyable experience (Herron & Jamieson, 2020). Older visitors, who more commonly visit museums as facilitators (Falk, 2016), also think it is important for a museum to make the content engaging both for themselves and for younger generations (Herron & Jamieson, 2020).

These findings suggest that the implementation of exhibition features that successfully enhance the experience of young people is also likely to have a generally positive effect on the experience of older generations.

Further analysis of this key stakeholder, through observational studies (section 3.1) as well as a generative session (section 3.2), provided deeper insight into the target audience's tendencies, experiences and desires regarding exhibitions.

Subsidy providers

As elaborated upon in detail in section 2.5, development project finances are largely driven by funds, donors and other sponsoring institutions. For an exhibition proposal to be implemented, it is essential to meet the necessary conditions for financing eligibility.

Technology developers & contractors (3D scanning, VR/AR, 3D printing)

In light of the proposed use of novel technologies for the enhancement of museum experiences, providers of this technology are also considered as indirect stakeholders. Any adjustments to existing solutions or a completely new application of a technology to enable implementation in an exhibition context would have to be facilitated by a party with the relevant expertise.

To gain an overview of the latest advances in the fields of the novel technologies deemed most likely to be relevant, the current limitations within the industry and the ends to which certain technologies may be applied in museum experience enhancement, an study of the technological state of the art was conducted; these findings are presented in section 2.4,.

Cultural heirs (of contested heritage collections)

Cultural-historical artefacts (e.g. pre-Columbian jewellery) are products of societies that, to varying degrees, still live on to this day. Descendants of native peoples often still practise certain customs and live by certain values that are rooted in those of their ancestors.

These people should be recognised as important stakeholders whenever topics such as cultural continuity and sensitivity emerge; their stances on the subject-matter are culturally valid and should be taken into consideration, while involving them in content creation may be key to providing appropriate context to exhibited artefacts.

Museum staff

The people that run a museum on the ground, notably conservators, technicians and service agents, will be involved in managing any implemented exhibition concept for visitor experience enhancement. Their first-hand expertise in shaping and running the museum experience might be valuable in a development process, while their required role in enabling an enhanced museum experience should also be taken into account.

2.2 - Study on museum experience and applicability of digital technologies

In order to grasp more comprehensively what would need to be considered with regard to focus established at the outset of this project, academic notions of museum visitor experience and the usefulness of digital technologies in a museum context were studied in depth.

Museums' evolved mission & value proposition

The first concepts that can be described as early museums (Lewis, 2015) came to be when affluent private collection holders started putting their collections on display in galleries or cabinets of curiosities and made publicly accessible (Wilkens, 2011). The museum existed primarily in service of its collections, not its visitors (Hudson, 1998). Generally small numbers of people would come to observe and admire the collection of which the museum was the custodian; for fulfilling their duty of conserving the collection a museum was adequately funded by the government, or in some cases by its private founders (Hudson, 1998).
However, direct funding of the cultural sector could not keep up with the enormous increase in the number of museums and expansion of their activities during the twentieth century, forcing museums to attract other sources of funding (Weil, 1999). Moreover, museums also had to adapt to changes in societal norms and standards, which made public funding increasingly conditional to the public merit provided by the recipient (Weil, 1999).

Thus, the museum sector gradually shifted towards its contemporary role, as described by Desvallées & Mairesse (2010, p. 57): "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". Heralding this shift in 2007, the International Council of Museums (ICOM) redefined the mission of a museum as being visitor-centred in the first place, rather than solely conservation-centred (Vaz et al., 2018), and explicitly reinforced museums' leisure and educational purposes in its most recent definition (Sandahl, 2018; Chen et al., 2021). Redefining and enhancing exhibition spaces has thus been on museums' agenda for the better part of two decades, and museums' emphasis on providing visitors with an attractive learning experience is now greater than it ever was (Pastore, 2021).

Museum visitor experience enhancement

Enhancement, as definable for the field of cultural heritage and museum management (Simone et al., 2021), is "a wide function that includes all activities that aim to increase or improve the value, quality, desirability, or attractiveness of tangible and intangible heritage of humanity and its environment preserved in museums.". With successful enhancement of a museum experience, the exhibited collection serves as input for providing services that enable visitors to more comprehensively grasp the value of cultural objects, and apply that understanding to personally relevant situations, before, during and after their visit (Simone et al., 2021).
More concretely, the aspects of a visit that can be addressed to influence how a visitor's stay unfolds in a way that enhances their experience of the museum include guidance, visitor flows between spaces, modes of acquiring information, and the buildup of 'museum fatigue' (Davey, 2005; Ciasullo et al., 2016).

The proliferation of digital technologies in museums

Many museums turned to implementing digital technologies for interactive and more communicative elements, in an effort to achieve a more meaningful museum experience and attract and engage more visitors (Chelini, 2012; Bitgood, 2013; Mason, 2013; Witcomb, 2015; Vaz et al., 2018), especially young people, whose interest and attendance had long been in decline (Marketing Museums to Millennials, 2010). While it was quickly established that digital technologies had great enabling potential, initially the sector was mostly unsuccessful at leveraging this potential in a way that added value to the content as experienced by visitors (Hall, 2013; Ciasullo et al., 2016). Still today, learning how to apply technologies in ways that enhance information, communication, education and enjoyment is still an ongoing issue in the museum sector (Daniela, 2020; Simone et al., 2021).
Franklin and Papastegiadis (2017) attribute the struggle of many museums to build a valuable experience to a widespread, primarily top-down approach to learning, which they define as an "ancient and culturally paternalistic form of 'educational recreation' that appeals only to a very narrow segment of the educated middle classes".
Oftentimes, all visitor 'interaction' is merely reactive to what the museum pushes them towards; this lack of a bottom-up process, in which visitors co-create added value to their experience, limits the impact digital technologies can have to enhance the museum experience (Simone et al., 2021).

The enabling potential of digital technologies has shown to be put to better advantage following a more constructivist approach, in which not the knowledge dictated by the museum, but visitors' active participation in building their own knowledge through their personal experience is central (Mygind et al., 2015; Pastore, 2021). Using technology to transform visitors from passive consumers to active participants involved in co-creating their own experience has in fact been at the core of the museum sector's increasing success at enhancement (Kraemer, 2018).
In the last decade, more and more museums have indeed succeeded at finding ways of implementing digital technologies as tools to appropriately support and enhance identified critical elements of the visitor experience (Cerquetti, 2014; Devine & Tarr, 2019; Giannini & Bowen, 2019).

Value co-enhancement using technologies as tools for authentic visitor experiences

It is the implementation of technologies as tools and not as ends which is fundamental to their usefulness in value creation (Olesen, 2016; A. Mol, personal communication, October 2021: Appendix A). Naturally, enhancement requires an existing value proposition to be enhanced. For museums, a key concept at the core of their value proposition and a measure by which a museum experience can be fundamentally distinguished from other modes of leisure and education, is authenticity (Thyne & Hede, 2016; Evrard & Krebs, 2018).
While Evrard & Krebs (2018) strongly rejected virtual elements as a substitute for direct contact with genuine artworks, they also validated physical and digital elements of the experience as complementary, with digital elements adding value and enhancing the 'real' experience through the creation of an additional dimension to the experience.

Digital elements of an exhibition can serve to elaborate more effectively upon authentic artefacts, and need to refer to the original thing in some way to have any relevance; however, the authenticity of a museum experience encompasses more than only the notion of exhibited objects being genuine and original (Thyne & Hede, 2016). While an original artefact, which may be perceived as impressive and stimulate interest for being 'the actual thing', would be considered 'indexically' authentic, this original may also be understood and experienced through a manifestation that resembles it, which would be 'iconically' authentic (Peirce, 1998; Grayson & Martinec, 2004). The Archeon Museum Park in the Netherlands, a living history museum centred around enactments of several historical ages and places, can be seen as a good example of an authentic experience in the iconical sense. The experience can be perceived as authentic by visitors because they feel like they are present and participating in 'the real thing', even though every single object and element there is replicated. Museums can indeed create or augment authenticity as experienced by visitors through their active involvement and participation in activities (Wang, 1999), and though seeing an indexically authentic artefact might make visitors feel more impressed or mindful (Thyne & Hede, 2016) than an object replica in and of itself would, iconically authentic participatory aspects of an experience have been reported to induce affective responses and be most memorable (Baron et al., 2001).
Counts (2009) and Thyne & Hede (2016) support that, in service strategies for visitor experience enhancement, elements perceived as indexically authentic and those perceived as iconically authentic can best be employed in synergy with one another.

Considering the avenues for usefulness of digital technologies in experience enhancement in this light: while they can aid to better communicate the indexical authenticity of an exhibited artefact, their main usefulness for experience enhancement appears to lie in their potential to facilitate visitors' personal involvement and active participation in an iconically authentic narrative, allowing them to co-produce their experience to be more valuable, albeit with a need for sufficient guidance throughout to help any hesitant visitors overcome the confusion or reservations they might have with regards to participating (Thyne & Hede, 2016).

Need for a strategic approach to technological enhancement of museum experiences

If technological features are integrated with the appropriate aim to enhance a specific element of the museum experience, results can be achieved in ways that traditional exhibition features may not enable; technological features may allow for solutions that are compact, responsive, flexible, mobile and multimedia (Simone et al., 2021). As for the areas that such features may serve to enhance, Hazan & Hermon (2015) proposed a framework for the implementation of participatory communication nodes in museums; they highlight interactions, storytelling, personalisation of the experience, more informational depth and a more coherent exhibition as suitable aims for which to implement technological solutions effectively.

Whatever the enabling potential of a considered technological tool might be for enhancing a certain element of the museum experience, such tools can only be effective if applied in coherence with other features and the exhibition content, following a strategy and action plan that match the museum's initial starting point, objectives and informed choices with respect to audience development (Carci et al., 2019). In turn, whoever the targeted audience might constitute, an understanding of their needs and expectations is key to the development of applications for which these technological tools are implemented (Mohd Noor Shah & Ghazali, 2018).
Since achieving coherence between touchpoints is vital for the enhancement of the visitor experience, and since the means of communication to visitors as well as the needs of visitors change continuously throughout their experience, an action plan should build upon a holistic understanding of the experience journey from start to finish and the role of touch points that characterise different moments (Varvin et al., 2014). Using 'the journey' as a metaphor in the context of museum design, Varvin et al. (2014) described the 'physical journey' and the 'mental journey' to distinguish insights related to visitor activities and touchpoints as opposed to insights concerning visitor needs and sentiments. They outlined the visitor journey along three stages: before, during and after the visit.
The projected visitor journey of this project's proposed concept example was also described by means of the 'journey map' design tool (adapted from Van Boeijen et al., 2014; Varvin et al., 2014), presented in (see section 5.4.1). In it, the dissected elements that constitute both the 'physical journey' and the 'mental journey' are presented distinguishably.

2.3 - Study on gamification for effective feature design

Having elaborated upon the relevance and usefulness of digital technologies for exhibition experience enhancement through the enabling of participatory activities, it was subsequently deemed appropriate to zoom in on how to approach designing interactive touchpoints to optimal effect.

Visitor motivations to participate

Yiannoutsou et al. (2012), distinguished two types of participatory activities relevant to the area of museum experience design: firstly for visitors to give input with user-generated content; secondly to involve visitors in processes of creating 'meta-artefacts', with games and stories based on the exhibited content. The latter is considered most applicable when it comes to enhancing how pre-existing museum content is experienced. However, independent of the degree of interactivity enabled with a technological feature, for an activity to be approached with higher levels of interest, the way it is formulated needs to evoke a motivation for visitors to participate (Deci & Ryan, 2000).

To make the concept of motivation more tangible, eight core drivers of motivation, which influence people's willingness to engage in performing a task, can be identified in the Octalysis model (Chou, 2019):

1. *Higher meaning or calling*
2. *Development and accomplishment*
3. *Creativity and feedback*
4. *Ownership and possession*
5. *Social influence and relatedness*
6. *Scarcity and impatience*
7. *Unpredictability and curiosity*
8. *Loss and avoidance*

Usefulness and benefits of gamification in museums

Precisely games and game elements, identified as being so suited to the aforementioned category of participatory activities that involves the creation of 'meta-artefacts' (Yiannoutsou et al., 2012), can be excellent instruments in motivational strategies for activating and retaining engagement (Huotari & Hamari, 2011; Burke, 2016). Games can lead people to be more interested, competitive, cooperative, result-oriented, inquisitive and solution-seeking, attitudes which are all beneficial to learning processes (Prensky, 2003). The application of game elements and game-design techniques in non-gaming contexts, such as museums, to improve user experience and engagement, is defined as gamification (Deterding et al., 2011).

Especially younger generations that have grown up with video games, which generally have higher expectations when it comes to what engaging should provide them with and how their experience should be shaped (Zichermann, 2011; Brida et al., 2016), are most receptive to game-like interactions and experiences (Cook, 2013). Catering to this crucial visitor demographic (identified in section 2.1) is thus a valid motive for museums to turn to gamification.

In fact, gamification has already been proven to be an effective method for raising visitor motivations to participate in educational museum activities (Kristianto et al., 2018; Nofal et al., 2020). Specifically, Nofal et al. (2020) found that gamification can effectively promote visitor motivation in processes that involve "constructing personal meaning, making choices about goals and engagement, adjusting challenges, taking responsibility and control for self-directed learning, and collaborating for joint goals and teamwork". Considering this, the motivating benefits of gamification may be expressed in several aspects of visitor interaction, helping to shape the visitor experience.

Firstly, gamification, especially interactive question-based games, can be an impactful tool for drawing visitors' attention towards a specific piece of subject-matter (López-Martínez et al., 2020).

Once a visitor is engaged, the need to get used to a new game may initially lead to lower learning effectiveness, though this is quickly compensated thanks to the continuous engagement retained by the visitor through their participation (Kim & Lee, 2015).

Peer cooperation and competition, which gamified interactions may promote, can contribute to visitor engagement being retained (Men et al., 2019). Perhaps even more notably though, continuous engagement can be stimulated by a sense of ownership created through gamification, making visitors accountable for completing the game; this sense of ownership can be achieved by giving visitors personal physical tokens for them to use in interactions or by having them create such tokens themselves, and can be expanded to encompass a larger part of their journey by requiring these personal physical ftokens to be used at several interaction points throughout an exhibition (Nofal et al., 2020).

Such a scenario for more holistic enhancement of the visitor experience lines up well with another potentiality for gamification highlighted by Yiannoutsou et al. (2012), who suggest implementing gamification elements throughout an experience to support visitors in making connections between the different exhibited artefacts and the overarching concepts, beliefs and narratives that tie them together as one coherent exhibition. Jeon et al. (2020) also support directly that gamification of a museum exhibition with technological features, in a way that delivers involvement in a leading storyline, can make the visitor experience more enjoyable.

To further influence visitor behaviour in a manner that guides visitors through a coherently designed experience, a fundamental principle of game design can be implemented: creating artificial conflicts within interactions by giving out rewards and punishments on the basis of a player's (non-)compliance with quantifiable constraints (e.g. correctness, accuracy, time) (Salen & Zimmerman, 2004; Nofal et al., 2020). Such a conflict can be competitive in nature, between two or more players, or puzzle-like or collaborative, between the player and the game challenge itself.

Rewards to be attained in a gamified experience should be immediate upon the completion of a goal (e.g. receiving a collectable item for figuring out a riddle), but the completion of a series of intermediate goals should also add up to the achievement of an overarching learning objective and reward (e.g. gathering relevant insights by completing

a quest to deliver a complete set of collectable items and unlocking special access to an additional exhibition space); small intermediate rewards, even if non-educational, can be an effective way of retaining visitor motivation and building up anticipation for the experience's overarching learning objectives (Nofal et al., 2020).

Considerations for effective gamification design in museums

If not properly designed, gamification and other strategies of using digital technologies aimed at enhancing an exhibition experience may lead to spectacularisation, trivialisation and 'disneyfication' of the exhibited content, generally sacrificing education for superficial entertainment (Balloffet et al., 2014; Vistisen et al., 2019).

To aid educators (i.e. exhibition makers) in designing gamification to effectively support the subject-matter, Tu et al. (2015) proposed a model based on four pillars, summarised as follows:

1. *Goal Setting*
   The gamification should be outlined by meaningful learning objectives and instructions; it should be identified what the intended goal of implementation is and what visitor behaviour should ideally be effectuated.

2. *Player Engagement*
   The gamification design should integrate elements that can promote intrinsic motivation, as well as elements that can promote extrinsic motivation, accounting for the different motivational patterns of the four different game player characters that people can assume (Bartle, 1996; Kim, 2012). Which motivational pattern is most relevant depends on the nature of the gamified interaction in question and the role that the player is expected to fulfil. The four game player characters and their motivational patterns are:
   - *the achiever*, motivated by gathering points, completing challenges and 'beating' the game;
   - *the explorer*, motivated by discovering and trying out everything there is to a game context;
   - *the socialiser*, motivated by the social interaction with others that a game facilitates;
   - *the killer*, motivated by opportunities to 'beat' other players and compete to be the best.

3. *Progressive Designing*
   The gamified interactions should be formulated in line with a core engagement loop of motivation, action and feedback (Kim, 2011), from '(social) call to action', to 'player (re)engagement', to 'visible progress' to 'positive emotion'. Also, the complexity of challenges should be built up gradually; they should be simple to start participating in.

Figure 2: The core engagement loop for gamified interactions, applicable for progressive gamification design (adapted from Kim, 2011).

4. *Environment Building*
   Visitors should be engaged in an interpersonal environment, in such a way that a person's actions and accomplishments can be personally related to a sympathisable character or other participating visitors.

Furthermore, when considering the different possibilities and requirements of specific gamification elements within a game system, three types need to be accounted for, as defined by Werbach & Hunter (2012), namely 'dynamics', 'mechanics' and 'components'.

- *Dynamics* are the themes within the overarching structure of a game system that shape how a player will progress throughout the game and what drives them to do so. Each of the eight drivers of motivation, defined in the aforementioned Octalysis model (Chou, 2019), can be regarded as a basis on which to employ a dynamic (Chuah, 2021). Examples of common dynamics are a narrative, progression or constraints.

- *Mechanics* are concepts that drive the processes and activities through which player interactions are enabled in a game system. Many game mechanics exist which vary widely, from resource management, trading and collecting, to navigation, role-playing, feedback, rewards and penalties, to turn-taking, collaboration and competition, to give a range of examples.

- *Components* are the tangible game features used to implement the desired mechanics and dynamics. There are countless game components, but prominent examples include quests, avatars, virtual item inventories, puzzles, unlockable content, upgrades, teams, points and leaderboards.

The aforementioned four pillars (Tu et al., 2015) and the three types of game elements (Werbach & Hunter, 2012), may be applied, respectively, as the guidelines and toolbox for effective gamification design; the gamification system designs featured in the concept proposal of the project presented in this report (section 5.6) exemplify these guidelines and key elements being accounted for, as do the examples shown in figures 3, 4 and 5.

Figure 3: The online multiplayer role-playing game RuneScape features an elaborate interactive trading system (image source: RuneScape Wiki, n.d.).
The components 'merchant', 'item inventory', 'option selection' and 'price' facilitate the mechanics 'resource exchange' and 'asset value', which in turn contribute to the dynamics 'scarcity', 'ownership' and 'progression'.

Figure 4: In the single-player strategy game Empire: Total War, within the interactive diplomacy system, the mechanics 'negotiation' and 'feedback' are achieved through the components 'counteroffer' and 'envoy comment' executed by AI-controlled factions (image source: HeavenGames, n.d.).

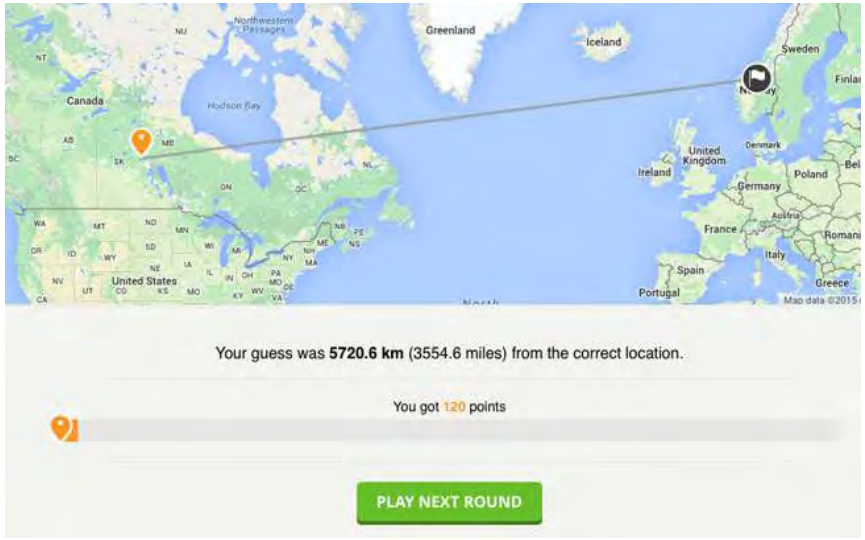


Figure 5: In the internet game GeoGuessr, points are awarded based on the proximity of a random place's guessed location on the map to its actual location; the more points a player accumulates within five rounds, the higher their placement on the worldwide leaderboard (image source: Buczkowski, 2015).

2.4 - Study on the state of the art of digital technologies

Having established what sort of experience elements and interaction dynamics and mechanics should be pursued in exhibition design, the technological tools with which such intended interactions could be enabled were to be considered accordingly.

The aim of this study was to build informed awareness of the extent to which the considered technologies may or may not be able to fulfil a valuable function in exhibition enhancement, to aid in subsequent design activities, as part of which it would be necessary to identify existing and think up new promising technological applications for museum experience enhancement

The technologies considered in this study were included in light of their emerging relevance to content creation in recent years. Ongoing explorations of potential applications for these technologies in the museum sector have also been researched and documented.

2.4.1 - Digitalisation & modelling

Digitalising an artefact is the first step towards any experience that includes a model of the artefact, be it a digital or physical one. Since many museum artefacts are uniquely handmade and may also be very intricate, such as is the case for most pre-Columbian jewellery, a model of an artefact that communicates its authentic visual qualities effectively requires a high degree of accuracy.

A modelling technology, which has seen recent developments that were deemed relevent to highlight in this study, is 3D scanning. 3D scanning allows for the creation of digital models with maximal accuracy, directly copying the dimensions of the original. For the purposes considered in this project, some 3D scanning techniques may be preferable over others though.

CT scanning machines can produce the most accurate 3D scans (Bergner, 2019), but scanning an artefact that combines metal and organic material might result in distorted data which is difficult to process. Besides, CT scanning machines are not portable, meaning any scannable artefact would have to be transported to the machine, something collection holders might not be enthusiastic about.

Portable 3D scanners offer a more suitable alternative. There is a great variety of 3D scanners for a wide array of purposes, but the most suitable for scanning jewellery artefacts are those with the highest accuracy and resolution. Scanners like the Artec Micro and the Solutionix D700 are the current top of the line, and specifically cater to jewellery scanning (O'Neill, 2022). The supported object size of these scanners is large enough for most contemporary jewellery, but too small for many pre-Columbian jewellery artefacts. In this case, handheld scanners like the Artec Space Spider offer more versatility, while also still retaining relatively high accuracy and resolution.

Even with these 3D scanners, successfully scanning a pre-Columbian artefact could still prove challenging, depending on the reflectiveness of the object's surface. Reflections

distort structured light patterns, leading to invalid measurements by the optical hardware (O'Neill, 2022). Usually this is remedied by coating the object with a matte scanning spray, but this might not be an option for historical artefacts. Non-corrosive self-vanishing scanning sprays do exist (Van Donink, 2019), but it would still be up to an artefact's owner to grant permission to apply it.

While 3D scans of artefacts do not provide much of an experience by themselves, high-precision digital models can serve as input for the implementation of various other technologies in a museum exhibition context.

2.4.2 - Model production

To bypass limitations in interactivity with original museum artefacts, which often need to be conserved carefully and displayed in glass display cases, interactions could instead be facilitated with physical models that allow for personal experiences with original artefacts to be approximated.

Naturally there are several ways to create such a model; for instance, it could be crafted by hand through a process identical to that of crafting an original artefact, or it might be possible to be manufactured with industrial tooling techniques. Most notably in light of the potential applications considered for this project though, additive manufacturing (i.e. 3D printing) methods might open new avenues for model production capabilities in the museum sector.

Applications of additive manufacturing

Additive manufacturing technologies are prevalent in industries that require production on a small scale of highly efficient or customisable parts. On-demand production, often for maintenance and repair, but also for object models and mockups, is another additive manufacturing business product that serves clients in countless industries. The primary industries where 3D printing technologies are applied are medical (for e.g. customised implants), aerospace (for e.g. propulsion system parts, blades), automotive (for e.g. Formula 1 or concept car parts) and energy (for e.g. manifolds, pumps, turbines). In such cases more traditional production methods such as casting or machining are often less cost efficient or technically unable to realise an optimised design (B.J.L. Leferink, March 2022, personal communication: Appendix B).

Another notable niche for 3D printing, and one of the fastest growing sectors for the technology, is jewellery manufacturing. Renowned jewellers like Cartier and Tiffany & Co. have adopted additive manufacturing to produce jewellery pieces with previously unfeasible geometries. 3D printing is generally used to shape resin or wax models for lost-wax casting production. The most advanced high-precision 3D wax and resin printers for jewellery production on the market are those from Solidscape (B.J.L. Leferink, March 2022, personal communication).

For jewellery designs whose shape prohibits lost wax casting as a production method, direct 3D printing through sintering (selectively applying and melting of metal powder) can be a suitable alternative in some cases, though production precision is more limited and a lot of post-processing is required. Only the firm Cooksongold specialises in the 3D sintering of precious metals; jewellery manufacturing is one of the primary applications for their machines (B.J.L. Leferink, March 2022, personal communication).

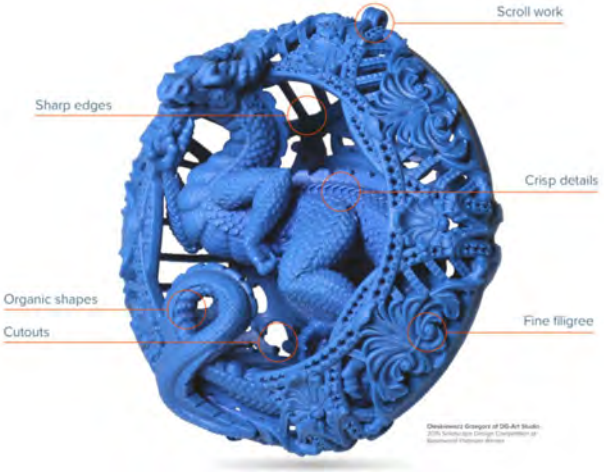


Figure 6: Solidscape 3D printed wax model for lost-wax casting of jewellery pendant (image source: Solidscape, n.d.).

Design considerations for museum sector

A challenge that museums have faced is to expand interactive exhibitions to more high-fidelity sensorial stimulation than only visual and auditory (A. Mol, personal communication, October 2021). 3D printing could serve as a gateway to change this. Regarding the case of pre-Columbian adornment exhibitions: due to the high level of intricacy typical of many pre-Columbian jewellery artefacts and the absence of a need for large-scale industrial replication of these objects, 3D printing could offer a fitting solution for the replication or artistic reinterpretation of artefacts. The pre-Columbian techniques and knowhow of manually replicating such jewellery objects could be recovered and applied, but considering that the only goal would be to present a tangible and actionable model in an exhibition, 3D printing seems like the more viable alternative in most contexts.

Existing applications in museum sector

Some museums around the world have already explored some possibilities of implementing 3D printed models into their exhibition, for example to replicate a tomb to make it accessible or to make objects tangible instead of just viewable (Coates, 2020; Samaroudi & Rodriguez Echavarria, 2019). However, such 3D printed replicas have been made of plastic, and replicas of wearables or otherwise usable objects have not been made

part of any museum exhibition yet. The possibilities that high-fidelity models can offer to enhance how an exhibit is experienced have thus not yet been fully explored.

Figure 7: 3D printed replicas of archaeological artefacts that visitors are allowed to touch, at the Manacor Museum of History in Spain (image source: 3D ADEPT Media, 2018).

2.4.3 - Virtual reality (VR)

Though VR used to be associated primarily with gaming, nowadays the technology is recognised as a valuable tool in countless industries; from training medical professionals, to touring prospective buyers through a house that has yet to be built, to social encounters in the 'metaverse' (Thompson, 2022).

Principles

VR's ability to immerse users in any setting has raised suggestions of its potential to promote empathic responses among users. While the extent of this potential has seen mixed results and much is still unclear (Villalba et al., 2021; Ceuterick & Ingraham, 2021; Shin, 2018; Bang & Yildirim, 2018), and that empathetic potential depends heavily on user traits as well as the developed content (Shin, 2018), an experience of presence and flow has shown to be a strong predictor of empathy and embodiment for VR storytelling (Shin, 2018). Presence can be defined as immersion into a virtual space; flow can be defined as an experience of immersion into a certain user action. Also, immersive VR experiences can make users shift from passive observers to active participants (Dumlu & Demir, 2020; Shin, 2018).

Meanwhile, high levels of user presence, active engagement and immersion in a VR storytelling experience have shown to increase cognitive processing by the end of the experience (Škola et al., 2020).

A VR experience depends on the hardware used. Passive VR experiences only require output hardware, but interactive VR hardware consists of both input devices and output devices. The most specialised input hardware consumer devices today are motion sensors, voice sensors, biometric sensors, eye tracking sensors, sensor gloves, track-pads and nunchuck movement controllers (Howard, 2018; Wang et al., 2021)
The most advanced output hardware as far as immersiveness is concerned are all variations of stereoscopic HMDs (Head-Mounted Displays), specifically headsets that are tethered to computers with cables, wireless headsets, which may be standalone devices or linked to a computer, and mobile-powered headsets, with which a smartphone is inserted into a head-mounted casing and kept at a fixed distance from a lens that distorts the display to create a larger field of view (Wang et al., 2021).

Design considerations for museum sector

The different kinds of HMDs all come with different advantages and drawbacks. Tethered devices offer the highest quality and most complex (custom-made) content, and enable implementation of the most technological features. The main drawbacks of tethered devices are users' limited mobility, the high costs of the equipment and the technical requirements of the computer they are connected to (Wang et al., 2021).

Figure 8: Wired prototype of an 8K VR headset by Sony, intended for business, medical and industrial applications (image source: Fahey, 2021).

Figure 9: Tethered VR headsets used for fixed-location-based entertainment (image source: Academy of International Extended Reality, 2021).

Meanwhile, wireless headsets allow for greater user mobility, and they can also be used without any connection to a computer. However, content creation possibilities for standalone headsets are fully controlled by headset manufacturers and content quality is lower than can be achieved through a computer (Wang et al., 2021). Also, even for headsets that are wirelessly connected to a computer, battery life is a potentially limiting factor to take into account. Wireless headsets are also more prone to theft and damage from being dropped.

Figure 10: Wireless VR headset (Oculus Quest 2) being used for a mixed reality arena-scale multiplayer shooter game (image source: UploadVR, 2018).

The mobile-powered headset is the most accessible, but also lowest quality type of HMD (Wang et al., 2021). Content development is solely dependent on the smartphone operating system, allowing users to install an app on their own smartphone. Cardboard headsets are the cheapest and most limited, while high-end models are more ergonomic and allow for audio connectivity for more immersive sound (Anthes et al., 2016).

Figure 11: Three mobile-powered HMDs: the Google Cardboard, the Samsung GearVR Innovator Edition and the Gameface Mark IV (image source: Anthes et al., 2016).

These solutions all considered, there are also some general drawbacks to the implementation of VR in a museum setting. A main limiting factor in the present day is the current cost of VR equipment and installations, as well as the potentially high cost of content creation, management and upkeep of a VR exhibition. Such high cost could potentially mean that the only feasible way by which a museum would be able to implement a VR exhibition would be for a limited number of visitors and/or with limited content quality (Coates, 2021).
Besides, VR technology developments currently happen so fast that equipment can quickly become outdated (Wang et al., 2021). Though outdated VR technology can still serve to create an experience in a multitude of ways, it is something to consider before investing.

Existing applications in museum sector
VR technology has already been implemented by various museums across the world; for example to enable a virtual visit to the museum, to show a painter's studio from a true first-person perspective, to map out information in 3D, and to have visitors curiously play around as Alice in Wonderland (Coates, 2021; Carlsson, 2020). With rare exceptions like the last example though, most VR experiences in museums seem to immerse visitors as passive observers, with little degree of interactivity for active participation. Besides, the use of VR technology for interactive cultural-historical storytelling does not seem to have been fully implemented anywhere. An interactive VR storytelling experience of the original context and people behind pre-Columbian jewellery artefacts would thus be a novelty.

Figure 12: The exhibition 'Dare to Discover' at the National Maritime Museum in Amsterdam uses an installation with wired VR headsets to provide an immersive screening of the 17th century harbour of Amsterdam (image source: Scheepvaartmuseum).

2.4.4 - Augmented reality (AR)

AR technology mostly serves the same ends as VR technology; its immersive potential is not as high, but barriers for implementation in museums can be less present and use by visitors more accessible.

Principles
Instead of having to wear a headset, images, texts or sounds can be superimposed onto an existing environment. This can be done through smartphone apps, (transparent) monitors or (holographic) projections, to name some prominent examples (Coates, 2021).

Design considerations for museum sector
Implementing AR features is a relatively accessible way to add context to existing exhibits. Besides, since people are not completely isolated from their real environment like with VR, non-digital social interactions are not hindered, making AR applications able to be casually experienced by multiple people at once (Museum Boijmans van Beuningen, 2018).

Figure 13: Interface of 'Skin & Bones' AR app, developed to effectively communicate background information on the exhibited animal skeletons in the Smithsonian National Museum of Natural History (image source: Smithsonian Institution, 2015).

Existing applications in museum and adornment sectors
AR technology has seen use in the jewellery industry, mainly for virtual try-ons. Companies like TRYON and MirrAR offer different AR solutions for jewellery e-commerce, retail stores and exhibitions.

Figure 14: MirrAR 'WebAR' e-commerce dashboard showing a virtual earring try-on (image source: MirrAR, n.d.).

The company Magic Mirror offers displays with AR capabilities, and specifically markets these to museums for implementation as a costume try-on booth or interactive whiteboard. There are more examples of interactive mirrors in museums, like in the Design Museum in London.

Figure 15: Interactive AR mirror at the Design Museum in London (image source: The Dots, n.d.).

With regard to exhibitions of pre-Columbian jewellery artefacts, AR functionalities could help to create an embodied interaction with the artefacts, or illustrate the artefact's original context of use, for example.

2.4.5 - Non-Fungible Tokens (for user objects)

NFTs have recently emerged as a new, and controversial to some, way of digital value creation. In this section, the functional application of NFTs for digitally usable artefacts is examined.

Principles

Non-fungible tokens, or NFTs, are unique digital tokens that can only have one official owner at a time, and can be used to represent ownership of digital items. The record of ownership of an NFT is secured and maintained through so-called blockchain smart contracts, which means the record cannot be modified and is verifiable. Theoretically, NFTs enable the digital replication of physical item properties like scarcity and uniqueness (Ethereum, n.d.).

Like all other businesses, each NFT project has to respond to a real market opportunity with a value proposition. For some NFTs this proposition is simply the (functionally symbolic) ownership of a .jpeg file that can be duplicated by copy-pasting or screenshotting, with the duplicates not being functionally inferior to the original file. Examples of people paying hundreds of thousands of dollars in cryptocurrency for such a 'proof of ownership', sold by a platform that created the token through blockchain-encrypting (a link to) a freely replicable file, have resulted in comparisons between the NFT market and tulip mania. However, this acquired reputation is not always justified, as NFTs can have a meaningful use that creates a valuable benefit for a community of users (Kaczynski & Duke Kominers, 2021).

Existing applications

NFT ownership can be used as proof of membership to access an online community, real world events or real-world exclusive brand fashion merchandise. Meanwhile, other companies are exploring the potential use of NFTs to record people's identity and reputation. For example, MIT now issues blockchain-based digital diplomas to alumni, which are effectively verifiable non-transferable NFTs (Kaczynski & Duke Kominers, 2021).

Digital fashion and jewellery is another notable field where a use can be found for NFTs. Digital jewellery has already been present on several platforms, primarily in gaming and social media. The popular game Animal Crossing (60M copies sold, 11M monthly players) collaborated with Japanese pearl jeweller Tasaki to create a limited collection that could be bought by players and worn by their in-game avatar, and the company DressX allows customers to dress photos of themselves in digital designer clothes and accessories, which they can then post online (Smith, June 2021).

Figure 16: Tasaki X Animal Crossing digital jewellery collection (image source: Smith, June 2021).

Figure 17: An example of a digital fashion product sold by DressX (image source: DressX, n.d.).

Design considerations for museum sector

Though a mainstream metaverse, a digital open world that can be lived through via a personal avatar, is still far away from being a reality, it could add a whole new dimension to artefact collections, if the uniqueness and compelling cultural (-historical) background of most items were to be transferred to a metaverse.

NFTs could serve as a proof of ownership for digital objects to be accessed in the metaverse and used by people's online avatar (Smith, August 2021). This would guarantee the transferability, authenticity and uniqueness of a digital object in the metaverse, while the object's maker could benefit from a fixed percentage of royalties for every resale in perpetuity, thanks to the NFT's smart contract; this is a big contrast with the traditional jewellery business.

Especially regarding the specific case of pre-Columbian jewellery, their generally maximalist style, which is highly prevalent in digital adornment culture (Smith, July 2021) and above all the prospect of wearability, albeit digital, all add to pre-Columbian jewellery artefacts potentially being suitable for conversion to digital accessories, provided it has not been deemed culturally insensitive or inappropriate.

2.5 - Financial state of affairs & confines for enhancement

While it has been established that the target audience is the stakeholder which a proposed exhibition experience should cater to, and while guidelines and tools for developing a museum concept effective at visitor experience enhancement have been identified, the viability of any concept stands or falls on the involved museum's financial means and willingness to invest in it. For this reason it is important for exhibition makers to develop a clear understanding of a museum's general modus operandi and revenue structure. For the purposes of this project case this has been done by collecting insights from museum industry insiders as well as by dissecting a representative museum's financial statements.

Museum revenue structure analysis

The museums in the Netherlands that are most relevant to look at in the context of this project are the Museum Volkenkunde in Leiden and the Tropenmuseum in Amsterdam, as these host the country's most notable collection of cultural-historical artefacts. Both museums are dependencies of the Nationaal Museum van Wereldculturen (NMVW).

The NMVW's revenue buildup for 2019, the most recent full book year that was not disrupted by the covid-19 pandemic, is presented in figure 18. The organisation's total revenue for that year amounted to €24.400.919 (Stichting Nationaal Museum van Wereldculturen, 2020).

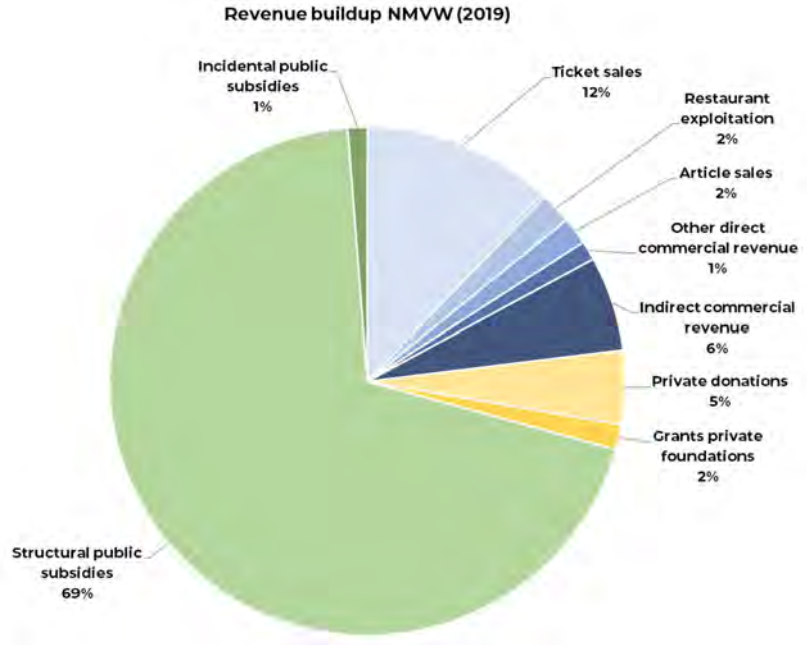


Figure 19: all sources of the NMVW's 2019 revenue and their respective shares (based on data from Stichting Nationaal Museum van Wereldculturen, 2020).

Considering the fact that direct revenue from commercial activities only accounts for a minor portion of a museum's total income, return on investment is not the most influential determinant factor in a museum's activities, as opposed to those of for-profit organisations. While museums still need to break even to sustain themselves, they can lean quite heavily on public subsidies and private donations. The high degree of museum subsidisation is due to cultural assets' general recognition as 'merit goods', meaning their existence is considered beneficial to society (Weil, 1999; E. Boreel, March 2022, personal communication: Appendix C).

Public subsidies are mostly provided on a structural basis, directly by the Dutch Ministry of Education, Culture and Science. However, these structural subsidies generally serve to cover structural expenses, while exhibition development is rather funded through incidental subsidies that funds can allocate based on a submitted grant application for a specifically defined project (E. Boreel, March 2022, personal communication; M. Reinen, March 2022, personal communication: Appendix C). Unfortunately for exhibition makers in this regard, incidental subsidies make up a far smaller share of museum revenue than structural subsidies.
A museum's budget for developing, implementing and operating the concept should thus be defined as the sum of the public and private grants attainable for the project and the projected additional direct revenue from visitors and patrons resulting from the exhibition development.

Design considerations
While increased visitor satisfaction would primarily serve to stimulate direct commercial revenue, compliance with criteria to successfully apply for sufficient public and private project funding can thus also be considered essential to account for as part of a concept's value proposition to the museum. More concretely, not only should a proposed concept for an enhanced exhibition experience increase visitor satisfaction, the concept's (publicly perceived) contribution to the museum visit as a cultural and societal 'merit good' should also be highlighted.

2.6 - Design project case: exhibiting pre-Columbian adornment

In this section it is described how the case of pre-Columbian adornment exhibitions serves as a suitable example of an area in which outdated exhibition design practices still persist, with discernible causes and consequences in society. This case thus provides ample opportunity to explore avenues for experience enhancement.

Figure 20: Moche ear ornaments made of gold and inlaid with turquoise, jade, lapis lazuli and spondylus shell, depicting an anthropomorphised bird (image source: The Metropolitan Museum of Art, (n.d.).

2.6.1 - Introduction to pre-Columbian adornment

Pre-Columbian jewellery and adornment present an extensive area of research that has been subject to countless studies in the fields of anthropology, ethnology and archaeology. Generally in exhibition design projects, most of the required in-depth knowledge on the subject-matter is to be provided by involved curators and scholars with expertise in relevant fields
However, it is also necessary for exhibition designers to have at least a general understanding of the principal aspects of the exhibition's subject-matter, be it to effectively collaborate with involved museum curators and other involved experts, or to independently develop additional content to be provided through proposed technological features.
For these purposes, this project involved a documentation of pre-Columbian adornment, included in Appendix D; the documented findings present the different types of jewellery pieces worn, cultures throughout history with notable adornment practices, historically prevalent symbolism and societal values, and a list of prominent modern-day collections.

2.6.2 - Prevalent contemporary exhibition practices

The 'Western lens'

The devastating consequences that such a lack of understanding and apathy for the native culture have historically had, are perhaps best illustrated by the origins of the legend of El Dorado. When rumours of a people that dumped copious amounts of gold into a lake reached Spanish conquistadors, it prompted them to suspect that these people must thus have an unlimited supply of the metal! The retelling of these rumours an ocean away gave rise to the legend of an undiscovered land of unfathomable material riches, which attracted many more Europeans to loot the continent and wipe out its grand civilisations for whatever gold and silver they had (Cooper, 2013).

Though the Europeans showed little interest in the spondylus shells and greenstones which the natives also prized highly Marcos, 1980; Wagner, 2001), the vast majority of gold and silver artefacts in the Americas did not survive the sixteenth century. Virtually all objects the Europeans could get their hands on were melted down into ingots and coins to be transported across the Atlantic. Most of the pre-Columbian artefacts in existence today have only been uncovered since the nineteenth century, after the establishment of archaeology and ethnography as fields of science (Colburn, 2005).

Nowadays, Western society is still predispositioned to admire gold and silver above most other materials, at least partially because of the fact that gold and silver are considered expensive. Shells may be regarded as pretty, but also mostly worthless. How advanced or primitive a society is, is often determined based on the society's technology-complexity, which is a typically Western-biassed benchmark (A. Mol, October 2021, personal communication).

However, while a society that does not possess the technology to smelt and cast metal might be disadvantaged militarily compared to a society that does, this does not mean that the activities the former's people engage in or the values they hold are objectively inferior; the shell carvings of a Taíno craftsman might require far more skill to make than a gold wedding ring, and his values and beliefs, as a product of his universe, can be considered just as valid as a conquistador's (A. Mol, October 2021, personal communication).

Implications of maintaining an exclusively Western perspective

An exclusively Western perspective being the most valid way of looking at things in the eyes of a European is perhaps lamentable, but less surprising given the values that have developed natively to their societies throughout the millennia.

Meanwhile though, several South and Middle American countries also proudly display 'the most imposing' golden indigenous archaeological artefacts from their territory in national museums. These objects are presented as a reflection of the historical and cultural significance and distinctiveness of their country's territory, legitimising their nationhood. In Caribbean countries however, where native pre-Columbian peoples also had rich traditions of adornment, just not so much of precious metals and stones, such prideful display of native adornment as national heritage is not as present (A. Mol, personal communication, October 2021).

There is thus little doubt that even modern nation-building narratives in pre-Columbian jewellery's regions of origin support the legacy of colonialism. The manner in which some jewellery artefacts are put in the spotlight, while other artefacts and historical adornment customs are not, is noteworthy. It is often more of a reflection of what European colonisers considered valuable than that it represents how pre-Columbian societies attributed symbolic value to the jewellery they crafted and the adornment they practised. Meanwhile, indigenous lifestyle and heritage are often still stigmatised as being primitive and of lower status; indigenous and mestizo heirship is often not embraced.

Although it would not be fitting to try to artificially resurrect pre-Columbian native adornment culture and superpose it onto the modern-day society in which its descendants live, it can be regarded as an injustice that, even though pre-Columbian jewellery was created as an expression of the values of indigenous societies, the manner in which these objects are often presented reflects a very different set of values (A. Mol, personal communication, October 2021).

Figure 21: A plethora of golden artefacts displayed with much splendour, but without informing (original) context, at the Museo del Oro, Bogotá, Colombia (image source: Red Cultural del Banco de la República, 2018).

The need for providing context on cultural-historical artefacts

Traditional Western exhibition practices for historical user objects do not differ much from standard practices for exhibiting paintings and other artwork; both see objects being displayed in isolation, save for a descriptive sign.

That such practices should be changed is argued by Colburn (2005), who puts forward three main objections against displaying collections of pre-Columbian artefacts as works of art:

"(1) There is concern about the loss of cultural context. Objects in museum vitrines are viewed differently than how they were viewed by those who made and used them. Many Pre- Columbian objects probably had either a utilitarian or a religious purpose; they were not fashioned as "works of art".

(2) Pre-Columbian artifacts are commonly exhibited apart from an exhibition of post-"encounter" artifacts from Latin America, suggesting either that the indigenous people of the region are extinct or that they have since done nothing of merit, whether in isolation or as a potent contributor to the mestizo culture of Latin America.

(3) Pre-Columbian artifacts are the cultural patrimony of those countries where they originated, where they were found. That they may have been freely-and legally-sold to collectors abroad is negated by the long-standing imbalance in wealth and power between the United States and individual Latin American countries; these sales were neither moral nor arm's-length transactions."

It can be argued that Latin American countries and museums have valid motives to contest European and North American museums' possession of pre-Columbian artefacts and claim them as rightfully belonging to the object's territory of origin. However, if a Latin American museum were to 'repatriate' an artefact and display it in a similarly 'Western' manner, as exemplified in figure 21, this in turn could arguably be regarded as hypocritical. For Latin American countries and museums to do justice to claims of local cultural heritage, but also for European and North American museums to better justify their stewardship over pre-Columbian artefacts, it is deemed necessary to exhibit these artefacts in a manner that communicates the full extent of their cultural-historical relevance in their original context of use.

Thus, when it comes to exhibition practices involving pre-Columbian adornment, ample opportunity for improvement may be explored. The potential usefulness of a more holistic approach to museum experience design, and of the technological tools available to enable adequate communication of content, particularly in ways that also improve visitor enjoyment and learning, appears to be unequivocal.

3. Practical research

In order to validate prior findings from the literary study on experience, and to complement these literary findings by gathering additional insights in the field, practical research activities were carried out. This research saw the extensive involvement of members of the target visitor audience, and was conducted in a real-life museum setting that approximated the project case in terms of exhibition content and typical presentation.
In this chapter, the approach and relevant outcomes of the two applied design research methods, an observational study (Van Boeijen et al., 2014) and a generative session (Sanders & Stappers, 2012), are documented.

3.1 - Observational study

Observational studies were performed with the aim of identifying behaviours, tendencies and preferences of a key stakeholder in a museum exhibition environment; this key stakeholder being the target audience of young adult museum enthusiasts.

3.1.1 - Approach

A group of four participants was invited to visit the Museum Volkenkunde (National Museum of Ethnology) in Leiden, where they were observed for the entire duration of their visit, which lasted two hours.

The participants:

- *3 males, 1 female*
- *1 Dutch, 3 Spanish*
- *Age group 20 - 30*
- *Highly educated; backgrounds in mechanical engineering, interaction design, philosophy and visual design*
- *2 Netherlands Museum Pass holders*
- *No prior acquaintance between participants*
- *All first-time visitors of the museum*

Figure 22: The researcher briefing the participants on activities in museum.

The Museum Volkenkunde was chosen as the setting for the observational research, since its exhibits were deemed comparable to the project's focus case of pre-Columbian jewellery in terms of display possibilities and relevance of objects' cultural and historical background to the exhibits. The presence of a temporary exhibition of pre-Columbian Aztec artefacts, facilitated in collaboration with Mexico's National Museum of Anthropology, further added to the relevance of the context in which data was collected.

The observations were made in a manner that minimised intervention by the observer in the experience and actions of the participants. Upon entering the exhibitions after briefing the participants, the observer assumed a follower role to allow the participants to guide themselves through the museum as they would otherwise. Questions were asked sparingly and only in order to have the participants elaborate upon a natural behaviour previously noted by the observer.
The collected data was later clustered in order to identify prevalent themes and patterns in the participants' observed behaviour. The complete observation notes and photos can be found in Appendix E.

3.1.2 - Outcomes

Group dynamic

One of the most striking insights on the participants was the fact that, right from the start, they behaved like a group going through the exhibitions together with each other, even though the participants had all been introduced to one another only five minutes prior to entering the museum. Not only did they follow each other around, they also made jokes and sparked discussions about the exhibits they observed together, and possibilities to interact with exhibits were mostly explored as a group. Moreover, every participant was proactive in sharing their enthusiasm and interest for certain exhibits with the others, stimulating them to discover it too.

Figure 23: The participants standing together and holding conversations about the exhibits in the first exhibition room they entered.
Figure 24: One participant expressing his puzzlement over an Aztec book led to another coming over to speculate, which in turn attracted the remaining two to come and take a look as well.

Museum experiences and group interaction thus positively reinforce each other; visiting a museum has shown to be an excellent activity to bring people together, while visitors in a group maximise each other's engagement with the exhibition. Besides, it is safe to assume that the vast majority of people visit a museum together with others, yet the exhibitions of Museum Volkenkunde (and probably several other museums around the world) do not seem to have been designed to explicitly accommodate group interaction.

Interaction & playfulness

Anything in the exhibitions that was interactive, which were primarily children's exhibits, drew the attention of the participants. Moreover, the participants spent far more time at each of the interactive children's exhibits than they did at most 'adult' non-interactive display cases in which an authentic artefact was exhibited. These instances also showed increased social activity between the participants, along with facial expressions of enjoyment. On several occasions participants expressed the wish to feel, wear or use certain objects on display that intrigued them, such as a Siberian salmon skin raincoat and an Aztec obsidian mirror. Not only did interactivity and playfulness appear to have an inviting effect and to trigger curiosity, facilitating the ability to interact with an object could also shape a more complete impression of it and thus satisfy visitors' curiosity.

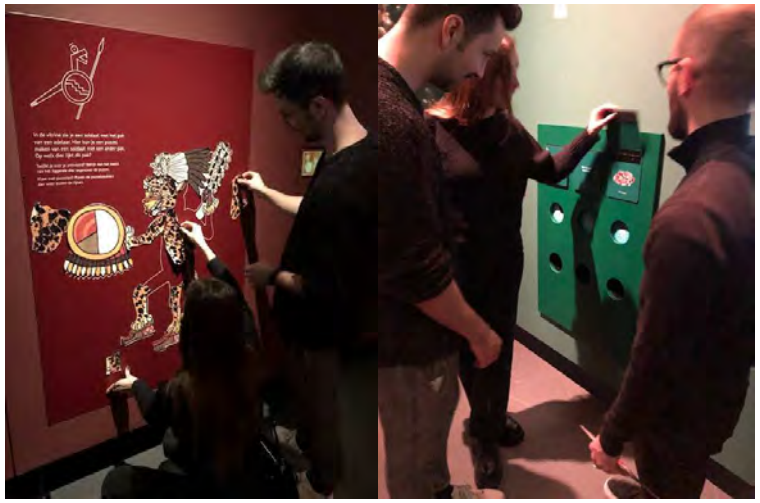


Figure 25 & 26: Participants interacting with children's exhibits together.

Relatability to own life & culture

More often than not, the jokes and anecdotes that the participants told one another as a reaction to an exhibit included a reference to their own shared culture and modern-day lives. Intentionally humorous references to internet meme culture were made on several occasions. Such statements further illustrate how it can be more enjoyable to not regard visiting a museum (or writing a thesis for that matter) as an exclusively serious affair.

Figure 27: A zoomorphic (frog) object, part of a historical Japanese writing set, described as "thicc" by one of the participants for its pronounced rear end.
Figure 28: The middle statuette's relatively large firearm blocking the view of its phallus prompted the participants to speculate that "he is compensating for something".

Graphically explicit exhibits, such as an Aztec statuette of a god wearing the skin of another person, or a headdress made from a human skull, evoked reactions of shock and intimidation from the participants, presumably also because of their relatability as human.

Figure 29: Participants spent quite some time in silence beholding Aztec human skull headdresses.

Whether of serious nature or not, connotations of relatability were shown to add to the level of engagement the participants had with exhibits, likely making them stand out among exhibits that evoked no such connotations.

Influence of exhibit environment on behaviour

Another notable pattern recognised throughout the observation session was the manner in which the different exhibition spaces seemingly affected participant behaviour.
Upon entering the first exhibition, initially very little is said, as the participants take in the large number of impressions, walking by the numerous display cases full of artefacts. Large numbers of impressions to process seemed to stifle social activity on multiple occasions. Conversation faltered shortly and picked up again quickly every time the participants entered and acclimated to a new environment. Notable exceptions to this pattern were observed however; whenever a new room did not have any background music, ambient sound or activity by other visitors, there was much less conversation between the participants. Any talking that took place was at low volume, breaking the silence as little as possible.
It could be the case that visitors feel less at ease in a silent room, or it might subconsciously be felt as antisocial to not behave more quietly in it. Whatever the case though, considering the insights gained with regard to the benefits of social interaction to a museum experience, stifling silence in exhibition rooms is mainly something to be avoided.

Need for context

In the participants' engagement process with the exhibits two stages were recognised. Initially, a certain exhibit would capture the participant's attention with its visual properties. Among the many objects some stood out to them, be it for coming across as beautiful, funny, impressive, quirky or confusing.
From thereon, curiosity being sparked consistently marked a tipping point in the participants, from having interest in the object's appearance to having interest in the story behind the object.

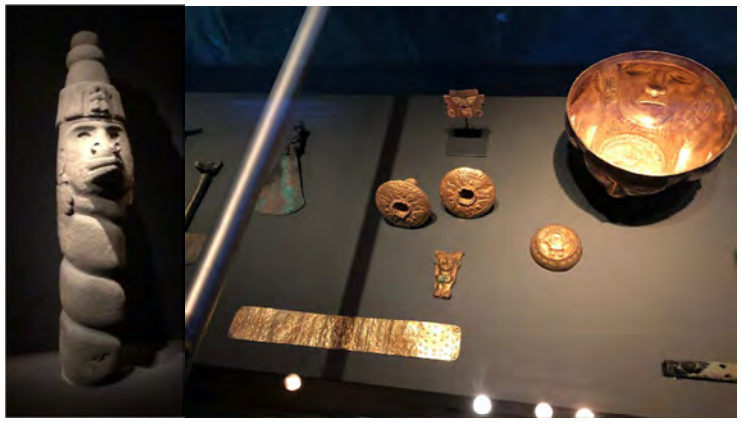
Even in the absence of any insights given as part of the exhibition on potentially contestable claims of legitimate ownership of certain cultural heritage artefacts, the participants expressed consciousness of the artefacts' provenance and ethical questions surrounding their exhibition.

[Spanish participant]: "It's probably not a coincidence that there is so much stuff from Indonesia here, right?"

[Dutch participant]: "I'm feeling slightly uneasy about it."

[Spanish participant]: "Yeah, I wonder how all the Aztec artefacts in the next room will make me feel."

The general consciousness of visitors towards contested heritage should further justify the necessity of a complete narrative to be shared, through exhibits' relevant context.
These findings are in line with concerns expressed by Colburn (2005), who argues against displaying cultural-historical artefacts as pieces of art (p. 21).



Figures 30 & 31: Aztec stone pillar & pre-Columbian jewellery artefacts; both exhibits do not show context.

Disinterest

The disinterest shown by the participants towards certain parts of the exhibitions can generally be attributed to a lack of curiosity being triggered. Throughout the museum visit this has seemed to have had less to do with the nature of the exhibited object, and more so with the manner in which they are presented. A lack of the aforementioned cultural context leaves the objects themselves unable to make an impression. Small signs with long descriptive texts in small fonts, as well as QR codes without any call to action, were usually completely ignored. Furthermore, the participants spent less and less time at every subsequent exhibition room, stating some rooms "only contained more of the same" and claiming to be overexposed by all the impressions on the way out.

The attention span of younger generations is measurably shorter than that of older generations (Subramanian, 2018), and museum fatigue is a very common phenomenon among visitors (Davey, 2005). A focus on minimising disinterest and fatigue can thus be an important factor to the improvement of a museum experience, especially younger museum enthusiasts; preventing visitors from disengaging by capturing the imagination, triggering curiosity and providing novelty throughout.

Figure 32: Towards the end of the museum visit, only one participant is curious enough to enter a side room with a display cabinet of Oceanic adornment artefacts. He stayed for around 15 seconds.

Post-visit feedback

The insights collected through observation were later shared and discussed with the participants. Some accounts of their observed behaviour demonstrated amusement, while their critical statements also implicitly affirmed what the observational study establishes:

- "We went to a museum of anthropology, but where were all the stories of the 'antropos', the people? We mainly just saw collections of objects."

- "Why is playing just for kids?"

- "At some points I saw some parallels and links to our own culture, that would be nice to know more about."

- "It felt like a missed opportunity at times to not have the context of objects, like when you just see a random stone carved block, I want to see what building it was a part of and why it looks like that! Maybe it was on a sign, but even then I would just read it and be like "okay" and, like, shrug my shoulders."

- "Some things I thought were almost insensitive from the museum. They put dolls and daggers next to each other in the same display cabinet just because they were from the same Indonesian island, and then had a wall projection of some smiling Indonesian muslim girls with hijabs. And next to some Aztec artefacts there was a random video of a Mexican woman making tortillas. If you want to make those links you have to tell how the things are related to each other."

- "There were so many things, you really have to choose what to pay attention to because it's too much to take in."

Main takeaways summarised

- Museum exhibitions should be designed for group activities.
- (Des)interest is contagious between visitors, especially from the same group.
- Museum exhibitions should be designed to activate visitors and evoke their curiosity.
- Visitors should feel at ease to interact socially; completely silent exhibitions should be avoided.
- Interactive elements should be directed towards adults and are most enjoyed playfully.
- Relatability is an effective trigger for engagement and interest.
- Museum artefacts should be exhibited with the relevant cultural context.
- The exhibition should show the degree of cultural-historical continuity and development of the presented culture's values.
- The quality of impressions should be prioritised over the quantity of impressions.

3.2 - Generative session

To supplement the insights on participants' latent attitudes, needs and desires gathered through observing their behaviours in a representative museum setting with additional findings on underlying attitudes and desires, a generative session was conducted with the same group of participants, immediately after their museum visit. The museum visit was deemed to be an excellent sensitising activity in preparation of this session.

The generative session entailed three exercises; firstly an individual expression exercise, secondly a visitor journey mapping exercise to be performed in pairs, and lastly a group brainstorm activity. These activities were aimed at leading the participants to consider their current notions of museum experiences, reflect on past experiences and subsequently imagine potentialities for future experiences. This approach to bring latent knowledge to the surface follows Sanders & Stappers' (2012) established model for examining experience domains, which denotes four steps in the path of expression across a person's timeline of experience:

1. *Observe and document current activities around the topic of the study*
2. *Recall memories from earlier experiences*
3. *Reflect on those memories and possibilities for the future*
4. *Express those possibilities for the future.*

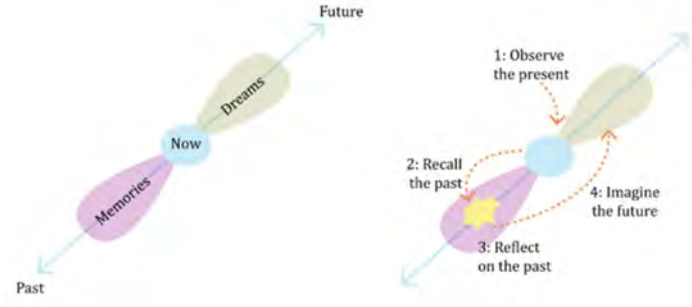


Figure 33: Experience domain model and the path of expression (Sanders & Stappers, 2012).

Figure 34: The toolkit available to the participants.

3.2.1 - Exercise 1: expression of experience and sentiments *(present)*

Observation and documentation of current activities had already taken place by performing an observational study in the Museum Volkenkunde, but in order to gain insight into the internal personal experiences behind the participants' observed behaviours, they were also instructed to express their individual experience of that day on paper using the provided toolkit.
This introductory exercise also served to sensitise the participants to sharing their sentiments surrounding their experience, while the museum visit had served the additional intent of sensitising the participants to the study topic as a whole.

Instructions

The participants were instructed to:

- Pick one exhibit piece in their head that they had seen in the Museum Volkenkunde earlier that day.
- Individually, in a free format, draw, describe, map out or express in any other way onto a sheet of A3 paper how they had experienced the activity of viewing and interacting with the exhibit.
- From when they first spotted it until when they walked on from it.
- Throughout: "What did you do? What did you think? How did you feel? What did you want?"
- Finish in 10 minutes.
- Present their creations at the end.

Figure 35: After receiving instructions, the participants are thrown in at the deep end.

Results

Chosen exhibits stuck in participants' heads due to:

- Appreciation of visual properties
- Familiarity
- Shock and intimidation
- Making one reflect
- Breaking one's expectations
- Interesting backstory

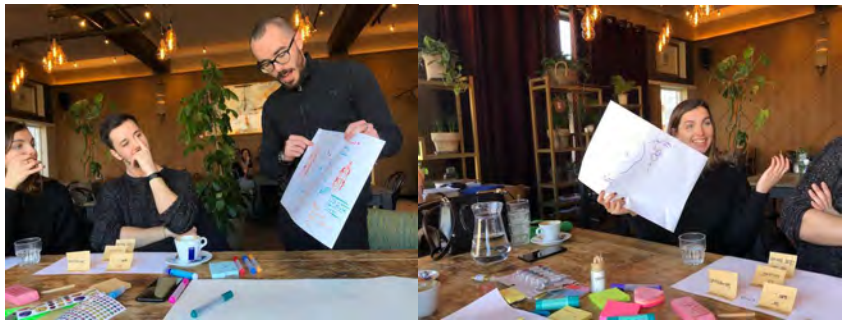
Initial (implicit) assumptions were commonplace.

- "Aztecs did not practice dental hygiene"
- "Oceanian; it's probably a surfboard"

Such assumptions were easily left intact, and participants themselves had to break with their own line of thinking and take the effort to debunk them.

Finding out the stories of the people behind the artefact made the artefacts much more interesting.
- made participant feel rewarded for curiosity
- exhibition design did not invite visitors to be curious though
There were many potential triggers, but curiosity needs to be channelled effectively.

A human presence in the artefact's narrative, like a real skull or attributing symbolical meaning, makes the artefact come a lot closer to the individual.



Figures 36 & 37: Participants presenting their results of the individual exercise to one another.

Main takeaways summarised

- The unique characteristic(s) of an artefact that make it stick in visitors' heads should be the focus of its exhibit.
- False assumptions by visitors should be foreseen and prevented.
- Visitors should be made to feel tempted to discover more.
- Visitors should be made to feel rewarded for being curious.
- Artefacts should serve as means for telling the story of the people behind them.
- An artefact's narrative should be humanised to reduce the experienced distance between it and the visitor.

3.2.2 - Exercise 2: Visitor journey mapping *(past)*

The second exercise involved having the participants recall memories of earlier experiences of visiting a museum. This activity had the aim of making their implicit frame of reference more insightful to the researcher, as well as to themselves to reflect upon in a later stage of the generative session.
The outcomes served to clarify what generally draws the participants to a museum, what they do and do not like about being inside, and what they want to get out of their visit; this mirrors the approach of Varvin et al. (2014) mentioned in section 2.2, distinguishing the pre-visit, visit and post-visit stages of the visitor experience journey.

Instructions

The participants were instructed to:

- In pairs, map out a journey of going to a museum.
- From how and why they had decided to go there, to how it was to be there, to how they felt about it afterwards.
- Start off individually by thinking back and recalling a specific occasion in the past when they went to a museum; not an art exposition and not any instance when someone else made them go.
- Discuss their past experience with the other to get an idea of how their experiences overlap and not.
- From start to finish, express their consensus on the experience on an A1 sheet of paper, in whatever format they preferred, using the toolkit at their disposal.
- Throughout: "Keep returning to the questions: What drew you to the museum? What did you enjoy and what not? What did you want to get out of your visit? How did you feel afterwards?"
- Finish in 25 minutes.
- Present their mapped journey at the end.

Results

Reasons for going:

- Have fun
- Shared experiences with other people (friends, date, even grandmother)
- Be exposed to novelty & shape interests
- Museum's fame and reputation as an important highlight
- Recommendations from social circle

The company a visitor is in influences their experience a lot:

- Nice to be with people that are into topic; they are more engaged and can share what they know and think.
- An enthusiastic guide can change the whole experience.
- Disinterest of others is also easy to go along with.
- Big crowds can make you feel less at ease and inclined to move on

A visitor's presence in the museum is also part of their experience.

- An impressive building can make being there feel more special
- Being inside feels like in a bubble, detached from the world outside
- Feels like being in a sanctuary for the exhibits
- Gives special awareness; devote more attention to specifics of exhibits

Retaining attention is often a challenge, even though it should be a museum's main objective to keep visitors from losing interest altogether.

It is helpful to:

- have a structure to make sense of the experience, a logical path to walk
- Give visitors some objectives during the exhibition; provide some extra purpose to the visit
- Challenges and objectives are playful; give a reason to stay engaged throughout
- Look at timelines, maps and maquettes; they provide a lot of understanding while being easy and satisfying to process quickly.

It is not helpful to:

- Have to depend on video and audio; you don't want to have to wait until the end of a fragment to be able to determine if it was worth your attention.
- See too many objects, especially if they are similar at first glance; they will not generate additional interest

Other negative feelings visitors might have during their visit are those surrounding the ethical questions surrounding contested heritage.

- it is better to confront these questions
- Important to give more background on the native perspective
- Limited quantity of artefacts with context, to avoid connotations of the exhibits being trophy cabinets.

Visitor sentiments immediately after finishing their tour of the exhibitions are mostly negative:

- To be forced to go through the museum store at the end gives you feelings of aversion just before leaving the museum.
- Sore legs; desire to rest physically.
- Mentally numb due to all the content and impressions; desire to rest mentally.
- Needing a moment to readjust to the outside world again.

Fondness of the experience comes later, as the experience starts to settle in your memory.

- Forgetting many details very quickly
- Remembering certain details very vividly
- Some specific things stick: the stickiness of the experience is what makes it memorable.
- Pleasant reminders to the experience days, months or years later.
- Imagining friends also liking the museum and recommending it to them.

Figure 38: Participants presenting their visitor journey maps to one another.

Main takeaways summarised

- A museum should cater specifically to social activities.
- Visiting a museum should feel like a novel experience.
- Visitors should be engaging each other with the exhibition.
- To a certain extent being in a museum itself already feels like a detached immersion to visitors; museums are suitable for doubling down on an immersive experience.
- Visitors should be given objectives throughout their experience, to give them an additional reason to stay engaged and to give structure to their experience.
- The experience should be cohesive.
- Artefacts should be shown as they were seen through the eyes of natives.
- The experience should be 'mentally sticky', in order to be memorable.

3.2.3 - Exercise 3: Brainstorm on ideal museum experience (future)

The third and final exercise of the generative session had the participants complete their reflective process on the highlights and shortcomings of earlier experiences, envision improved future experiences and express those visions in deliberation with one another.
As a result, the exercise provided insight into their wishes, preferences and aversions considering potential aspects of a future museum experience.

Instructions

The participants were instructed to review the results of their previous assignment, in which their reflections on past experiences had been mapped out, and use those insights as a starting point for what their ideal of a future museum experience would look like.
They were given three initial themes to use as a basis for their thought processes: "I don't want..."; "I want..."; "I hope novel technology could make it possible to...".

Results

Avoidances:

- Incohesiveness; do bring things that relate to each other together
- Unclear affordances; digital affordances are much less intuitive
- Low quality, gimmicky digital resources; no confidence in museums to provide quality digital content
- Dimly lit rooms
- Clashing inputs (sound from further disturbing what you're looking at)

Desires:

- More of an experience show
- Playing
- Stories!
- Impressive surroundings
- touch and hold and use objects
- Invite to interact; don't make it mandatory
- Maquettes everywhere

Imagined role technology:

- Video games
- VR simulated worlds
- AR supplement for physical exhibits; with phone?
- Have a 3D printed replica of an artefact that you can touch and interact with; makes it much more fun and memorable, engagement is important for human cognition.
- Use tech for storytelling:
  Seeing Van Gogh's surroundings and situation while he made certain paintings.
  Use objects to tell the story of an Aztec warrior who fought in a battle against the Tlaxcalans and wore a skull on his head, and how he pleased his gods.

Why even go to a museum and not use technology to make it obsolete?

- People used to go because it was the only way to see these exhibits and learn about them directly; Nowadays for the activity, the experience of visiting.
- Aura (Walter Benjamin); we put value on the idea of uniqueness of the original artefact, and by extension the uniqueness of the experience we had with it.

4. Design statement

Concluding the analysis, this section presents the starting point for the development of a design solution, after converging the gathered and validated key insights from the following research domains:

- the limitations of the scope and execution of the currently prevailing modus operandi for exhibition development;
- the behaviour, expectations, desires and values of the targeted audience;
- the potential usefulness of digital technologies as enabling tools for museum experience enhancement design and the conditions for implementing them effectively;
- the opportunities that could be unlocked by providing a comprehensive design approach for tech-enabled museum experience enhancement.

In a sense-making activity, the gathered insights were generalised and mapped out in a preliminary 'value drivers' model, accounting for the apparent interdependencies of the various foundational factors that emerged from the prior analysis as potential contributors to value creation in museum experience design.
The resulting overview, shown in figure 39, proved helpful in framing the eventual design space:

*"To design a conceptual design framework for museum experience enhancement **(what)**, for museums that want to improve their reputation and increase visitor flow with the 'benchmark' young adult visitor demographic **(who)**, effectively applying interactive and immersive technological solutions and gamification to provide an engaging and enjoyable learning experience centred around the contextual narratives of exhibited artefacts **(how)**, thereby contributing to visitor satisfaction and a consequent increase in museum popularity and perceived societal relevance **(why)**."*

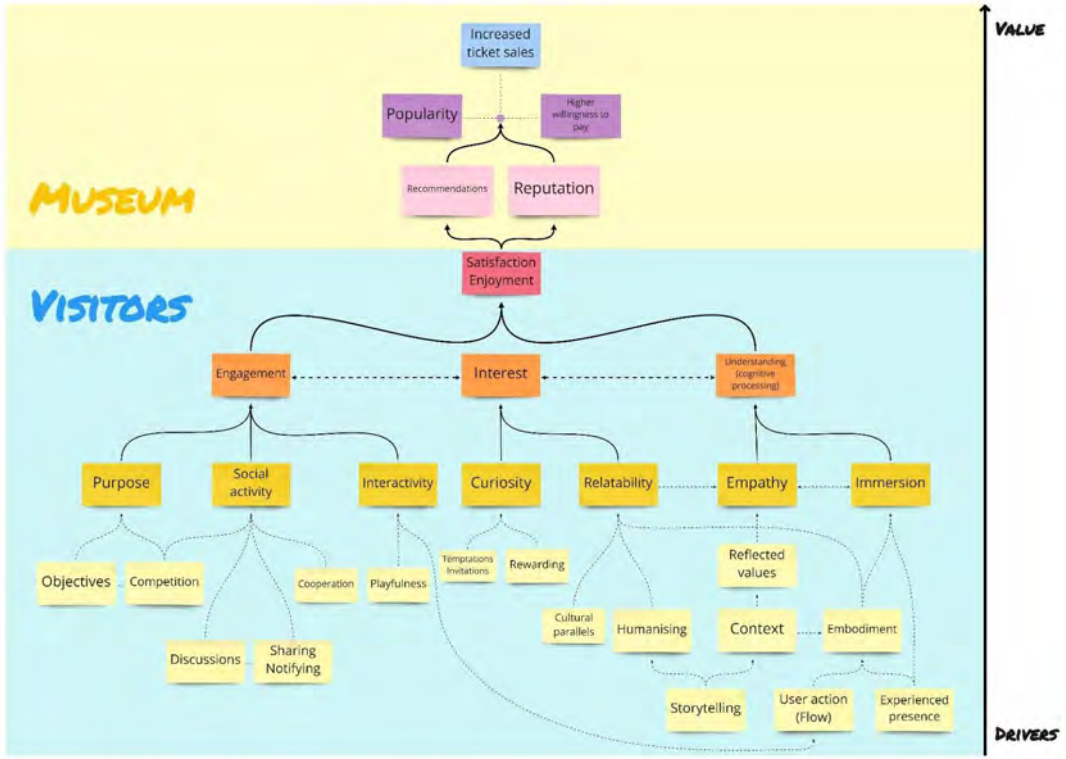


Figure 39: The preliminary model used to map out identified drivers of visitor satisfaction and added value for the museum.

5. Development

Equipped with the knowledge acquired through the prior studies, research methods and analyses, the development process would be initiated by entertaining a wide range of initial ideas and converging on a handful of directions for further ideation. This exploration and concretisation would lay the groundwork for an iterative 'Research through Design' (Stappers & Giaccardi, 2017) development process, by which bottom-up concept development and abstraction would allow for essential insights to be collected on the underlying principles of value creation at play.

5.1 - Exploratory ideation

Initial exploration of the design space took shape with ideation methods that served to diverge upon the ways in which different interaction and gamification principles, that had priorly been identified in the analysis as contributors to the visitor experience, might take shape in an exhibition concept, and subsequently, the potential uses that the considered technologies (see section 2.4) might have for effectively implementing those imagined experience elements.
Throughout this exploratory process, the documented research insights aided in passing some initial judgement on feasibility, desirability and viability of the formulated ideas.

5.1.1 - ‘How-to’ mind maps

To diverge upon a set of identified basic principles that can contribute to enhancing visitors’ experience of a museum exhibition, each of these would serve as the subject of a mind map revolving around the question “How to…?”. This design method was adopted from Van Boeijen et al. (2014).
All mind maps have been documented in Appendix G.

The resulting mind maps served to accomplish a translation from conceptual principles to a wide array of concrete examples that could serve as the building blocks for further idea generation, as well as later concept development.

5.1.2 - ‘Eureka’ canvas

Some ideas do not come about through the use of generative methods or tools, but just bubble up from time to time as one gets more emerged in the subject-matter, with a characteristic ‘eureka’ moment, a creative leap (Akin & Akin, 1996; Cross, 1997). Such basic ideas were then noted down and would later be organised based on the extent to which an interaction were to be physical or digital. The canvas is shown in figure 40.

Figure 40: The eventual 'eureka' canvas, reorganised after the randomly conceived ideas had gradually been added over time.

5.1.3 - Forced-fit tables

With a collection of idea building blocks, and a limited number of digital technologies considered for the solution space, these would all be put side by side in tables to form recipes for all kinds of different idea combinations wherever potential was recognised. All forced-fit tables can be found in Appendix H.

5.2 - Idea evaluation

Through trying out many different combinations of the concrete idea elements that had been established in the earlier stages of idea generation, a selection of twelve promising and varied ideas was eventually made. These ideas were subsequently drawn and thought out more comprehensively, in order to be presented to a group of participants sampled from the target audience for evaluation, through 'idea speed dating'.

5.2.1 - Approach

The ideas were presented to the group of participants one by one in order of increasing digitality; first came ideas revolving around the application of 3D printing, then AR, then VR and finally digital (metaverse) objects.

The participants:

- *5 males, Dutch*
- *Age group 20 - 30*
- *Highly educated; backgrounds in biomechanical engineering, fashion design, environmental sciences, construction consulting and naval logistics*
- *3 Netherlands Museum Pass holders*
- *Prior acquaintance between all participants; familiar setting conducive to discussion*

In response to each presented slide, on which an idea was introduced, the participants shared their personal impressions and discussed the idea for up to five minutes, before the next idea would be showcased.
At the end of the session, each participant was given stickers to vote for the four ideas personally believed to be the most appealing and promising.
The session lasted one hour in total, during which all conversation was recorded for subsequent analysis. The full session notes can be found in Appendix I, while an overview of the selected ideas and the main takeaways from the participants' feedback on each of them is given in section 5.2.2. The showcased sketches and descriptions of each of the ideas are presented in conjunction with participants' evaluation of each of them, following the same logical progression from least to most technology-dependent that was adhered to throughout the session itself.

5.2.2 - Outcomes

1) Wearable 3D printed hi-fi artefact replica
- Exhibited on a counter with a mirror.
- Trying on jewellery.
- Helping to adorn peers.
- Figuring out use of object.

Main feedback from target audience:
- Also interesting for youth.
- Interactivity and playing is also enjoyable for adults.
- Trying on is fun and more memorable.
- Important to make it vandal/idiot proof.

Participant votes: 5/5

2) Museum escape room
- 3D printed artefact replicas as central props.
- Deducting context story (detective/discovery/puzzle).
- Using artefacts as key to progress (to next stage/room).

Main feedback from target audience:
- Fun idea, but not feasible; small groups occupy a space for a long time, not suitable for museum visitor flow.
- Could only be implemented in a very simple manner.
- Independent escape room with historical/cultural theme in partnership with museum does seem like a good option, but this has nothing to do with the exhibition itself.
- Smaller puzzle elements in exhibition are interesting; easier to implement and take part, optional and interactive.

Participant votes: 0/5

3) Exhibition treasure hunt
- Series of collectable items to be found throughout exhibition.
- 3D printed artefact replicas (parts) as props.
- Use to tell different aspects of story of crafting and meaning.
- Deducting story from exhibition (detective/discovery/puzzle).

Main feedback from target audience:
- Very appealing.
- Challenges should be related but completion not necessary or in a fixed order; do and skip whatever you want as a visitor.
- Avoid creating the impression that it is too much effort to do.
- Avoid need to finish route to experience it as valuable.
- A journey/evolution/storyline could be effectively mapped out in steps through the different activities.

Participant votes: 4/5

4) Complementary objects for exhibited artefact through museum partnership
- Add 3D printed replicas of objects that match original artefact.
- Museum partnerships to exchange printable 3D files relevant to each other's exhibitions.
- Interactive visitor question board to get answers from local and partner museum experts.
- Smartphone AR exhibit filter that adds original users to exhibited objects; makes exhibit dynamic.
- More complete picture in exhibition.

Main feedback from target audience:
- Imaging of complete outfit is valuable; important to be able to properly understand objects.
- Phone is undesirable as core part of museum experience.
- Would be more fun directly at first glance; through screen or viewing device.
- AR supplement is promising; should be optional, not essential.

Participant votes: 1/5

5) Collectable elements throughout exhibition for AR self-adornment mirror at end
- Unlocking personal access to AR digital adornment elements (headdress, nose ornament, body paint stamps etc.).
- Through actions at points in exhibition (related to physically exhibited artefacts) and scanning personal collecting device.
- Try out collected adornment by selecting in AR mirror.
- Downloadable image of selected look.

Main feedback from target audience:
- "Shopping in the museum!", very well received.
- Make own preference for wearing and trying out adornment on self part of visitor experience
- Visitors put in more effort into understanding objects, in order to determine their preference for selecting it or not.
- Supports the exhibition theme throughout, instead of just enhancing one moment.

Participant votes: 3/5

6) AR mirror for creating personalised adornment look
- Large database of digital artefacts and adornment types from a selected culture.
- With various societal functions and symbolic/mystical meanings.
- Entertaining questions on interface with options to be chosen by visitor (e.g. "honour or power?", "Sun or Moon?").
- Personally selectable options from database determined based on answers given by visitor.
- Visitor creates own look on self with interactive AR mirror.
- Downloadable image of created look.

Main feedback from target audience:
- Unanimous rejection of concept dynamic.
- Described as "Instagram activity" and "Social media pop quiz for 'basic' teen girls that are also into astrology".
- High threshold to have to answer all questions.
- Relates objects to personal meaning inappropriately.

Participant votes: 0/5

7) AR mirror cultural guessing game
- Visitor can try on several predetermined adornment looks.
- Figuring out the role of the original user (priest, noble, warrior, craftsman, etc.) through trying on a certain adornment look on self.
- Figuring out the appropriate look for a historical user/context.

Main feedback from target audience:
- AR quickly becomes a gimmick this way, instead of an enabling tool.
- Simple guessing game does not create a more profound experience of the artefacts; superficial.
- Interactivity by itself is not the point, it should give deeper insight into what you are showing.

Participant votes: 1/5

8) VR interactive experience of mystical dream state / animal transformation ritual for which the artefact served a ritual purpose
- Use of VR headsets.
- Visitor as 1st person protagonist in virtual scenario.
- Mystery to solve in VR environment.
- Make symbolic/ritual representation come to life.

Main feedback from target audience:
- Valuable to make a culture's beliefs more tangible and comprehensive.
- Aversion toward having to put on VR headset.

Participant votes: 2/5

9) VR interactive experience of Muisca ceremony at Lake Guatavita
- Use of VR headsets.
- Visitor as 1st person protagonist(s) in virtual scenario.
- Co-op multiplayer challenge.
- As chief, priests and rowers on raft; performing ritual.
- Covering chief in gold dust and throwing gold objects into water.
- Correct actions required to progress in virtual scenario.

Main feedback from target audience:
- Real-life immersive acting museums (e.g. Archeon) perceived very positively; VR immersion and presence can also be effective.
- In VR, interactive and cooperative elements will expose the technology's limitations; these do not add value to the experience.
- Perceived threshold for VR is high; no optionality to experience.
- Execution is critical; easy to miss the mark.

Participant votes: 1/5

10) Creating personalised adornment look in exhibition to transfer to wearable look for personal metaverse avatar
- Large database of digital artefacts and adornment types from a selected culture.
- With various societal functions and symbolic/mystical meanings.
- Personally selectable options for adornment look on interface at exhibition.
- Transfer to unlock look as wearable for own digital avatar in metaverse.
- Only attainable through action in physical exhibition.

Main feedback from target audience:
- Unanimous rejection, as with idea 6.
- Metaverse aspect not considered relevant currently.
- In the future, it will appeal very much to a small niche of the museum audience, but not at all to most people.

Participant votes: 0/5

11) Artefacts as unique digitally owned (NFT) wearables in metaverse
- Only attainable through action in physical exhibition.
- Unique digital jewellery objects wearable by owner's avatar.
- Status markers with cultural and historical significance.
- Public log behind object in metaverse for community discourse about artefact.

Main feedback from target audience:
- Initial rejection of NFTs and artefact as a dumb revenue object.
- Hard to imagine value creation and business model, but agreement on potential future value of receiving or buying digitally usable object in museum, to subsequently own and use it in the digital world; "some sort of Pokémon Go could work well".
- By itself not a good/right reason to visit a museum.
- Does not enhance visitor experience of museum exhibition itself.
- Artefact in metaverse is without appropriate cultural context.

Participant votes: 1/5

12) Partnership with online multiplayer game; artefact as 'skin' or item in inventory
- Collectable series of digital artefacts.
- Online trading of resources and skills to craft.
- Each worn adornment piece grants a unique special trait to avatar, in line with original symbolic meaning.

Main feedback from target audience:
- Has nothing to do directly with an experience in a museum.
- Unique item effects cannot be balanced equally for gameplay.
- Knowledge about museum objects could be spread via game partnership, but would by itself not attract many to the museum.
- Enthusiasm for artefacts during museum visit would be stimulated by recognition from the video game, contributing to the visitor's museum experience.

Participant votes: 2/5

5.3 - Concept probe sketching

This section describes the bottom-up design approach to the development of an eventual value creation strategy, and presents the initial concept which was iterated and expanded upon for the purposes of further knowledge building.

5.3.1 - Approach

Following up on the concretisation of a range of promising ideas and their evaluation by the target audience, the initial explorative approach to the design space would further grow into a process of 'Research through Design' (Stappers & Giaccardi, 2017): generating experimental knowledge by "gaining actionable understanding of a complex situation, framing and reframing it, and iteratively developing prototypes that address it".
A concept or prototype may be developed on the basis of an incomplete set of background insights, forcing the designer to make their latent vision and assumptions explicit, and making the featured elements tangible to serve as topics of discussion, all to enable learning processes that may see some promising aspects of the concept being validated while exposing room for improvement on other aspects.
While a similar process executed by a different designer, or an altered process executed by the same designer, would most likely yield different results, these might also have been used in learning processes to generate missing knowledge. Supporting a Research through Design approach, Moussette (2012) argues that its outcomes are not random, but legitimate results attained and substantiated through "conversations with the design material and the design situation at hand".

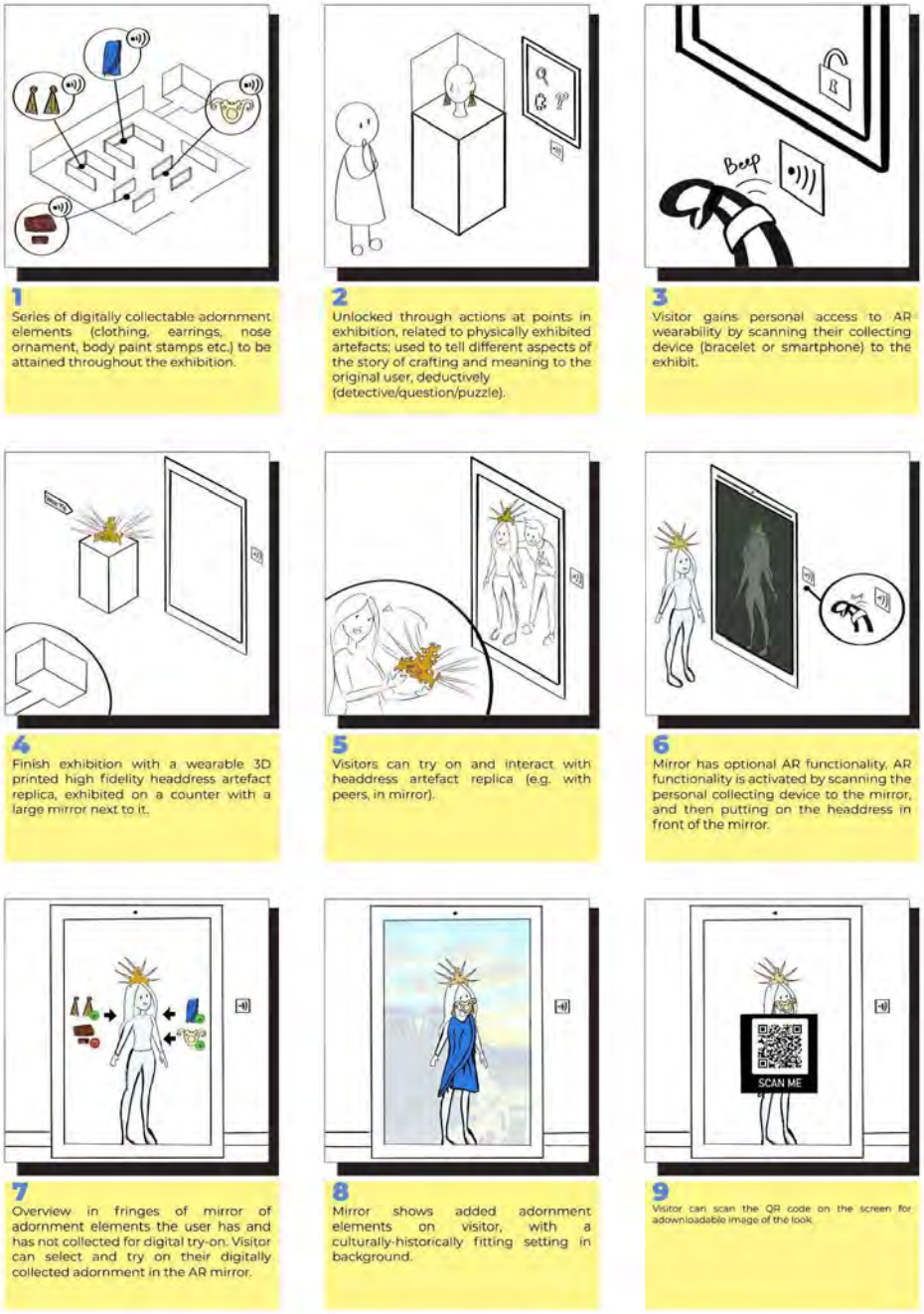
Applying the above to this project, even though the project's eventual design objective constituted a proposal for a strategic conceptual framework applicable to museum experience design in general, the most intuitive response to the design material and the design situation at hand was to flesh out the generated idea elements that had emerged as the most promising and interesting ones into an initial exhibition concept.
The idea elements that would shape the further development of an implementable exhibition concept were selected primarily on the basis of the extensive and outspoken feedback given by members of the target audience on the evaluated ideas, but also referring back to the gathered academic insights to supplement personal design intuition.
This initial concept would be used to acquire experimental knowledge to discover why the included elements had previously emerged as the most promising and where the concept might fall short. The lessons learned throughout this bottom-up design process would allow for the value created for this initially formulated exhibition case to be abstracted to generalisable functions and principles for value creation in museum experience design.

5.3.2 - Rationale for the initial concept probe

The considered options for technological features for the enhancement of an exhibition on pre-Columbian adornment artefacts were narrowed down to develop a concept deemed most suitable for further exploration.
While VR has seen some adoption by museums, the technology's current limitations when it comes to facilitating interactivity beyond just observing, as well as the high expected threshold for putting on a headset and physically isolating oneself, as reported by the members of the target audience that participated in the evaluation session, does not seem to make VR's high investment and operating cost justifiable in light of this project's aims.
Meanwhile, any transfer of artefacts to digitally usable objects in a metaverse can, as of 2022, be considered too far-fetched. While 3D scanning and other digitalisation techniques may allow for large databases of digitalised artefacts being built in the museum sector, a mainstream digital platform for digital artefacts to be implemented as personally usable objects is lacking. Permitting this would require a high level of commitment from a platform's developers, as well as enthusiasm from a mainstream public; meanwhile (aside from online video games) no metaverse has yet attained any level of mainstream adoption. This technology might become relevant in years to come and should be continued to be monitored, but it cannot serve as the basis for a concept centred around museum visitor experience within the scope at hand.
The initial concept probe does feature application of both 3D printing and augmented reality technology, and came to be as an integration of the most positively evaluated elements of the three ideas that received the most votes from the participating group of target audience members (see section 5.2).
A starting point of the initial concept probe was to more easily envision possibilities for implementing similarly developed concepts for different kinds of exhibitions, beyond the case of pre-Columbian adornment. The interactive features that shape the initial concept probe were imagined to be applicable to any exhibition of cultural-historical artefacts with wearability or usability, and potentially also for contemporary adornment exhibitions.

5.3.3 - Storyboard of the initial concept probe

The formulated concept probe is presented in this section by means of a visual storyboard supplemented with brief descriptions of the illustrated features. The choice to include a personal RFID bracelet system was driven by an interest to explore the potential uses of this technological solution for tying together multiple interactive touchpoints. This technology is not included in the presented outcomes of the study on the state of the art of promising novel technologies (section 2.4), in light of the notion that RFID solutions have been established for decades and the fact that it has no use for content creation as a standalone feature. The potential usefulness of RFID bracelets for improving the coherence of the visitor experience was proposed by a participant of the generative research session, who elaborated on her positive experience with the feature during a past museum visit.
All other technological features presented in the storyboard were also included to probe the extent of potential uses in exhibition design. The storyboard of the initial concept probe is shown on page 74.



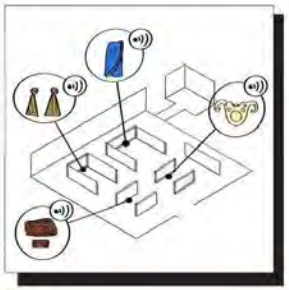
5.3.4 - Feedback on initial concept probe

The presentable concept probe would indeed serve its purpose as a tangible object of discussion in a subsequent meeting with the project partner, Current Obsession. Though this initial proposal for an exhibition concept was deemed to lack depth and to only account for a very specific and fictional best case scenario, the underlying vision was recognised as a promising starting point to diverge from in order to develop a more comprehensive concept proposal to aid in formulating a general strategic model for exhibition design.

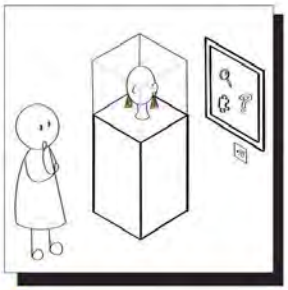
The group of CO representatives saw potential in the featured technological applications (RFID scanning system, gamified interactive exhibit interfaces, AR mirror) to realise a range of valuable experience elements.
However, criticism was directed towards the way in which the interactions and additional content were formulated. To have visitors digitally wear authentic artefacts was deemed generally inappropriate, considering the symbolic significance and societal function that many pre-Columbian jewellery artefacts had in their original societies. This manner of personal embodiment was also suspected to lead to a superficial interaction; though the technological application was not considered gimmicky, the imagined role of the visitor was thought to lead to insufficient involvement in a leading narrative.
Instead, the representatives proposed their vision for building meaning with contemporary (perhaps 3D printed) jewellery, with which historical adornment artefacts and their original meaning are reinterpreted by artists whose personal heritage and value identification may allow them to bridge the gap in cultural-historical continuity that has resulted from Western contact with the societies of the Americas. Such a formulation of interactive content would then add to the relevance of the original artefacts and adornment practices as perceived in visitors' own native context.

Following up on the new knowledge generated from Current Obsession's feedback on the concept probe as well as their own vision for exhibition design, the initial representation of the AR mirror interaction was adjusted and supplemented by the inclusion of contemporary adornment pieces, rather than exact replicas of original artefacts, in a conditionally rewarding manner, which was deemed more suitable to be integrated with featured gamification elements (as specified previously in section 2.3.

The resulting iteration is presented on page 76. as an altered version of the second half of the initial concept storyboard.



1
Series of digitally collectable adornment elements (clothing, earrings, nose ornament, body paint stamps etc.) to be attained throughout the exhibition.



2
Unlocked through actions at points in exhibition, related to physically exhibited artefacts; used to tell different aspects of the story of crafting and meaning to the original user, deductively (detective/question/puzzle).

3
Visitor gains personal access to AR wearability by scanning their collecting device (bracelet or smartphone) to the exhibit.

4
Separate 'altar' space with a pedestal in front of an AR mirror; visitor (and peers) can scan their bracelet to the reader on the altar, which places 3D models of their (cumulatively) collected items on the 'reflected' pedestal in the mirror.

5
Reflection of visitor and museum surroundings disappears, except for the pedestal. Ceremony setting appears and original wearer (e.g. high priest) digital character enters scene.

6
Digital character wears the presented pieces, enabling him to bestow the visitor with access to the 'bonus' exhibit space.
Visitors who lack the required items to present in service to the gods are deemed unworthy and instructed to return once they can prove themselves.

7
Visitors can enter 'bonus' exhibit space through a special entrance, consisting of the following sequence: A series of two sliding doors, a people counting sensor, an RFID gate reader. The 'airlock' style entrance will prevent visitors without access from entering the 'bonus' exhibit space.

5.4 - Dissection of generalisable contributors to enhancement

This section presents the successive design methods applied in order to deconstruct the underlying leading principles of the initial concept probe. Hereby, the probe served as a valuable 'learning-by-doing' tool to build the required expertise for proposing an effective design approach on a conceptual level.

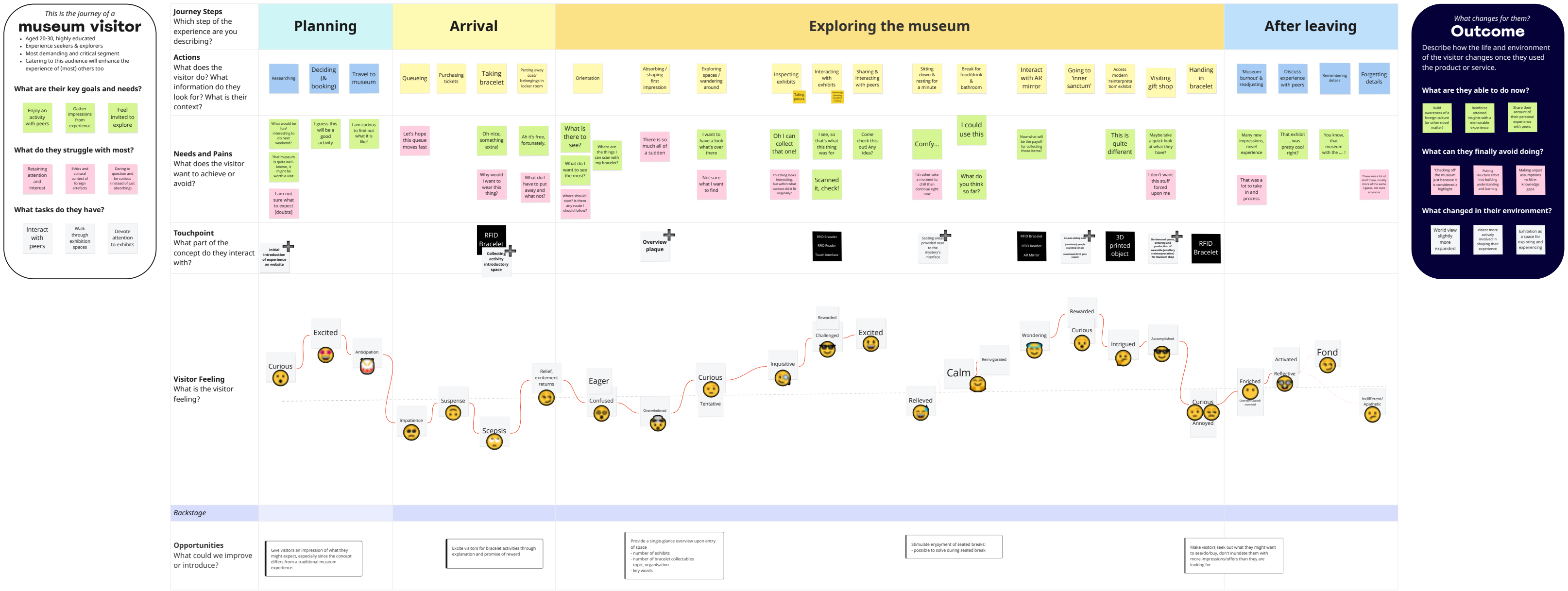
5.4.1 - Journey map

In an effort to shift the design of a concept for exhibition enhancement to occur from a more holistic perspective, the starting concept developed thus far was mapped out along with the supposed visitor journey of the exhibition in question, accounting for the pre-visit, visit and post-visit phases of the experience.
This design exercise served two main aims. In the first place, the method was meant to aid in improving upon the coherence of the starting concept's intended experience, following up on previous findings documented in section 2.2.
Additionally, the results served to more comprehensively deconstruct the different experience elements and corresponding touchpoints that made up this concept, for the underlying value drivers to be abstracted and considered in the context of a more general framework.

Approach

Mapping out the entire visitor journey and the concept touchpoints' role within it provided insight into the needs and sentiments of visitors throughout their experience, the extent to which the concept touchpoints contributed to satisfying these needs and sentiments, and more importantly, the moments where they did not.
The identified gaps, at moments in the journey where visitor sentiments were suspected to be the lowest and needs unfulfilled, were highlighted to be addressed through the introduction of additional touchpoints to be integrated into the proposed concept.

The consideration of the different stages of the visitor journey before, during and after their visit and the supportive functions that the concept should provide throughout, would aid in further developing the concept to be more coherent and well-integrated to shape an enhanced visitor experience as a whole.
The visitor journey map is shown in on page 78/79.


This is the journey of a
museum visitor
Aged 20-30, highly educated
Experience seekers & explorers
Most demanding and critical segment
Catering to this audience will enhance the experience of (most) others too
What are their key goals and needs?
Enjoy an activity with peers
Gather impressions from experience
Feel invited to explore
What do they struggle with most?
Retaining attention and interest
Ethics and cultural context of foreign artefacts
Daring to question and be curious (instead of just absorbing)
What tasks do they have?
Interact with peers
Walk through exhibition spaces
Devote attention to exhibits
Journey Steps
Which step of the experience are you describing?
Planning
Arrival
Exploring the museum
After leaving
Actions
What does the visitor do? What information do they look for? What is their context?
Researching
Deciding (& booking)
Travel to museum
Queueing
Purchasing tickets
Taking bracelet
Putting away coat/ belongings in locker room
Orientation
Absorbing / shaping first impression
Exploring spaces / wandering around
Inspecting exhibits
Taking picture
Interacting with exhibits
Sharing & interacting with peers
Sitting down & resting for a minute
Break for food/drink & bathroom
Interact with AR mirror
Going to 'inner sanctum'
Access modern 'reinterpretation' exhibit
Visiting gift shop
Handing in bracelet
'Museum burnout' & readjusting
Discuss experience with peers
Remembering details
Forgetting details
Needs and Pains
What does the visitor want to achieve or avoid?
What would be fun/ interesting to do next weekend?
That museum is quite well-known, it might be worth a visit
I am not sure what to expect [doubts]
I guess this will be a good activity
I am curious to find out what it is like!
Let's hope this queue moves fast
Oh nice, something extra!
Why would I want to wear this thing?
Ah it's free, fortunately.
What do I have to put away and what not?
What is there to see?
What do I want to see the most?
Where should I start? Is there any route I should follow?
Where are the things I can scan with my bracelet?
There is so much all of a sudden
I want to have a look what's over there
Not sure what I want to find
Oh I can collect that one!
This thing looks interesting, but within what context did it fit originally?
I see, so that's what this thing was for
Scanned it, check!
Come check this out! Any idea?
Comfy...
I'd rather take a moment to chill than continue right now
I could use this
What do you think so far?
Now what will be the payoff for collecting those items?
This is quite different
Maybe take a quick look at what they have?
I don't want this stuff forced upon me
Many new impressions, novel experience
That was a lot to take in and process
That exhibit ..... was pretty cool right?
You know, that museum with the .... !
There was a lot of stuff there, mostly more of the same I guess, not sure anymore
Touchpoint
What part of the concept do they interact with?
Initial introduction of experience on website
RFID Bracelet
Collecting activity introductory space
Overview plaque
RFID Bracelet
RFID Reader
Touch interface
Seating areas provided near to the mystery's interface
RFID Bracelet
RFID Reader
AR Mirror
2x auto sliding door
(overhead) people counting sensor
(overhead) RFID gate reader
3D printed object
On-demand quote, ordering and production of wearable jewellery (reinterpretation) for museum shop
RFID Bracelet
Visitor Feeling
What is the visitor feeling?
Curious
Excited
Anticipation
Impatience
Suspense
Scepsis
Relief, excitement returns
Eager
Confused
Overwhelmed
Curious
Tentative
Inquisitive
Rewarded
Challenged
Excited
Relieved
Calm
Reinvigorated
Wondering
Rewarded
Curious
Intrigued
Accomplished
Curious
Annoyed
Enriched
Overstimulated/ numbed
Activated
Reflective
Fond
Indifferent/ Apathetic
Backstage
Opportunities
What could we improve or introduce?
Give visitors an impression of what they might expect, especially since the concept differs from a traditional museum experience.
Excite visitors for bracelet activities through explanation and promise of reward
Provide a single-glance overview upon entry of space
- number of exhibits
- number of bracelet collectables
- topic, organisation
- key words
Stimulate enjoyment of seated breaks:
- possible to solve during seated break
Make visitors seek out what they might want to see/do/buy, don't inundate them with more impressions/offers than they are looking for
What changes for them?
Outcome
Describe how the life and environment of the visitor changes once they used the product or service.
What are they able to do now?
Build awareness of a foreign culture (or other novel matter)
Reinforce attained insights with a memorable experience
Share their account of their personal experience with peers
What can they finally avoid doing?
'Checking off' the museum just because it is considered a highlight
Putting reluctant effort into building understanding and learning
Making unjust assumptions to fill in knowledge gaps
What changed in their environment?
World view slightly more expanded
Visitor more actively involved in shaping their experience
Exhibition as a space for exploring and experiencing

5.4.2 - Deconstructed concept system tree

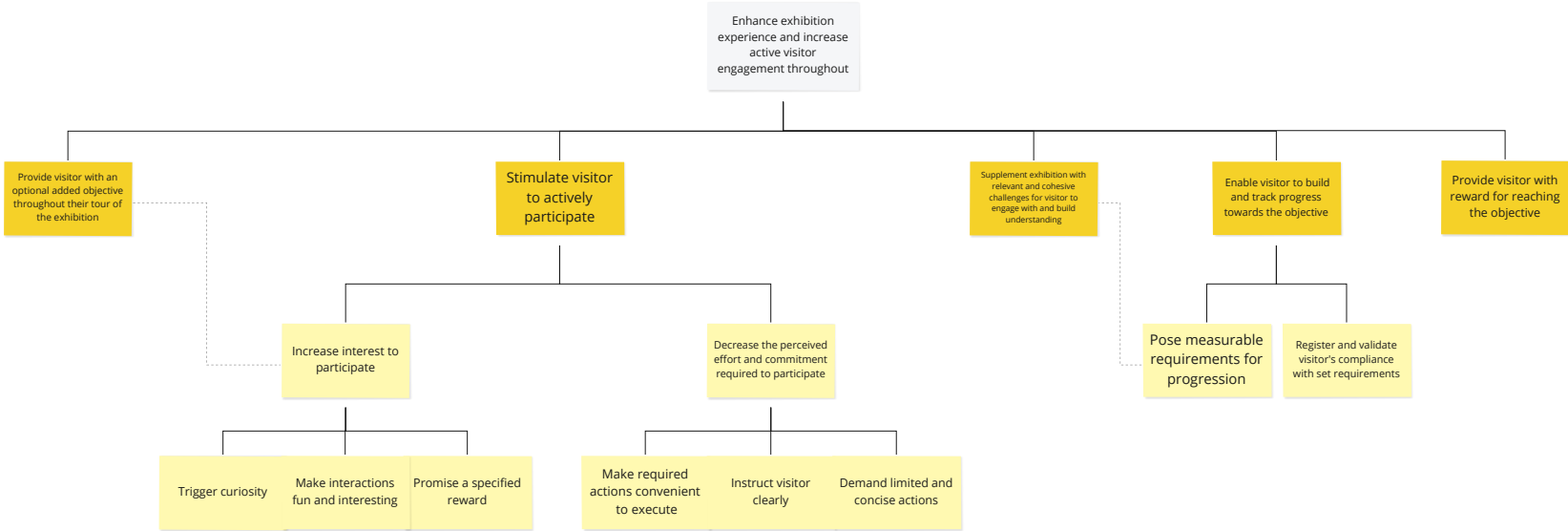
With the aim to more clearly identify in which regard the different features of the initially sketched concept would each contribute to the enhancement of visitors' experience of the exhibition, and how these features collectively shape a coherent concept, each distinguished touchpoint's inherent sub-functions, as well as the system interactions between each of the features, were considered and structured accordingly in a system tree.

The system tree can be found in Appendix J.

5.4.3 - Abstracted function tree

To aid in establishing which underlying drivers for visitor satisfaction (i.e. value creation) are successfully effectuated in the initial concept as well as how these were achieved, the generalisable functions that each system element would ultimately serve were abstracted to a more conceptual (i.e. general) level, building upon the resulted insights from both the visitor journey map as well as the concept deconstruction as presented in the system tree. Structuring the interconnections between these core functions and sub-functions would further pave the way for defining a conceptual design framework for tech-enabled museum experience enhancement.

The conceptual function tree is shown on page 82/83.


Enhance exhibition experience and increase active visitor engagement throughout
Provide visitor with an optional added objective throughout their tour of the exhibition
Stimulate visitor to actively participate
Supplement exhibition with relevant and cohesive challenges for visitor to engage with and build understanding
Enable visitor to build and track progress towards the objective
Provide visitor with reward for reaching the objective
Increase interest to participate
Decrease the perceived effort and commitment required to participate
Pose measurable requirements for progression
Register and validate visitor's compliance with set requirements
Trigger curiosity
Make interactions fun and interesting
Promise a specified reward
Make required actions convenient to execute
Instruct visitor clearly
Demand limited and concise actions

5.4.4 - Assessment through morphological chart

Having captured the experimental concept's leading functionalities on a conceptual level, it was necessary to make some initial assessment of the validity of these conceptualised functions for other explorable design contexts. To this end, a morphological chart was employed.

When part of a mostly 'Research for Design'-based process (Stappers & Giaccardi, 2017), a morphological chart is typically used by designers at the beginning of the idea generation phase (Van Boeijen et al., 2014), to compose a number of elaborated ideas, which may then be evaluated on the basis of priorly outlined criteria to arrive at a starting concept.

However, the method's usefulness for exploring (the potential for) alternative manifestations to the functions that compose a product (Roozenburg & Eekels, 1995) within a bottom-up 'Research through Design' process was also identified; in this instance it served for probing the extent to which the conceptual functions, priorly abstracted from the starting concept, might succeed in leading designers to various satisfactory concept designs for different exhibition scenarios.
Here, the distinction was made between core functions and auxiliary functions; core functions were deemed integral to achieve the desired dynamics for visitor engagement and learning, whereas auxiliary functions are regarded as important factors for the effective implementation of the core functions.

The resulting morphological charts are shown below and on page 85..

CORE FUNCTIONS	1	2	3	4	5	6
Provide side objective (to task visitor with throughout exhibition)	Collectables	Personal input as contribution	Beat competitors	Storyline quest	...	...
Instruct visitor (on exhibition activities)	Pictorial step instructions	Video	Try-out dummy example	Infographic	Booklet	...
Challenge visitor (to increase cognition)	Quiz	Riddle	Cracking code	Finding hidden feature/secret	Puzzle	...
Assess completion (of tasks at exhibition)	Registered checkpoints	Test acquired knowledge	Password	Cumulative grade	Leaderboard placement	...
Reward visitor (for performing tasks at exhibition)	Exclusive access	Item gift	Discount at purchase	Acknowledgement	Give feedback on extent of positive/meaningful impact made	...

AUXILIARY FUNCTIONS	1	2	3	4	5
Trigger curiosity (for engaging in tasks at exhibition)	Novelty	Mystery/ confusion	Eye-catching	Sensation of opportunity	...
Make tasks enjoyable	Story/plot	Collaborative	Game	Multisensory	...
Make task requirements concise	Multiple choice	Option to get extra hint	Warmer / colder indications	Progress bar	...
Increase convenience (of performing tasks at exhibition)	Automatisation	Standardised format	Short duration	Limit decisions	...

Outcomes

The range of potential solutions that emerged from the morphological chart reaffirmed confidence in the established core functions as leading design guidelines for effective tech-enabled museum experience enhancement.
Furthermore, some of the envisioned manifestations featured in the morphological chart would later also be identified as features of alternative concept suggestions, given by an independent exhibition maker and members of the target audience involved in evaluating the eventual design framework proposal and corresponding concept prototype (section 6.1; section 6.2.6).

The generalised core functions would shape the foundation for the five integral stages of the proposed conceptual design framework, whereas the charted auxiliary functions and other priorly identified general sub-functions would inform the design considerations most relevant to each main design stage, included in the framework below the design stages.
The formulated alternatives for manifesting these functions would also be included in the proposed design framework, albeit less prominently, as examples to designers for potential points of departure in addressing each corresponding stage, to trigger their inspiration for applying the framework within their own exhibition experience design context.

5.5 - Proposing a conceptual design framework

In this section the final steps taken to put together the new findings into a framework are reported, and the framework itself is presented, along with a description of how the information included in the proposed framework is structured and should be read.

5.5.1 - Building on preceding academic groundwork

The conceptual functions established in section 5.4.3 as core drivers for tech-enabled museum experience enhancement show a high degree of correspondence with the principal design stages of an integrated framework for designing relevant museum experiences by play, proposed by Vermeeren & Calvi (2019), which had not been considered as part of initial knowledge building efforts in this project, nor the subsequent Research through Design approach to build further knowledge throughout concept development.
Not only did the discovered overlap with this existing integrated framework to some extent further validate the efficacy of the core functions at which this Research through Design process had arrived independently, this framework also served as suitable groundwork upon which to give shape to a more elaborate conceptual framework for tech-enabled museum experience enhancement.

Figure 41: Framework Design for Relevance by Play (image source: Vermeeren & Calvi, 2019).

5.5.2 - The conceptual design framework

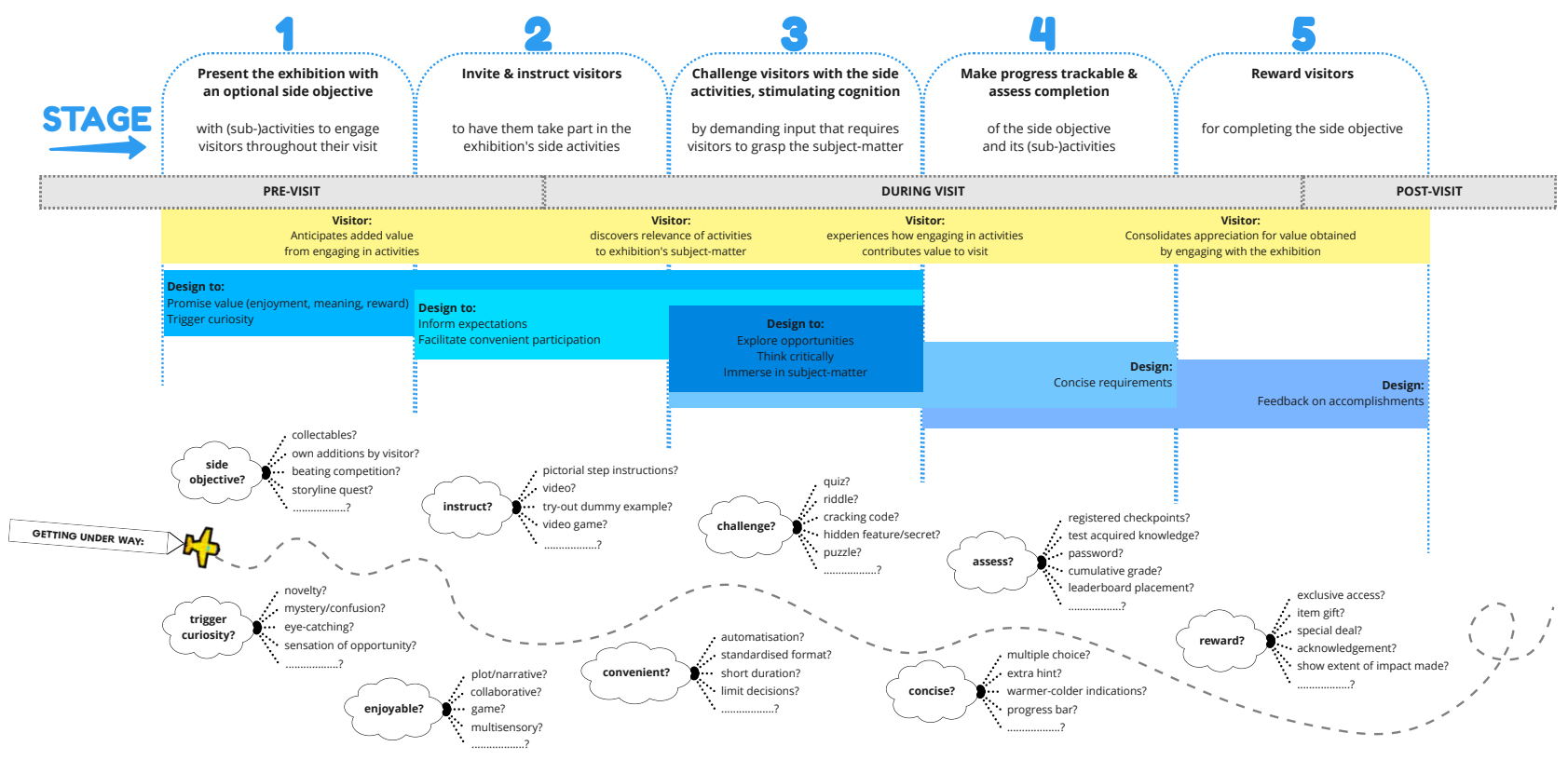
This section presents the proposed conceptual framework for guiding exhibition makers in the design of add-on features for (museum) exhibitions, aimed at stimulating visitor engagement and participation in learning activities as a means of enabling visitors to co-produce a more relevant and satisfactory exhibition experience.

Below the five proposed leading design stages, exhibition experience designers can identify (from top to bottom):

- (in grey:) the phases (before, during, after visit) of the visitor experience which each stage helps to shape;
- (in yellow:) the desired developments in the visitor's experience, corresponding to subsequent phases before, during and after their visit;
- (in different shades of blue:) the design elements that are relevant to each stage, which a designer should focus on integrating;
- (in 'flight route':) suggestions for concretising each design stage, with tangible examples that designers may consider as a starting point for ideating the potential manifestations of concept features that they deem most suitable to the exhibition they are designing for.

An envisioned exhibition experience modelled after this framework may serve as a point of departure for exhibition makers to consider both the usefulness and the requirements of novel technological solutions, notably 3D technologies, to accomplish any desired features effectively.

The framework is shown on page 88/89


STAGE
1
Present the exhibition with an optional side objective
with (sub-)activities to engage visitors throughout their visit
2
Invite & instruct visitors
to have them take part in the exhibition's side activities
3
Challenge visitors with the side activities, stimulating cognition
by demanding input that requires visitors to grasp the subject-matter
4
Make progress trackable & assess completion
of the side objective and its (sub-)activities
5
Reward visitors
for completing the side objective
PRE-VISIT
DURING VISIT
POST-VISIT
Visitor: Anticipates added value from engaging in activities
Visitor: discovers relevance of activities to exhibition's subject-matter
Visitor: experiences how engaging in activities contributes value to visit
Visitor: Consolidates appreciation for value obtained by engaging with the exhibition
Design to: Promise value (enjoyment, meaning, reward) Trigger curiosity
Design to: Inform expectations Facilitate convenient participation
Design to: Explore opportunities Think critically Immerse in subject-matter
Design: Concise requirements
Design: Feedback on accomplishments
GETTING UNDER WAY:
side objective?
collectables?
own additions by visitor?
beating competition?
storyline quest?
.....?
instruct?
pictorial step instructions?
video?
try-out dummy example?
video game?
.....?
challenge?
quiz?
riddle?
cracking code?
hidden feature/secret?
puzzle?
.....?
assess?
registered checkpoints?
test acquired knowledge?
password?
cumulative grade?
leaderboard placement?
.....?
trigger curiosity?
novelty?
mystery/confusion?
eye-catching?
sensation of opportunity?
.....?
enjoyable?
plot/narrative?
collaborative?
game?
multisensory?
.....?
convenient?
automatisation?
standardised format?
short duration?
limit decisions?
.....?
concise?
multiple choice?
extra hint?
warmer-colder indications?
progress bar?
.....?
reward?
exclusive access?
item gift?
special deal?
acknowledgement?
show extent of impact made?
.....?

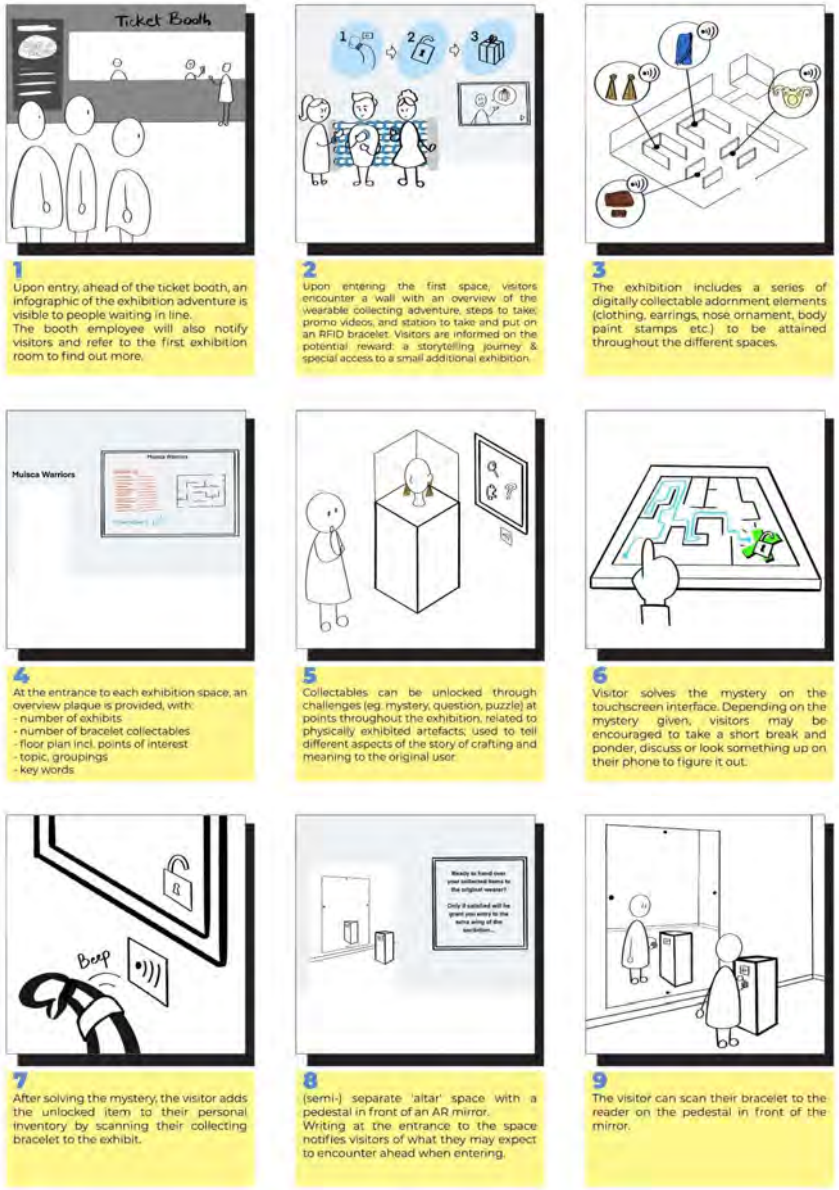
5.6 - Applied concept proposal

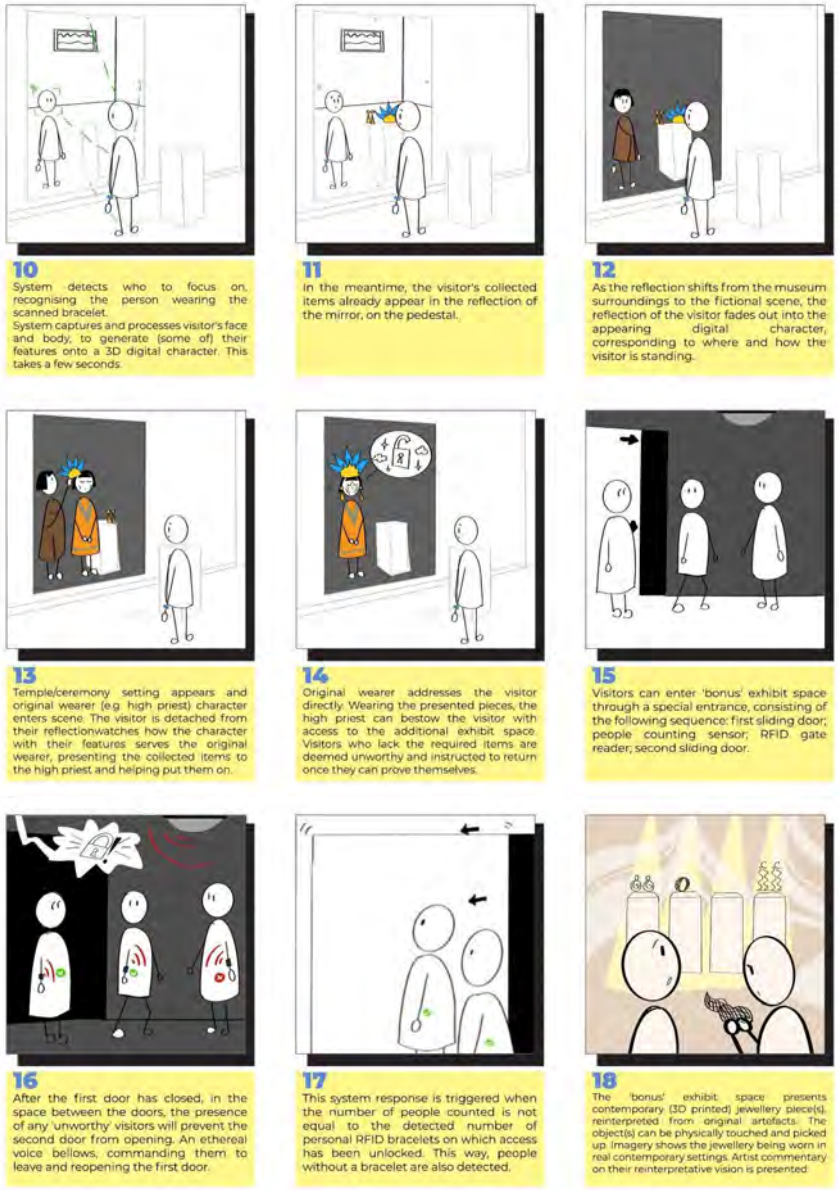
Resulting concepts can go in many directions, depending on the subject-matter and contents of the exhibition, the wishes of a collection holder, the available budget, and more. Of the proposed framework's five leading stages, different designers might personally consider some to be more applicable to their project than others. The extent of feasibility, viability and suitability of outcomes thus varies on a case-by-case basis. It is expected however, that exhibitions with non-abstract content which is well complemented with additional context and narratives, such as cultural- or natural-historical objects, are most easily suited to being (re)designed in line with the proposed framework.

To illustrate what suitable implementation of this framework to the fullest extent for an exhibition experience design could result in as a concrete concept for add-on features, a further developed iteration of the initially proposed concept for a hypothetical museum exhibition on pre-Columbian jewellery is presented as an exemplification.

5.6.1 - Storyboard

The concept storyboard presented in this section serves to narrate the museum experience provided with the concept from the perspective of the visitor themself.
This experience starts ahead of the actual visit, when potential visitors are introduced to the participatory activities and additional content on the museum's webpage (shown in figure 42, p. 93). In the storyboard, the distinguishable moments and interactions that the visitor experiences during the visit are all presented separately, in an order that reflects the relevance of contributions made to the overarching museum journey. The storyboard ends at the moment when the visitor leaves the museum; the post-visit experience consolidation is thus not illustrated, but the way and extent to which this occurs would differ strongly per museum visitor, depending not only on their personality but also on the co-productive contributions they would have made to their own experience. Nonetheless, the drivers for increasing visitor participation and cognitive processing, and as such for increasing subsequent experience memorability, most notably gamification dynamics, are illustrated in the storyboard on pages 91 – 93.





10
System detects who to focus on, recognising the person wearing the scanned bracelet.
System captures and processes visitor's face and body, to generate (some of) their features onto a 3D digital character. This takes a few seconds.

11
In the meantime, the visitor's collected items already appear in the reflection of the mirror, on the pedestal.

12
As the reflection shifts from the museum surroundings to the fictional scene, the reflection of the visitor fades out into the appearing digital character, corresponding to where and how the visitor is standing.

13
Temple/ceremony setting appears and original wearer (e.g. high priest) character enters scene. The visitor is detached from their reflectionwatches how the character with their features serves the original wearer, presenting the collected items to the high priest and helping put them on.

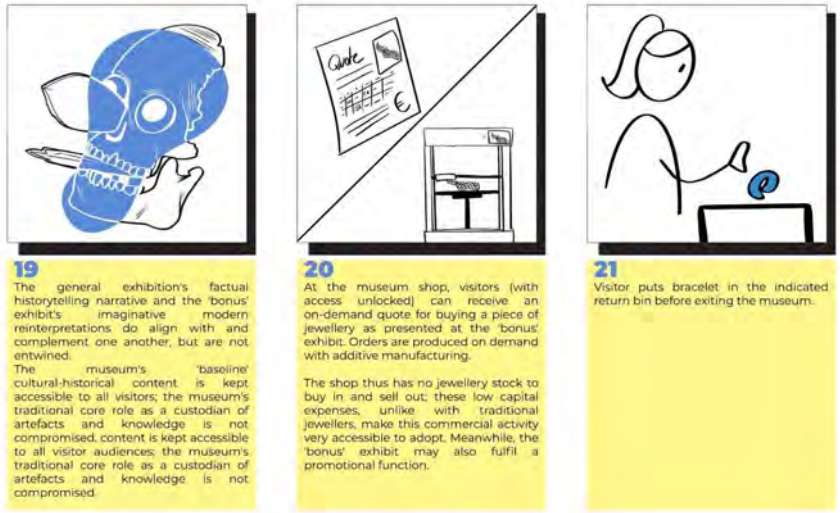
14
Original wearer addresses the visitor directly. Wearing the presented pieces, the high priest can bestow the visitor with access to the additional exhibit space. Visitors who lack the required items are deemed unworthy and instructed to return once they can prove themselves.

15
Visitors can enter 'bonus' exhibit space through a special entrance, consisting of the following sequence: first sliding door; people counting sensor; RFID gate reader; second sliding door.

16
After the first door has closed, in the space between the doors, the presence of any 'unworthy' visitors will prevent the second door from opening. An ethereal voice bellows, commanding them to leave and reopening the first door.

17
This system response is triggered when the number of people counted is not equal to the detected number of personal RFID bracelets on which access has been unlocked. This way, people without a bracelet are also detected.

18
The 'bonus' exhibit space presents contemporary (3D printed) jewellery piece(s), reinterpreted from original artefacts. The object(s) can be physically touched and picked up. Imagery shows the jewellery being worn in real contemporary settings. Artist commentary on their reinterpretative vision is presented.



19
The general exhibition's factual historytelling narrative and the 'bonus' exhibit's imaginative modern reinterpretations do align with and complement one another, but are not entwined.
The museum's 'baseline' cultural-historical content is kept accessible to all visitors; the museum's traditional core role as a custodian of artefacts and knowledge is not compromised. content is kept accessible to all visitor audiences; the museum's traditional core role as a custodian of artefacts and knowledge is not compromised.

20
At the museum shop, visitors (with access unlocked) can receive an on-demand quote for buying a piece of jewellery as presented at the 'bonus' exhibit. Orders are produced on demand with additive manufacturing.

The shop thus has no jewellery stock to buy in and sell out; these low capital expenses, unlike with traditional jewellers, make this commercial activity very accessible to adopt. Meanwhile, the 'bonus' exhibit may also fulfil a promotional function.

21
Visitor puts bracelet in the indicated return bin before exiting the museum.

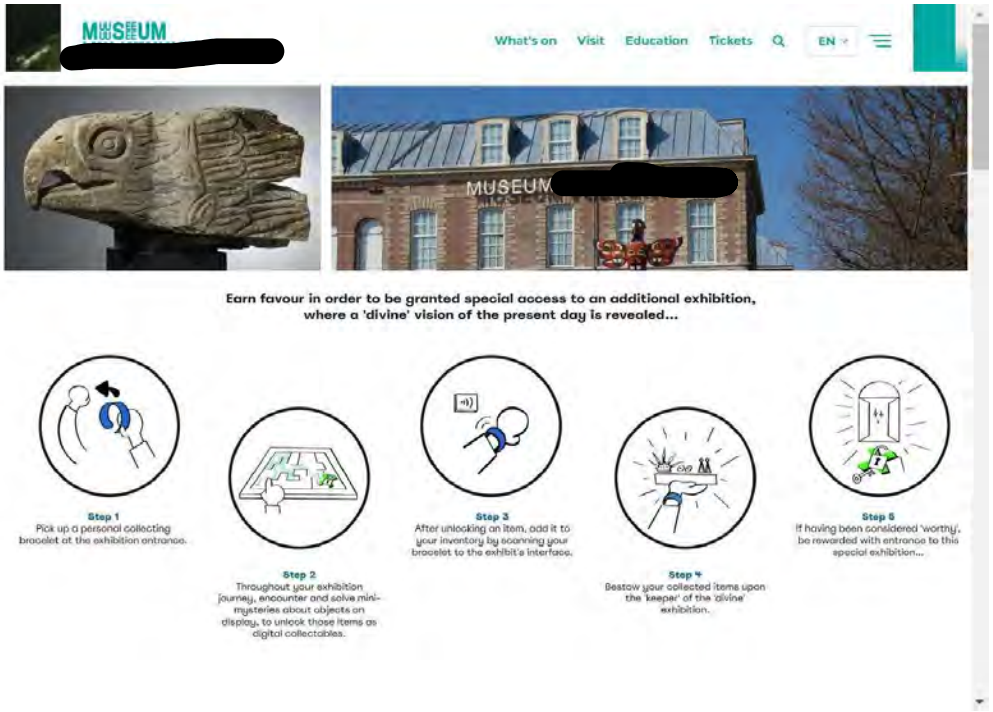


Figure 42: The proposed pre-visit web-explainer.

5.6.2 - Bracelet system specs & logistics

While designing the RFID bracelet system, for which reusable bracelets were eventually proposed, the choice for either single-use bracelets or reusable bracelets had been considered.
Single-use bracelets were initially thought to be a more suitable option, due to concerns about bracelet theft. The more high-end reusable bracelets were imagined to perhaps be desirable for visitors to take home, as an illegal souvenir or to wear as an accessory. Single-use bracelets, similar to those often used at festivals, would allow for this, at an estimated price per unit of €0.30, compared to the estimated €6 per reusable bracelet.
Theft prevention measures were thought to be unnecessarily costly and complicated.

A short interview was conducted with a young adult museum card holder who had recently visited the Fashion For Good Museum in Amsterdam, one of a handful of museums worldwide that have implemented an RFID collecting bracelet system as a solution for creating a more interactive experience. The full question and answer notes of this interview can be found in Appendix K.
From the impressions gathered with this interview, a more nuanced perspective on the comparison between reusable and single-use bracelets was formed.

Figure 43: RFID bracelet at the Fashion for Good Museum in Amsterdam (image source: Fashion For Good, n.d.).

Design considerations

Single-use bracelets were not deemed especially desirable as a souvenir, in contrast to paper festival bracelets, partially due to its RFID tag. Moreover, single use of a plastic RFID tag with metal components was considered wasteful.
Most notably though, single-use bracelets were calculated to be the more expensive option for exhibitions with a duration of more than around two weeks. With an estimated average usage of 1.5 visitors per day for reusable bracelets, and assuming the aforementioned prices per unit of both kinds of bracelets, the one-time investment in reusable bracelets would quickly earn itself back when compared to the running costs of having to buy single-use bracelets periodically. Even when assuming a monthly bracelet loss of 10% due to damage or theft, with the associated replacement costs, reusable bracelets are still much cheaper over time.
This cost comparison also puts the need for theft prevention measures into perspective, as these would quickly cost more than what they would save in bracelet replacement costs. Besides, insights from the conducted interview make it more reasonable to assume that visitors generally have no interest in keeping such a trinket as a plastic bracelet from a museum visit, especially if it is too unwieldy to wear for more than its intended purpose inside the museum. The bracelet design by itself might be a sufficiently effective theft prevention measure.

Bracelet system proposal

Though slightly less simple than only requiring a ticket vendor to give out single-use bracelets with purchased tickets, the logistics of the proposed reusable bracelet system were deemed comparable to countless tried and tested systems. The idea for the dispensary rack for bracelets was borrowed from the successful concept of supermarket self-scanners, though the bracelet racks would not even require recharging capability, as the bracelets would contain passive RFID tags that function with electromagnetic energy emitted by scanning points. The only logistical requirement would be for staff to reset, clean and return used bracelets.

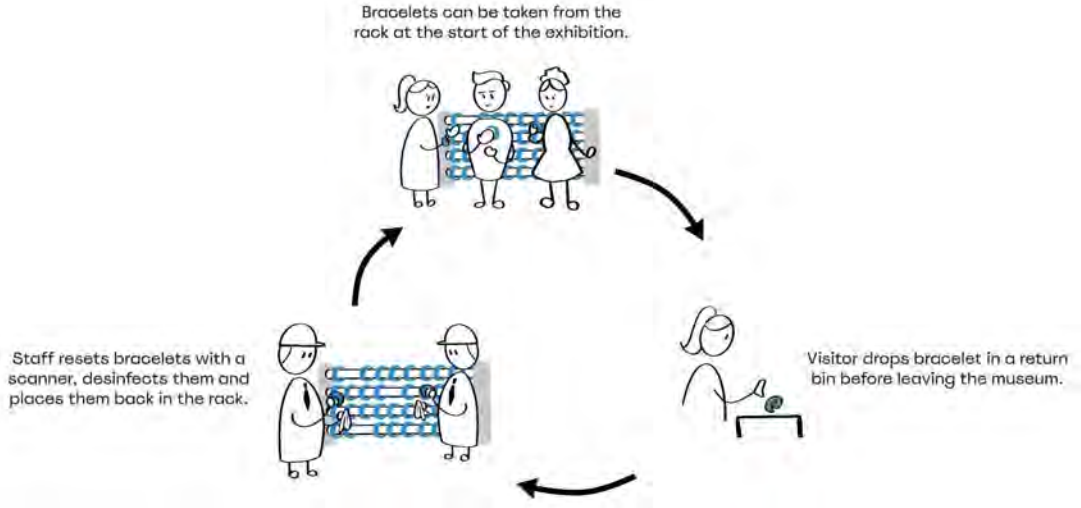


Figure 44: The process of bracelet use and reuse.

5.6.3 - Interfaces for gamified interactive challenges

As established in section 2.3, gamified challenges can be devised in different ways to suit the exhibition maker's goals of highlighting certain information related to an exhibit. In the case of this concept, the challenges serve to give visitors more insight into the historical background and societal significance of artefacts and their users.

Different types of challenges have been exemplified, namely a map-trivia quiz, a trading game and a riddle corresponding to a hidden location. The designs of the conceptualised challenges borrow elements from established (video) game components, mechanics and dynamics (section 2.3).
Pinpointing a location on a map using limited provided information and one's own deductive powers is a common core element of geography and navigation games (such as in figure 5, p. 23).
Meanwhile, trading mechanics are widespread among several genres of video games. The two specific features implemented in this challenge activity are a personal inventory with attributable value, and the game AI's ability to weigh offers, respond to them and make counteroffers (such as in figure 3, p. 22).
Posing riddles as keys to finding hidden features in order to progress, lastly, is quite commonplace in adventure and puzzle games, as well as in escape rooms. Such challenges are less linear and can also be physically participatory. In this specific riddle, "the sweat of the Sun" and "the tears of the Moon" refer to an artefact in which both gold and silver are processed. In Inca mythology, gold and silver were seen as manifestations of the sweat of the Sun and the tears of the Moon respectively.
The proposed challenge interfaces are shown in figures 45 – 50.

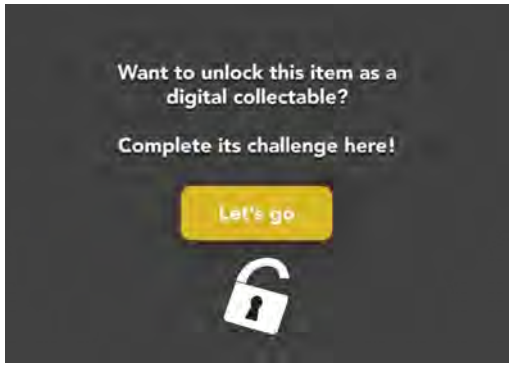


Figure 45: Stand-by starting screen.
Figure 46: Challenge completion screen; spondylus necklace unlocked.

Figure 47: Case introduction, including essential information for the challenge.

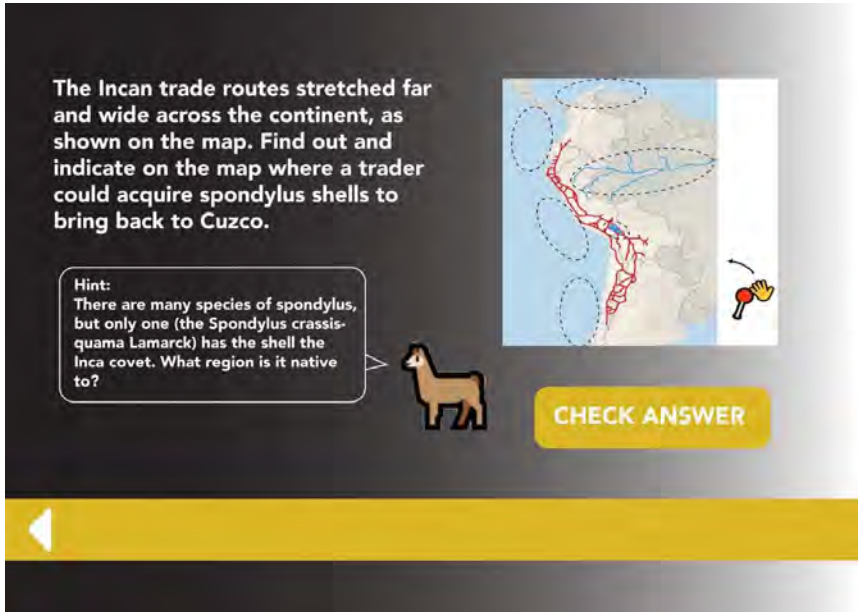


Figure 48: Map-trivia challenge; visitors build more contextual awareness on artefact provenance.

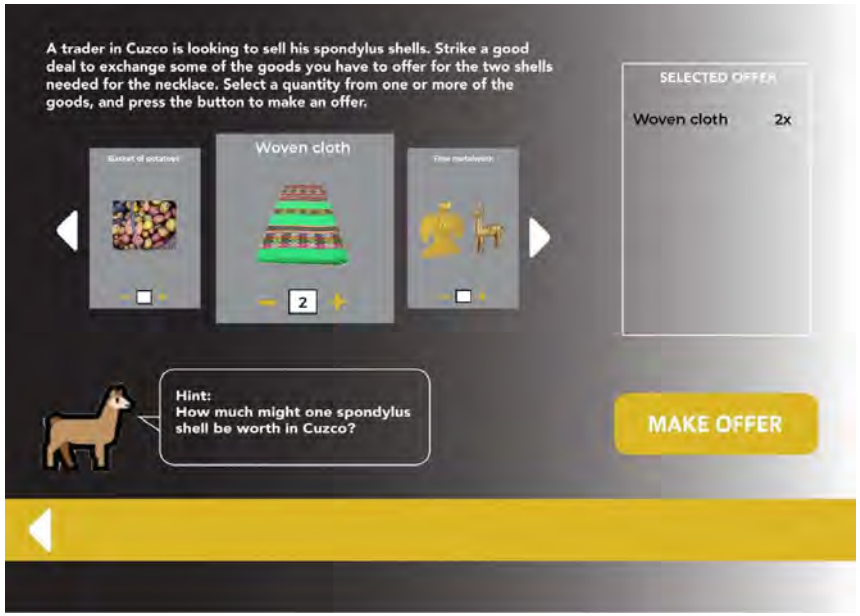


Figure 49: Trading game challenge; to gain an idea of the different societal notions of value at play.

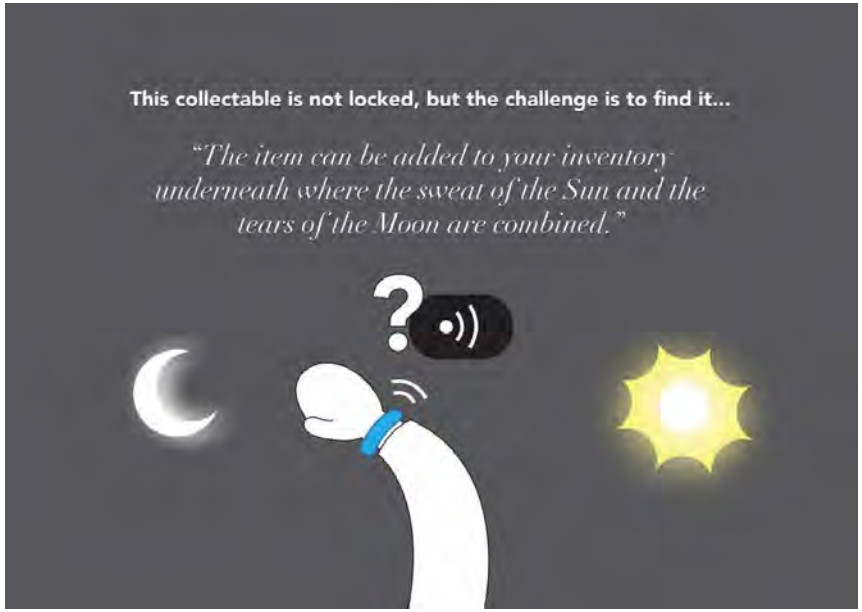


Figure 50: Riddle challenge; visitors have to discover which artefact the riddle refers to.

5.6.4 - Business value proposition

To provide an idea of the stakeholder context within which a concept, such as the one illustrated in this thesis, would be brought about, and speculate on the potential for the proposed design approach to inform a standard for business practices or a service model, figure 51 shows the complete value proposition structure of the exemplified concept, reflecting the value generated between involved stakeholders through the full implementation of the concept.

Illustrating the business value proposition for this project's applied case, Current Obsession is included to represent a service provider for exhibition development.

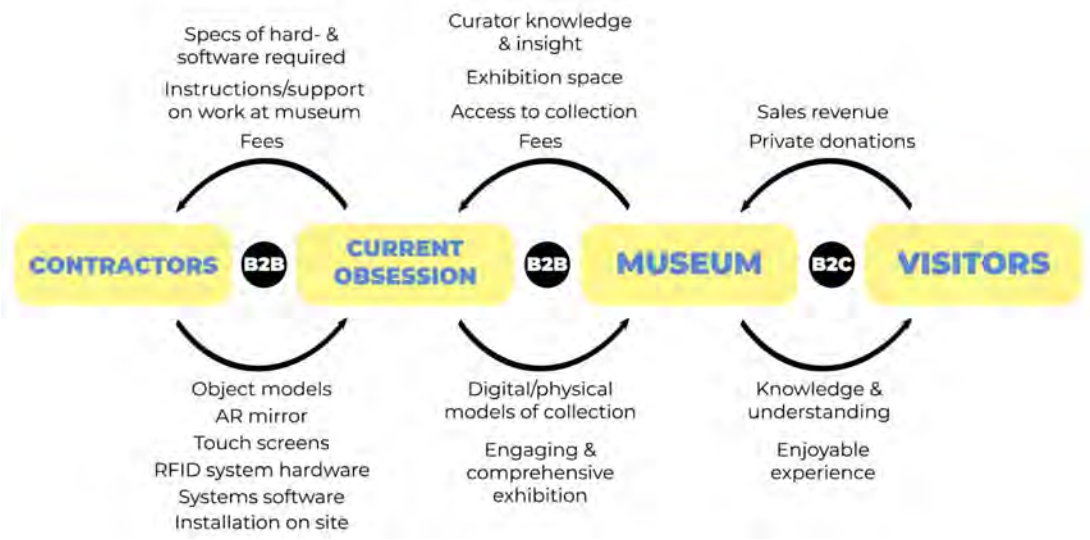


Figure 51: A structured overview of the business value proposition for the case of the presented concept example.

6. Evaluation

The aim of the conducted evaluative activities presented in this section was to validate the intended effectiveness of the proposed designs, and collect further insights to translate to considerations for improving the designs or implementing them in a real-life setting. Representing both targeted stakeholder groups, a professional exhibition maker as well as members of the visitor audience were involved in this process.

6.1 - Evaluative interview on design framework & applied concept

In order to gain a better understanding of how to align the strategic framework and its proposed potential uses with the stakeholder to which it is actually directed, an evaluation session with an exhibition maker was conducted. An independent exhibition maker was presented the design framework proposal and corresponding applied concept, and subsequently interviewed to let him share his perspective on the proposal as an insider of the museum sector and exhibition development processes.

The guide formulated and used for conducting the session, including the session aims, the scripts for briefing and presenting the designed proposal, and the interview questions, as well as a comprehensive summary of the session notes, can be found in Appendix L.

6.1.1 - Outcomes

The interviewed exhibition maker shared his views and considerations on the applicability of the conceptual framework in his field of work, while also commenting on the applied concept example. From his extensive feedback, the leading validations and considerations regarding the proposed design were condensed, as presented below.

Validations

- Exhibition makers often take defining the content that they wish to share as their main starting point, not accounting for how and why visitors might want to be presented with those exhibits. The framework helps identify and bridge that gap.
- Challenge activities may serve to guide visitors' curiosity and attention towards a specific matter that an exhibition maker might want to highlight.
- Example's manifestation of AR mirror as a feature is deemed a promising way to magnify an impression or sentiment experienced by visitors, if an exhibition maker wishes to give more weight to a specific matter they consider important.
- Exhibition experiences that revolve around artefacts are estimated to be the most easily suitable to improve upon applying the framework, though opportunities are also recognised for designing improvements for the experience of art exhibitions.

Considerations for applying framework

- The effectiveness of add-on features to increase levels of engagement and the general suitability of the framework for exhibition design is deemed highly dependent on visitors' baseline level of interest in the exhibition's content.
- When making efforts to cater to explorers and experience-seekers, exhibition makers should consider to what extent that might negatively affect the experience of professionals/hobbyists and rechargers. (definitions: Falk, 2016; see also section 2.1).
- Exhibition makers that define a concept for an exhibition in line with the framework, may have to compromise between their concept and the vision of collaborating artists and researchers, in instances when content is provided by such external parties.
- A potential bottleneck for visitor flow around a central individual interaction, similar to the AR mirror in the concept example, might be avoided if the level of personal involvement of one interacting visitor can also sufficiently magnify the impression given to spectators, (partially) eliminating the need to give every individual a turn to interact.

6.2 - Concept prototype testing & evaluation with target audience

While the intended effects of the proposed concept on the visitor experience had been well established, the concept's development had thus far involved several (implicit) assumptions on the target audience. However, whether the intended effects might be accomplished through the proposed features, and whether the assumptions on target audience behaviour would remain apparently valid, had yet to be affirmed in practice.

6.2.1 - Approach

To evaluate how the proposed concept example would be experienced by museum visitors in actuality, and to what extent the intended aims of the different concept sub-elements would be achieved, the concept was emulated in a space with lo-fi prototypes of exhibits and the proposed solutions for interactive touchpoints, to allow for a series of five role-play testing sessions with participants belonging to the target audience.

The selected participants:

- *5 males; 4 Dutch, 1 Curaçaoan*
- *Aged 22 - 27*
- *Highly educated; backgrounds in mechanical engineering, industrial design engineering, environmental studies and history.*
- *3 Netherlands Museum Pass holders*

The full guide formulated for setting up the prototype exhibition space and conducting the test sessions can be found in Appendix M. Presented in it are the aims of the research, the prior assumptions to be assessed, the items and tools that were required to set up the exhibition prototype, the script for briefing participants and requesting informed consent, the actions required by the researcher during the sessions to direct the tests, and the prepared questions for the semi-structured interviews to be held with the participants after prototype testing.

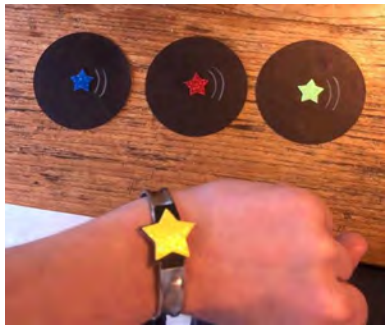


Figure 52: RFID bracelet & scanning point props used for the exhibition prototype.

Figure 53: Excerpt from the animated slides used for the prototype to emulate the AR mirror with a large screen. The image demonstrates how the processing of a visitor's facial features mixed onto the digital character might be simulated in the prototype testing session.

6.2.2 – Findings on prototyped features

The findings presented in this section served to evaluate the proposed exhibition concept example from the perspective of the target audience. These findings were arrived upon through analysis of the observational notes as well as interview transcriptions, based on the recordings made of the test sessions. The session notes can be found in full in Appendix M.

The findings are presented per sub-element of the proposed concept and grouped on the basis of their implications, namely:

- as validation of the intended effectiveness of sub-elements of the proposed concept as well as the assumptions formulated at the outset of prototype testing ('supportive findings');

- as apparent insights deemed consequential for the tested concept or exhibition designs in general and thus important to take into consideration ('novel considerations');

- as indications of points of the proposed concept that require or may benefit from design adjustments, some of which may be generalisable as avoidances in the field of exhibition design as a whole ('indications for improvement').

6.2.2.1 - Shaping prior expectations (pre-visit information)

Supportive findings:
Participants understood having been tasked to complete challenges and scan their bracelet to register progress.
The pre-visit explainer was judged to be effective at informing visitors what interactions they will be engaging in.

Participants reported that the introductory explainer made them curious to find out what carrying out the activities would be like.
The degree to which the exhibition's interactions are explained ahead of the visit seems satisfactory.

Novel considerations:
Participants recommended to clarify beforehand what narrative/thread they will be following throughout the activities.
To reduce potential feelings of uncertainty or confusion as initially experienced by visitors, the exhibition maker may opt to elaborate further beforehand on the storytelling aspect of the exhibition experience.

"The added features are the tools used to make it more coherent, but what does everything cohere to?" - participant

Indications for improvement:
Ahead of their visit, visitors are not yet made aware enough of the motives for interacting with the exhibition's touchpoints.
The introductory explainer should firstly present the 'what & why' of the overarching objectives, followed by the general 'how' of the tasks to be executed.

6.2.2.2 - Scanning & interfaces

Supportive findings:
Matching icons on the bracelet and scanning points were effective in communicating correspondence for interaction.
The recognisability of correspondent touchpoints was found to be satisfactory even while using cardboard prototypes; actual equipment is thought to be more easily recognisable than non-functional cardboard prototypes.

Physically scanning the bracelet to add an unlocked item to one's digital inventory was reported to be a satisfying action.
An RFID bracelet is deemed to be an inviting and rewarding solution for personal registration of performed interactions.

Whenever participants did not receive any response from an attempted interaction thought to be possible, they moved on to another action perceived to be the next most logical, without noticeable hesitation or frustration.
A lack of any system response from an interactive touchpoint appears to be an effective indicator of (different) prior action being required.

"The bracelet turns making the choice to interact into a more conscious action."
- participant

Novel considerations:
Rather than first regarding an exhibited object and its description, visitors were commonly drawn immediately to the exhibit's interactive touchpoint.
This behaviour is not deemed to be problematic, since every participant also looked extensively at the artefact and the sign, either to orient before interacting with the corresponding interface, as a part of completing the challenge, or after completing the challenge as a result of interest primed by the interaction.
For all three of these observed scenarios, the time and attention devoted to the object and sign of these exhibits showed to be greater than for the object and sign of exhibits that were not supplemented with an interactive touchpoint.

6.2.2.3 - Trading challenge

Supportive findings:
The comparative trade value of the different goods was quickly understood by all participants.
The ease with which a general understanding of the value of the different trade items could be acquired is deemed to be satisfactory.

Indications for improvement:
Participants expressed the want to receive a reaction or counteroffer when an offer they make is not accepted.
To make the learning process of trial and error more insightful, the interface should present visitors with feedback specific to their offer.

The buttons in the trade offer selection window are not used according to their intended function. Multiple participants resorted to only saying out loud what they wanted to offer.
Navigating between and selecting different goods seemed to be unnecessarily complicated and confusing; this interaction design can be simplified. However, this problem might appear much less pronounced when evaluated with a functional tablet application.

The trade goods in the player's inventory and those in the trader's inventory was not immediately clear to all participants.
The tested screen only explained the task through text; it should be visualised more explicitly to make it more intuitive to visitors how to proceed.

6.2.2.4 - Trivia-map challenge

Supportive findings:
Informing the participants on the extent of the Incan trade network was reported to result in all of the selectable regions of origin of the shell being considered as a plausible answer.
The information on Inca geo-economics as provided to visitors makes a satisfactory contribution to a more comprehensive understanding of the complexity of Inca society and the exhibited artefact it produced.

Novel considerations:
Participants expected that all necessary insights could be obtained from the exhibition content.
Visitors may not be expected to collect required information on their smartphone to complete a challenge without having been instructed to do so.

Participants resorted to guessing when they did not know how to progress.
Not making it clear what action visitors are tasked with may result in random attempts that do not contribute to knowledge building.

Indications for improvement:
Consulting the internet on their phone was regarded as cheating or giving up.
The challenge should be designed to be completed using only exhibition content. Consulting a smartphone is considered to negatively impact visitor involvement and attitudes.

Participants relied on being informed how to approach solving the challenge.
To guarantee achievability for visitors that are committed to completing a challenge, the approach to solving challenges should be informed and not be left open-ended.

6.2.2.5 - Riddle challenge

Supportive findings:
The knowledge attained through completing the riddle challenge was reported to be most firmly consolidated in participants' memory, apparently due to the large amount of effort it demanded from them.
Having visitors apply newly acquired knowledge for problem solving appears to greatly increase the consolidation of this knowledge into memory. The amount of effort that is put into problem solving seems to be determinant for the extent to which the required information can be recalled later.

Participants reported appreciation for the requirement to apply newly acquired knowledge.
Visitors may be expected to enjoy experiencing information to be relevant to the experience in which they are involved.

Novel considerations:
The prototyped challenge was shown to be too complex and open-ended for participants to complete independently and quickly.
An inability to complete the challenge in spite of trying may quickly lead to impatience and frustration, which can undermine an otherwise satisfactory experience design as a whole.

Indications for improvement:
Participants inspected places at random and complained that the riddle could refer to anything in the testing space, and that it was not clear where to look or what to do in order to increase their understanding of the riddle.
The scope of explorable avenues to solve the riddle should be more narrowly delimited, and a clear starting point should be given.

Backtracking to inspect exhibits that participants had already engaged with in the hope to find essential clues was reported to be confusing and tiresome.
The riddle challenge should be presented at the entrance to the room in question. Priming visitors in advance may stimulate a more inquisitive mindset.

6.2.2.6 - Non-interactive exhibits

Supportive findings:

Participants reported to have noticed that the larger amount of background information provided on some of the exhibited objects, made them stand out from the rest of the objects, which would increasingly be regarded as 'more of the same jewellery' as they passed by consecutive exhibits.

For an exhibited series of objects that might be assumed to belong to the same category, learning of unique background stories may lead visitors to maintain continued interest and perceived exhibit novelty.

The envisioned use of artefacts (e.g. how a serpent lip ornament would be worn) appears to contribute more to participants' impressions than the isolated visual properties of artefacts themselves.

Storytelling elements to accompany exhibited objects are found to be desired and appreciated by visitors, to fill conscious as well as unconscious gaps in their understanding of the exhibit.

Novel considerations:

Participants expressed a desire for more background information on the non-interactive exhibits, especially after having acquired more depth at interactive exhibits.

Additional depth and perceived relevance of an exhibit provided with interactive elements may increase a perceived lack of depth and relevance of non-interactive exhibits.

When visitors experience that an exhibit cannot provide them with a sufficiently comprehensive impression of the subject-matter to satisfy their curiosity, this could potentially leave them more indifferent towards subsequent knowledge building processes during their visit.

The research assumption that "the interactive challenges presented will prompt the participants to want to find out more on the topics" is also validated further by this finding.

6.2.2.7 - Augmented reality mirror

Supportive findings:

Participants reported having experienced the personal involvement in the interaction with the AR mirror as being enjoyable and memorable.

A hi-fi augmented reality mirror seems to be a potentially effective solution for providing an immersive and relatable interaction, with which to stimulate visitor engagement and cognition.

Participants reported to regard the AR mirror as a solution with the potential to effectively trigger as well as satisfy their curiosity to complete all required challenges.

The application of an AR mirror like in the tested concept may increase the perceived relevance of completing the exhibition's side challenges, driving increased curiosity and commitment in visitors to engage with them.

Novel considerations:

Some participants were drawn to the AR mirror as soon as they saw it.

For the AR mirror's intended purpose as a part of the tested exhibition concept, placing it in sight of recently arrived visitors may lead to interference with their initial orientations in the museum and subsequent confusion.

The intended sensation of 'kneeling humbly' by scanning the bracelet close to the floor was not noticed and experienced as such by the participants.

When visitors assume their aim is to interact normally with a touchpoint, accommodating them by placing touchpoints at intuitive and perceivably logical points is deemed to be the more relevant design consideration.

Indications for improvement:

Participants do not seem to recognise the motive for interacting with the AR mirror prior to doing so.

The relevance of the AR mirror, as part of a coherent storytelling journey throughout an exhibition, should be recognisable to visitors before approaching. This may be indicated ahead of the AR mirror or informed more explicitly by the pre-visit explainer.

6.2.2.8 - Supplementary exhibition

Supportive findings:

The contemporary content was reported to increase the perceived insightfulness and relatability of the exhibition as a whole.

Showing visitors reinterpretative works with a clear connection to exhibited cultural-historical artefacts may generally be assumed to contribute to the experienced relevance and comprehensiveness of the exhibition as a whole.

The contemporary content was experienced as novel and differentiated, yet relevant, following up on the prior exhibits.

The renewed interest that contemporary works seem to be able to spark in visitors who experience a level of museum fatigue suggests that a supplementary exhibition extension with differentiated content is unlikely to be perceived by visitors as an unattractive reward for completing the general exhibition's side objective.

Novel considerations:

The participants experienced suspense leading up to the reveal of the additional exhibition's contents.

Building suspense around a reward may increase a sensation of positive surprise, but was also found to raise visitor expectations of the content.

Indications for improvement:

Participants felt underwhelmed with the lack of stimulating interactions in the additional exhibitions, at the end of their interactive journey.

An additional exhibition, as integrated as in the tested concept, should include interactive elements, in line with or exceeding the level of interactivity of the general exhibition.
An interactive element, the possibility to physically handle or digitally wear the exhibited contemporary adornment pieces had been proposed as part of the concept.
However, evaluating this interaction with cardboard props in a lo-fi test setting had been omitted from the test design, as the extent to which such props could emulate the envisioned real-life interaction had been judged to be too limited to yield any representative data. This proposed interaction is thus to be evaluated with a high-fidelity test setup that is more representative of the proposed concept in actuality.

6.2.2.9 - RFID bracelet

Supportive findings:

The bracelet's functionality was reported to be recognisable and intuitive.

The correct way of using an RFID bracelet during a museum visit may be expected to be self-explanatory to visitors.

Wearing the bracelet was not experienced as bothersome.

The requirement to wear a bracelet is not expected to reduce visitors' willingness to take part in supplementary activities during their visit.

Participants reminded themselves to take the bracelet off at the end.

Accidental theft has not shown to be a potential issue in need of addressing. A prominently placed return bin with a clear sign at the exit of the museum is assumed to suffice for avoiding all bracelet losses, except if due to intentional theft or damage (see section 5.6.2).

6.2.3 - Memory consolidation

Five days after the sessions, each participant was contacted and asked a short series of follow-up questions, with the aim of gaining more insight into whether the exhibition's interactive challenges and touchpoints had contributed to knowledge acquisition and recallability.
A recurring topic addressed in the challenges was the societal meaning originally attributed to objects and the materials of which they were crafted. While some pieces of information were exhibited with support of interactive features, other pieces of information related to this topic were exhibited through traditional non-interactive means.

When being asked *"What do you remember about the materials the artefacts were made of?"*, all participants mentioned gold and silver, and multiple mentioned seashells. These materials all featured in an interactive challenge that corresponded to an exhibited object. Gold was present in the majority of exhibited artefacts, so participants' universal recollection of it was to be expected, especially when also considering the image that gold enjoys in present-day Western society (see section 2.6.2). However, both silver and seashell were only present in a single exhibited artefact.
Meanwhile, jade, turquoise, other minerals, tumbaga and ceramics were not recalled by any of the participants. All of these materials were also present in at least one of the exhibited objects and included on the descriptive signs, but the exhibition of these artefacts and materials was not supported by additional interactive features.
Perhaps most notably, one participant mentioned cloth, a material which could in fact be found in none of the exhibited artefacts, but which only featured as a tradeable good within one of the interactive challenges.

Responding to the subsequent question *"What can you tell me about the societal meaning surrounding these objects?"*, all participants referred to the spiritual, religious or ceremonial significance of the objects. Mentions of this kind of symbolism had been present in the AR mirror scene and the descriptions of several of the exhibited artefacts, as well as having been the subject of the interactive riddle challenge, which all participants had experienced as being difficult to complete. Similarly, the notion that the exhibited artefacts served as revered prestige objects, worn to signal the wearer's high status, was also recalled by three out of five participants.
This stands in contrast with other notions of societal meaning that had not featured as part of any of the interactive touchpoints. Only animal-related symbolism, which had been described on the signs of seven of the nine exhibits no less, was mentioned once.

Outcomes

These findings indicate that the information that participants had been introduced to by way of interactive features had generally consolidated in their memory far better than information that had been exhibited without any element of interactivity. The prototyped additional features of the exhibition concept thus seem to be effective at increasing the comprehensiveness of the visitor experience.

6.2.4 - Intentions to visit

Part of the justification for a museum to invest in implementing additional features in an exhibition would be the prospect of increased popularity and visitor numbers as a result (see section 2.5). For this reason, participants were asked to elaborate upon the degree to which learning of the presence of interactive features, like the ones they had experienced during the concept testing session, might lead them to have more interest in visiting a certain museum.

Participants dismissed the presence of activities and interactive features as a direct reason by itself to visit a museum, stating instead that the most important factor in deciding whether to visit a museum by far is the museum's subject and collection.
One participant went further by expressing that he would in fact be wary of a museum promoting itself with "fun challenges, augmented reality experience and a cool quest", expecting that it might be "lame" or otherwise not well-executed.
However, also the two participants that were most sceptical that their intentions to visit might increase as a direct result supposed that interactive features could contribute to increased interest indirectly. Concretely, participants stated that positive reports and recommendations from friends about their museum experience and the enjoyability of interactive features would certainly make them consider going there themselves.

"I have been to the Gemeentelijk Museum in The Hague, where they had such a fun children's section that I actually recommended the museum to others." – participant

Outcomes

Thus, in light of participants' apparent perception of museums as having a questionable reputation as developers of technological and participatory exhibition features, extensive promotion of an interactive exhibition experience might not be an effective way for a museum to attract more potential visitors. Nonetheless, implementing additional exhibition features that promote interactivity and contribute to a more enjoyable and satisfactory visitor experience has been found to remain a promising approach for increasing museum popularity and visitor numbers, primarily through increased word-of-mouth promotion of the museum experience expected to result from higher visitor satisfaction.

6.2.5 - Limitations of test setup

Whereas concept evaluation with a fully functional test setup in an actual museum would have yielded participant data which may be expected to quite accurately represent visitor behaviour, perception and attitudes, the lo-fi setup to which this research was limited has yielded data that, to an unknown extent, cannot not wholly represent how the participants might have behaved had they been museum visitors in a real-life setting and how they might have experienced their visit.
A number of areas were identified in which participants' behaviours and perceptions were suspected to have differed to those in the actual museum experience that the lo-fi setup served to emulate:

- All participants walked the same linear route past the exhibited artefacts (with the area having been set up in a circle on account of the limited space available).

- Multiple participants reported paying more attention to all the content and reading the signs more intently than they normally would, due to the fact that they were participating in tests in a simulated environment and that the scale of the one-room setup was far smaller than an actual museum with several halls would be.

- The lo-fi props did not seem to impress or otherwise impact the participants particularly, to the extent that the envisioned exhibits might actually do. This was further demonstrated by participants wanting to pick artefacts up and giving few reactions on how the artefacts looked visually. As a result, the observed importance of other triggers (e.g. the context and story of artefacts, interactive elements) in leading visitor interest might be somewhat overrepresented.

- The lo-fi representations of technological features (RFID scanners, touch screens, responsive interfaces, AR mirror) did not seem as effective in communicating their function as the actual features are expected to be, as also indicated by participants.

Outcomes

Testing the lo-fi props as if they were functional prototypes required a willing suspension of disbelief from the participants. This seems to have translated to their (latent) aim being to consciously and critically test the prototyped exhibition; a mindset which would not be present in real-life museum visitors. As a result, the findings gathered from the prototype tests do not allow for a definitive evaluation of the concept; more elaborate testing with hi-fi prototypes in a representative museum space would be necessary to draw more solid conclusions with which the concept might be validated further.

6.2.6 - Discussed viability of concept principles

In order to explore the potential relevance of the tested concept for benefiting different real-life museum experiences, as it might be recognised by the participants through their personal experiences as a regular museum visitor, they were asked to think back to a museum visit that they had recently experienced first-hand, and subsequently speculate how the general principles of the concept that they had just tested might be applicable to the museum in question in a way that could have made their experience more valuable.

On the Rijksmuseum, Amsterdam:

"Maybe touring it with an interactive bracelet could allow you to learn a lot more, by adding more background through those activities without actually changing or compromising the existing essence of the exhibition.
For example, there is a well-known painting with a swan that has an extensive implied message about the brothers De Witt and the republic being threatened, or something along those lines. I do not think this is mentioned on the sign next to it. A small game or challenge or easter egg could be perfect to add some more optional depth which is not considered essential to the general experience offer."

On the Mercedes Benz Museum, Stuttgart:

"I can imagine that implementing such a concept there could work very well. You go through an entire chronological timeline of Mercedes, but right now when you get to the end you just leave and 'that's it', and that is a bit of an anticlimax.
It might be cool to have a couple of these interactive points on every floor and that you could collect your favourite cars, to then drive one of those in a simulator at the end or take home a miniature model. That could add a lot to the experience.
I also think you could adapt such a concept to cater to different groups, children or adults for example, by changing the sort of reward that you can get. Adults might enjoy getting more interesting insights to add to the ones they have gained already, while children might want to earn a cool toy or a memorable object that they can put on display on a shelf in their room."

On the Museum of Art History, Vienna:

"There were countless objects and paintings that I was curious about, but in the end the visit as a whole felt quite boring, and I do not remember most of what was there. It was just hall after hall of more collections on display. You could look at everything and read what it was, but every object must have had a story behind it that would have made it so much more interesting if you would have been aware."

On the National Museum of Denmark, Copenhagen:

"That museum already emphasises storytelling and augmented reality and those kinds of things, so using more powerful impressions instead of just more information. I think including the element of personalisation and involvement that you have here would make everything they already have there work even better."

Outcomes

In spite of the limited means with which the concept could be communicated to the participants and tried out by them, broadly speaking the concept's principles were interpreted as a promising starting point to address current shortcomings in a range of different museum exhibitions. Though hypothetical and thus not definitive, their validation served to better predict the general viability of the proposed conceptual framework with which concepts such as the tested prototype might be designed.

6.3 - Concept adjustments proposed in response to evaluation

Following up on the outcomes of the prototype testing session that indicated a need for some improvements, some incremental adjustments were made to parts of the proposed concept storyboard, the pre-visit explainer and the game challenge interfaces

In line with the scope of this project, other identified points for improvement were not further iterated upon, instead informing recommendations for future development.

The final minor iterations presented in this section serve to illustrate how a process of continuous development, evaluation and redevelopment may lead to increasingly improved and validated design results.

6.3.1 - Iterated proposal pre-visit explainer

From spoken participant feedback as well as from behaviours displayed by them during the testing session, it emerged that the proposed pre-visit explainer fell short in informing visitor expectations ahead of their entry into the exhibition space. While none of the participants had any difficulties understanding and executing the tasks announced to them involving use of the RFID bracelet and participation in interactive game challenges, the overarching objectives of the intermediate tasks and rewards were not as clear to them.

In response to this shortcoming, the pre-visit explainer was reformulated to firstly present the 'what & why' of the overarching objectives, followed by the general 'how' of the actions required to achieve these objectives. This iteration of the pre-visit explainer is shown below.

6.3.2 - Iterated communicators ahead of AR mirror

During the testing sessions none of the participants, after learning that the prototyped interaction touchpoint did in fact represent an AR mirror, recognised the relevance of this feature before seeing the interactive scene play out in front of them. The intended interaction with the AR mirror is to be impressive and significant in shaping the gamified narrative that guides the museum journey. As such, it is deemed necessary for visitors to know that it only makes sense for them to approach the mirror and try to interact with it after having attained all required collectables. Participants had reported that this had not been communicated clearly, so in addition to the adjustments made to the proposed pre-visit explainer, additional information to guide the intended journey would also be provided at relevant moments during the visit itself. This addition to the concept storyboard is illustrated in figure 54.

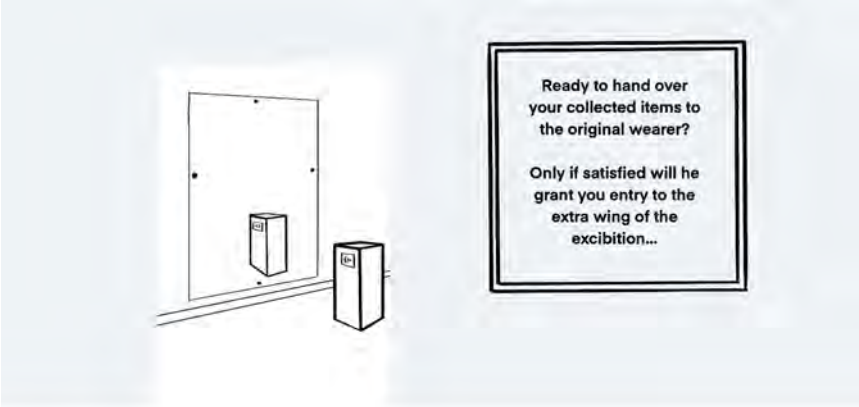


Figure 54: When passing by the AR mirror area, visitors are informed how it is relevant to enter at which point in their journey

6.3.3 - Iterated proposal game challenge interfaces

For all three of the prototyped game challenges a need for improvement was also recognised. For the trading challenge, this applied to the interface layout, which did not serve to adequately guide users in understanding the game objective intuitively, as well as the confusing and complicated interaction resulting from an excess of buttons for which it was apparently unclear how they enabled the intended functionalities. The map-trivia and riddle challenges turned out to be too open-ended and thus difficult for participants to determine how to approach solving the challenges.

In the reiterated interfaces of these prototyped games, shown in figures 55 - 58, these issues are addressed by providing more information useful for making deductions, the frame within which the challenges should be approaches was delimited more explicitly and the layout and amount of buttons were reorganised to communicate the task at hand and available actions more intuitively.

Figure 55: The iterated map-trivia challenge. Now, the information given with the hint makes the correct answer more easily deductible, though cognition is still required.

Figures 56 & 57: The iterated trading challenge. The user can now identify clearly how their selected offer compares to what is offered and demanded by the trader. Now users only need to press the 'plus' buttons once for every unit of trade goods they wish to add.

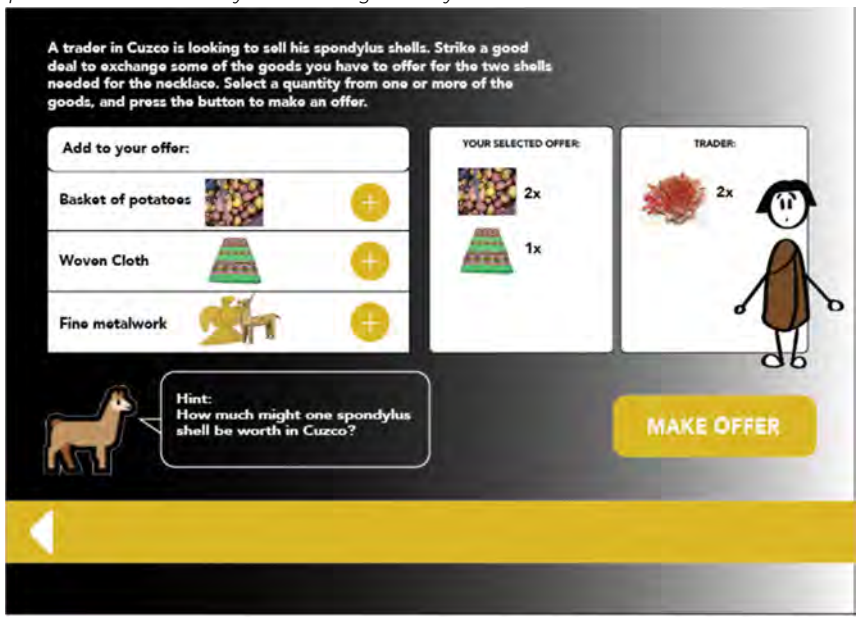


Figure 58: The iterated riddle challenge. The information is reformulated to make the thing the riddle refers to and the actions required to solve the challenge more easily deductible.
The riddle would need to be provided at the entrance to the space where the solution can be found.

7. Discussion

The findings presented in this thesis should be regarded within the frame to which the design project was confined. This section presents the limited extent to which some results could be achieved, as well as the potential avenues for the results achieved in this project to serve further development in the field.

7.1 - Limitations of study

Though from the outset the hope had been to be able to involve an actual museum or other exhibition maker in concept development, the possibilities to do so within the scope of this project turned out to be limited. While both representatives of Current Obsession as well as professionals in museum exhibition development were involved in evaluating results achieved in the project, this involvement remained on a conversational level.
Within this project it was only possible to assume a fictional museum exhibition on pre-Columbian adornment as a design case, with prototype testing being limited to a lo-fi setup for enacted 'museum visits'.

Though the proposed results of this project may serve as a jumping-off point for applied design efforts, further validation and adjustment to suit real-life use scenarios is required.
A need still remains for the proposed conceptual framework to be used by designers in the field for the development of real exhibitions, and for the proposed applied concept to be implemented and tested with functional technological features in an actual museum exhibition setting.

7.2 - Recommendations for further development of proposed designs

Throughout this project several interesting directions for further research or design activities were discovered. The extent to which these directions were explored within the scope of this project allowed some considerations relevant for future work to be put forward. This section serves to shed some additional light on the results achieved at the conclusion of this project, and provide suggestions and cautions for researchers and designers pursuing further development.

7.2.1 - Economic feasibility of value-creating technological features

This section presents a roughly estimated cost build-up of the technological applications featured in the proposed concept example, allowing for some surface-level evaluation of the economic feasibility of the proposed concept example within the context of the museum sector.
The primary aim of this section is to provide exhibition makers with more concrete awareness on the budgetary requirements of the technological solutions proposed for this concept, which might to an extent also apply to and be taken into consideration for tech-enabled exhibition concept designs of their own creation.

Outcomes

The approach and substantiations for estimating the cost of the proposed concept example's technological features are described in Appendix N.

The resulting estimates add up to a total cost nearing €30.000, as shown in figure 59.

Designation	Unit cost	Qnt	Cumulative cost
~~3D scanner~~	~~€ 7,000.00~~	~~1~~	~~€ 7,000.00~~
3D scanning services (/hour)	€ 85.00	5	€ 425.00
3D printed object (metal)	€ 3,000.00	1	€ 3,000.00
~~3D printed object (polymer)~~	~~€ 600.00~~	~~1~~	~~€ 600.00~~
AR mirror	€ 22,500.00	1	€ 22,500.00
RFID reader	€ 500.00	4	€ 2,000.00
RFID bracelet	€ 7.00	100	€ 700.00
Total cost			**€ 28,625.00**

Figure 60: An overview of the estimated costs of the proposed concept features.

Economic feasibility in museum sector

The exemplified technological features are characterised by different levels of cost-prohibitiveness. Prominent museums can more easily raise large funds for their exhibitions; in 2019, the Netherlands' largest museum, the Rijksmuseum, had allocated budgets for exhibitions, development and automation that cumulatively exceeded 8.17 million euro (Rijksmuseum, 2020).

Smaller museums however, might not be able to secure funding for the extensive application of novel technologies to enhance their exhibition experience. As concluded in section 2.5), for the most part this depends on a museum's ability to convince grant providing organisations that the required funding applied for is proportional to the value that the expenses could add to the museum experience as a societal merit good.

Implications of concept downscaling for the business value proposition

Depending on the budgetary constraints imposed upon them, exhibition designers might need to scale down the package of enhancement features to be implemented. Provided the coherence and relevance of all remaining experience elements is retained, following the proposed framework's design principles may still enable a degree of value creation with suboptimal financial means.

For example, in the case of this project's proposed concept example, omitting the largest expense, the AR mirror, would remove an impactful interaction touchpoint from the experienced narrative. However, with the remaining collecting bracelet system, challenge interfaces and unlockable exhibition space with handleable pieces, the core gamification dynamic shaped by participating in challenges to attain both intermediate rewards as well as an overarching reward still remains mostly intact.

At reduced cost, a scaled-down concept might thus still allow for value creation towards a visitor experience that is more engaging and comprehensive, albeit to a more limited extent. Creating an overview of the business value proposition, as shown for this project's exemplified concept in section 5.6.4, may aid exhibition makers in determining how downscaling would impact different pillars of the existing value proposition of a designed concept.

7.2.2 - Potential obstacles to implementing features

Under certain circumstances, obstacles to the effective implementation of the proposed concept may emerge. During research on technological feasibility, and in the evaluation with a professional exhibition maker, two potential obstacles were already identified.

In museums with high peak visitor numbers, a handful of touchpoints for individuals to have interactions that take more than a few seconds, most notably the AR mirror and the challenge interfaces, might pose a bottleneck to visitor flow. Having visitors wait their turn to participate is expected to severely undermine the spontaneity and attractiveness of the participatory activities, and is thus to be avoided.

Adjusting to such a scenario might mean having to provide a valuable interaction within a shorter time-frame or investing in more featured touchpoints, though the latter would of course come at increased cost.

Another potential obstacle, which applies specifically to the AR mirror, might emerge in the development of software applications. Though the proposed AR mirror interaction has been identified as being technologically feasible, the realisation might still be hampered in the case of the few manufacturers of the necessary state-of-the-art AR mirrors being unwilling to provide the highly customised software and hardware solutions required for facilitating the proposed interaction. Such a one-off development would lie outside their targeted markets, generally fashion retail. Some AR mirror developers, such as Magic Mirror UK, do cater to the museum sector, but the technological capabilities of their products are inadequate for enabling the concept's proposed interaction to the fullest extent. An AR mirror that can process full 3D model files, and not just warp .png images, is required.

More extensive contact will have to be established with the manufacturers of state-of-the-art AR mirror products to further explore the extent to which a high-capacity AR mirror solution may be developed to feature in a museum exhibition.

7.2.3 - Suggestions for further development

Large-scale gamified challenge generation

A drawback of gamifying (elements of) a museum experience, identified by López-Martínez et al. (2020), is the labour-intensity of developing interactive challenges or question-based games for each and every different piece of subject-matter that might want to be addressed.

To make this process more feasible, they developed a platform for which the creation of relevant and enjoyable game questions was effectively automated using software tools that autonomously collect relevant input from web databases.

Exhibition designers faced with the task of gamifying a large exhibition requiring a great number of interactive touchpoints may want to consider the potential for automating parts of the game development process.

Strategic roadmap

Accounting for the scenario in which a service provider for exhibition development, in this project case assumed to be Current Obsession, would adopt the proposed conceptual framework as a leading principle of their value proposition in a new service model, the adoption of such a model, and the future opportunities for expanding it, may be strategised in greater detail. For these purposes, a strategic roadmap including future horizons could be developed; a suggestion for such future strategic horizons is given here:

Horizon 1 (2023):

The service provider supports museums in (re-)design for visitor experience enhancement.

Horizon 2 (2027):

The service provider facilitates technology-enabled collaboration and digital artefact loaning/exchange between museums worldwide (which seems particularly promising to help settle issues of contested ownership of heritage objects).

Horizon 3 (2033):

The service provider facilitates the transfer of digitalised (contemporary) works of adornment to a metaverse platform to allow for digital usability by personal avatars.

7.2.4 - Other envisioned concept ideas

In the course of activities aimed at validating the relevance of the proposed conceptual design framework beyond merely the case of the applied concept example developed in this project, some speculations with involved stakeholders took place on alternative outcomes of using the design framework, for the case of different exhibitions.

For instance, the interviewed exhibition maker imagined an interactive mystery setting with hidden features and riddles as a promising concept idea for exhibitions that revolve around paintings and other artworks, regarding the potential need for personal interpretation of works, and the possibilities for playing around with implicitly depicted messages or symbolism.

Neither the interviewed target audience members, involved in testing the applied concept prototype, showed any lack of inspiration to suggest potential alternative outcomes of tech-enabled enhancement designs for random museums they had experienced first-hand. Their imagined suggestions are described in section 6.2.6.

These mentions of imagined outcomes may serve exhibition makers to recognise a need or a potential for experience enhancement of their exhibition project, irrespective of its subject-matter and contents. This project is concluded with the hope that the proposed conceptual design framework for tech-enabled museum experience enhancement will see real-life use in guiding exhibition makers and museum curators alike to successfully effectuate increased visitor satisfaction.

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Appendices

The appendices to this thesis have been provided in a separate supplementary document.

Appendices

Appendix A - Exploratory interview with academic expert

A. Mol is an archaeologist and researcher of storytelling in video games at the Leiden University Centre for Digital Humanities.

(Documentation in Dutch)

Question guide interview

Expertise Angus Mol

- Technologie, digitale tools en game-elementen gaan natuurlijk heel breed, wat ligt er wel (en niet) in jouw straatje?

- Kun je wat toelichten over je expertise in de pre-Columbiaanse Cariben?

Narratief cultureel erfgoed

- Als je het hebt over cultureel erfgoed, in het algemeen en specifiek pre-columbiaanse artefacten, wat is belangrijk voor bijv. tentoonstellers om erover te vertellen?

- Wat ontbreekt er volgens jou nu vaak nog in het narratief?

- In hoeverre kan men (en specifiek hedendaagse bewoners van het westelijk halfrond) zich nog (terecht) identificeren met dit cultureel erfgoed? Gezien er in de huidige culturen vaak zo weinig over is van de oorspronkelijke. Is het erfgoed zonder erfgenaam?

- Ik zou met het delen en laten ervaren van deze artefacten willen bijdragen aan een levende legacy van de oorspronkelijke sieradenculturen; zo dat het een impact heeft op hedendaagse sieradengewoonten: trends inspireren, hedendaagse accessoires toegevoegde betekenis geven in de ogen van de drager. Hoe zou ik dit kunnen bereiken? Dat het verleden op die manier als basis/input dient voor het heden en de toekomst..

Toepassing technologieën

- Hoe kunnen technologieën, digitale tools en game-elementen effectief toegepast worden bij het delen van geschiedenis en cultureel erfgoed?

- Wat kan er qua storytelling en historytelling allemaal mogelijk gemaakt worden met behulp hiervan, wat je mist bij een meer traditionele tentoonstelling? Op welke gebieden kan het waarde toevoegen?

- Hoe kun je de inhoudelijke boodschap en informatie rondom bijv. een artefact volledig overbrengen, maar een ervaring ook immersief, interactief en engaging maken?

- Wat zijn wellicht verdere valkuilen bij de implementatie van zulke tools voor het delen van cultureel erfgoed? Zijn er do's en don'ts?

- Wat voor doelgroepen spreken deze toepassingen in het algemeen aan, en welke vaak niet?

- Zouden nieuwe toepassingen voornamelijk van nut zijn om nieuwe doelgroepen aan te spreken? Of kan tegelijk ook traditioneler publiek ermee bediend worden? Of is dit een een balans/afweging?

- Wie zie jij als mogelijke target audiences van zo'n digitally-enabled tentoonstelling van sieradenartefacten?

- Denk je dat zulke technologieën het best toegepast zouden kunnen worden als aanvulling op een fysiek tentoongesteld artefact? Of wordt (de aanwezigheid van) het artefact er wellicht overbodig door?

- Waar liggen volgens jou de huidige limitaties van digitale toepassingen en technologie mbt historytelling en storytelling?

- Wat voor mogelijke toepassingen van technologieën of game-elementen kun jij je voorstellen om het verhaal van pre-columbiaanse sieraden vollediger te vertellen?

Transcript excerpts interview Angus Mol

15.00
Complexiteit [van een maatschappij] is een term die een bepaalde evaluatie met zich meebrengt. Men kijkt vaak naar technologie-complexiteit, terwijl er veel meer is wat een samenleving definiëert

15:45
Wat sieraden doen: er zijn een heleboel manieren van opsmuk, de esthetiek die eromheen hangt heeft in de pre-columbiaanse wereld niet per se dezelfde connotaties als wat wij eraan hangen. Wij zijn vooral gefocust op Colombia omdat daar zoveel goud is, en de mate van waardering daarvoor is iets wat de Europeanen hebben meegebracht. Goud was zeker belangrijk, maar slechts een onderdeel van een constellatie aan materialen. Er zat kosmologische waarde aan

17.00
In de cariben is schelpwerk bijv. extreem complex, niet de tools maar wel de kunde en het vormgeven

17.30
Heel veel van de sieradencultuur van toen daar nu niet meer bedreven, omdat veel materialen niet compatible zijn. Een hele grote sieradencultuur gebaseerd op schelp kan nu niet uit de grond gestampt worden, schelpsieraden vereisen handmatige craftmanship

18.30
Wij vinden vandaag de dag vaak andere dingen mooi en belangrijk dan de inheemse volkeren van toen. Hun sieraden reflecteren hun waarden, niet de onze, dus zijn daarom niet deel van hedendaagse sieradencultuur.

19.00
Er is veel roofkunst als het om goud gaat, maar in de tussentijd erg veel wat niet eens in de spotlight staat omdat het geen goud is, ook in regio van oorsprong. Landen in regio hebben ook vooral gouden artefacten gevonden en geshowcased om een historisch narratief van trots voor hun natie te kunnen vormen, maar ironisch genoeg dus wel gebaseerd op de waarden van de kolonisator. Het beeld van de toenmalige sieradencultuur is daarnaast ook distorted omdat goud ontzettend goed bewaart.

20.00
Schelpen, veren, body stamps is veel vergaan, kan dus ook moeilijk een impact maken, minder tastbaar

In hoeverre kan men (en specifiek hedendaagse bewoners van het westelijk halfrond) zich nog (terecht) identificeren met dit cultureel erfgoed? Gezien er in de huidige culturen vaak zo weinig over is van de oorspronkelijke. Is het erfgoed zonder erfgenaam?

20.30
Natiestaten zelf claimen eigendom, maar daarbinnen ook nog inheemse volkeren
Nazaten DNA en cultureel zijn er vaak nog, alleen minder in de grote steden en er hangt nog steeds vaak een stigma van lage status aan, dus wordt vaak niet omarmd
Ik zou met het delen en laten ervaren van deze artefacten willen bijdragen aan een levende legacy van de oorspronkelijke sieradenculturen;

Musea zullen ontzettend geïnteresseerd zijn in het bieden van een ervaring waar mensen redelijk massaal sieraden om kunnen doen die fysiek achter glas moeten blijven.

zo dat het een impact heeft op hedendaagse sieradengewoonten: trends inspireren, hedendaagse accessoires toegevoegde betekenis geven in de ogen van de drager. Hoe zou ik dit kunnen bereiken? Dat het verleden op die manier als basis/input dient voor het heden en de toekomst..

1. mensen willen er wat mee omdat ze het identificeren als hun erfgoed
2. als inspiratie laten dienen voor hedendaagse designs
3. werken met influencers, of (instagram) filters; soft / social technology
    - Digitale augmentatie van onszelf (online) gaat vlucht nemen

31.40
Je zou kunnen zeggen dat het misschien niet eens erg is als het verhaal [achter de artefacten] deels uit beeld verdwijnt, als het dan gaat om cultuur levend houden. Musea willen dat verhaal wel altijd op de voorgrond, maar ook dat kan op een toned down manier; het hoeft niet per se exclusief binnen de muren van het museum of alleen te koop in de museumshop; musea willen hun reach juist vergroten, vooral sinds coronatijd.

Wat ontbreekt er volgens jou nu vaak nog in het narratief?

Betreft pre-columbiaanse artefacten wel echt de hoek van die mensen van daar zelf, heden ten dage maar ook zeker in het verleden; die is moeilijk om in tekst uit te drukken, dus met alleen een bordje of een audiotour is het niet mogelijk om dat perspectief echt te ervaren. Sieraden zijn al helemaal ervoor gemaakt om een 'embodied experience' te zijn.

38.30
Hoe kun je de inhoudelijke boodschap en informatie rondom bijv. een artefact volledig overbrengen, maar een ervaring ook immersief, interactief en engaging maken?

- Het moet niet opgedrongen zijn, maar allereerst gewoon leuk
- Wellicht extra leuk voor mensen die al een specifieke interesse hebben
- De informatie moet niet in your face zijn, maar moet je ook links kunnen laten liggen

Het moet eerst engaging zijn, en dan zal een deel van de mensen verder willen kijken. Ook de mensen die niet verder kijken dan de engagement zullen op zijn minst een positieve ervaring gehad hebben met een stukje verleden dat ook belangrijk is voor andere mensen; ze zullen wel een associatie houden met 'pre-columbiaans' en dat onthouden, wat op zich al een grote winst is als het op erfgoed aankomt.

41.00
Zouden nieuwe toepassingen voornamelijk van nut zijn om nieuwe doelgroepen aan te spreken? Of kan tegelijk ook traditioneler publiek ermee bediend worden? Of is dit een balans/afweging?

Je kan niet iedereen bereiken met een medium, dus dat zou ik niet proberen, maar er kunnen wel meerdere media zij aan zij bestaan. Wel is het ook zo dat de technologie geen obstructie moet vormen. De informatie moet geen obstructie vormen en de technologie niet. Verschillende publieken zullen verschillende aanvliegroutes hebben; sommigen zullen ertoe aangetrokken zijn vanwege het feit dat er VR in het spel is.

43.00
Wel hebben musea in het algemeen meer moeite om jongere mensen binnen te halen, dus het is waardevol om die doelgroep aan te kunnen spreken. In het algemeen zijn jongere mensen meer geïnteresseerd in technologische toepassingen, maar niet als gadget. Alleen om een VR bril op te kunnen zetten zullen ze het niet doen, ze zijn minder snel onder de indruk en worden er minder op zich door getrokken. Er zijn bredere en specifiekere keuzes te maken [van VR tot instagram filters] als toepassing.

44.40
Wie zie jij als mogelijke target audiences van zo'n digitally-enabled tentoonstelling van sieradenartefacten?

Ligt aan toepassing. Met een AR overlay zijn het smartphone-savvy mensen die een app willen installeren, daartoe bereid zijn.

Met VR moeten die tools er wel liggen en er moet iemand zijn ter begeleiding.

- Beginnen met audience, dan tool selecteren

49.00
Denk je dat zulke technologieën het best toegepast zouden kunnen worden als aanvulling op een fysiek tentoongesteld artefact? Of wordt (de aanwezigheid van) het artefact er wellicht overbodig door?

Nee, want het fysieke object zal altijd het ankerpunt van de betekenis zijn. Dat is wat het verhaal kracht geeft. Dus het authentieke artefact (of het narratief ervan) zal op een of andere manier geïntegreerd moeten zijn.

52.30
Remixes van het origineel zijn ook cultureel interessant voor weer een andere groep mensen. Zoals een oud sieraad-artefact, waar een moderne draai aan gegeven wordt. Verschillende authentieke dingen, of nieuwe, samenbrengen tot nieuwe.

53.30
Waar liggen volgens jou de huidige limitaties van digitale toepassingen en technologie mbt historytelling en storytelling? Wat zou waardevol zijn om te laten beleven, wat we vanwege tech limitaties wellicht nog niet mee kunnen geven?

Met sieraden sec, is hoe het daadwerkelijk voelt om het object te ervaren en om te hebben nog moeilijk, wellicht kan daar met 3D printing enigszins in de buurt gekomen worden. Het ervaren met meer zintuigen dan alleen het visuele is nog een technologische horde die in dit veld nog weinig overkomen wordt.

1.01.15
Speelsheid is een heel belangrijke factor als het gaat om engagement, meer nog dan het visuele. Game-elementen, maar ook speelse filters, grappig.

1.03.15
Streven om link te leggen tussen traditie verleden en het heden; dan is het waardevol om contact te zoeken met mensen die nog echt contact hebben met dat verleden, vooral ook mensen die de heritage niet alleen in hun DNA hebben maar het ook op een bepaalde manier beleven, en heldere ideeën hebben over welke dingen misschien beter níet gedaan zouden moeten worden (zoals: artefact mag echt niet gedragen worden door mannen).

Appropriation is ook een touchy verhaal waar je rekening mee moet houden bij je invulling.

In contact met museum vragen of ze me in touch kunnen brengen met iemand die me meer kan vertellen over het belang van dit soort objecten in de huidige samenleving en ook vroeger vanuit eigen ervaring.

Appendix B - Notes of interview with 3D printing industry expert

Deeper insights into the state of the art of 3D printing technologies and their applications were gained through a personal interview with B.J.L. Leferink, in March 2022. As a business executive at SLM Solutions Group and longtime insider of the additive manufacturing industry, Leferink has expert knowledge of the potential applications of 3D printing technologies, the spectrum of different 3D printing techniques, the industry's leading firms and the latest advancements in manufacturing capabilities.

Industries applications

- Medical (implants).
- Aerospace (propulsion systems, blades).
- Automotive/mobility.
- Energy (manifolds, pumps, turbines).
- Maintenance and repair, on-demand production.

Reasons

- Another method is less cost efficient or unable in terms of optimised design.
- Weight reduction.
- Customisation.
- modelling, mockups; to get an accurate representation of the original.

Jewellery industry

- Tooling for jewellery, 3D printed resin and lost wax casting Ook voor mass production geschikt als het om kleine objecten gaat die je in bulk kunt printen.
- Lost wax casting; Solidscape jewellery resin printers.
- The acidity of fingers may cause metal models to oxidise; this is less of an issue with plastics.
- Cooksongold – EOS printers for sintering gold.

Museum industry

- 3D printed artefacts models are already being made for museums on some occasions.
- Models are ordered by museums and manufactured by on-demand 3D printing service providers.
- Any replication of owned artefacts will require consent from the owner.

Appendix C - Notes of interviews with museum sector insiders

Two exploratory interviews were conducted with young adult individuals with expertise in the museum sector, specifically an independent curator and a development & fundraising museum employee. The main areas of interest for these interviews were the nature of partnerships museums commonly operate in with external parties in order to realise an exhibition, and the formation of budgets by all stakeholders to invest in and realise an exhibition.
The notes taken of the information shared by these insiders would prove to be valuable sources for reference at a later stage, when building insight into the general revenue buildup of museums.

Independent exhibition maker

M. Reinen is a Dutch-Curaçaoan music collector, cultural documenter and curator of a museum exhibition about his findings on the forgotten music scenes of the former Netherlands Antilles. The partners with whom he is collaborating on the project have much experience in the museum sector to contribute, and their exhibition has drawn interest from the Rijksmuseum, Stedelijk Museum and Tropenmuseum. The exhibition is to be finished and opened for visitors around the summer of 2023, and will be presented for a duration of two to six months.

(Documented in dutch)

Welke doelen hebben jij en het museum met het maken van de tentoonstelling?

Externe curator:
1) mensen die gepresenteerd worden een platform geven dat ze verdienen maar nooit gehad hebben; eerbetoon.
2) Als rolmodellen portretteren voor nieuwe generatie.
3) inzicht geven aan bezoekers over cultuur en bestaan op een andere plek.

Museum:
1) Zichzelf als 'woke' presenteren en meegaan met de hedendaagse tijdgeest.
2) Ongehoorde verhalen en gebeurtenissen gehoord maken; dit is echt een trend bij de meer prominente musea in Nederland.

Wat voor verhouding heb je als tentoonstellingsmaker met het museum? Is het museum een klant die een product bij jullie afneemt? Werken jullie in opdracht van het museum? Hebben jullie enkel toestemming gekregen om een ruimte zelf te vullen? Is het een samenwerking met gelijk partnership en gedeelde belangen/opbrengsten?

Externe curatoren werken voornamelijk als zzp'ers.

Eerdere ervaring met het maken van een tentoonstelling of een succesvolle pilot is essentieel voor musea om curatoren te beoordelen en ze een kans te geven; musea hebben altijd maar beperkte middelen, dus ze committeren zichzelf niet zomaar aan een project.

Museum toont interesse; 'wat heb je ervoor nodig?'.

Budget in overleg vastgesteld op basis van benodigdheden en verwachte impact van plannen.

Daarbinnen veel vrijheid voor externe curator.

Collecties in eigen bezit museum worden grotendeels binnenshuis vormgegeven door eigen curatoren.

Tegenwoordig steeds vaker externen ingehuurd/betrokken om expertise toe te voegen (bijv. Indonesische experts voor Indonesisch erfgoed, voor discourse).

Culturen die vroeger gemarginaliseerd werden onder koloniale heerschappij kunnen evenmin als andere culturen in een vacuüm vastgelegd worden, zoals vaak gebeurt in Westerse musea; de objecten passen dan niet in de uitheemse omgeving. Culturen leven en veranderen door de tijd heen, dus er is zeker een hedendaags aanknopingspunt voor historische objecten. In een land ver van de oorsprong vandaan zijn er limieten aan de compleetheid waarmee ze tentoongesteld kunnen worden. Gelukkig zijn musea al veel bewuster dan vijf jaar geleden, en dat bewustzijn is het belangrijkste beginpunt voor verbetering.

Hoe wordt de totstandbrenging van een tentoonstelling gefinancierd?

Fondsen en subsidies.

Uit potje van museum (tickets, verkoop, locatieverhuur, donaties, sponsoren).

Als je al naamsbekendheid hebt dan kan het zijn dat het museum de financiering compleet voor je rond maakt.

Externe curators en musea hebben allebei geen winstoogmerk, ze willen vooral de inhoud tentoonstellen en verspreiden.

Hoe groot zijn algemeen de budgetten van musea en makers voor investeringen in tentoonstellingen?

Er zijn tentoonstellingen die 4.000 euro vereisen om te realiseren, maar ook andere die 50.000 kosten, of meer. Dat hangt af van wie het maakt en wat er nodig is, wat het museum wil bereiken en hoe breed de publieke interesse is.

Fondsen zullen nooit het volledige bedrag betalen; altijd samen met geld van het museum of van een private geldschieter.

Van fondsen krijg je in het algemeen maximaal zo'n 25.000 euro; van Europese heel soms max 60.000, maar dan moet je ook een breder maatschappelijk doel dienen met je project dan alleen cultuur.

Vooral voor grotere projecten komt vaak een groot deel van het geld van het museum zelf, die het uiteraard ook weer ergens van krijgt.

Als het museum je al financieel steunt is het ook makkelijker om het verder rond te krijgen met subsidie, die wordt dan eerder toegekend.

Is het budget dat jullie nu hebben genoeg om alles te doen wat je zou willen doen?

Nee, maar je kijkt hoe ver je komt met het geld dat je is toegekend, en als dan blijkt dat je voor bepaalde dingen die je nog wilt/moet doen meer nodig hebt kun je daar gewoon weer een aanvraag voor indienen die meestal wordt toegekend als je ze kan overtuigen van het belang, en dat is ook makkelijker dan in het begin.

Hoe wordt er inkomen gegenereerd en door wie?

Royalty's voor kunstenaar/eigenaar

Werk kan soms verkocht worden (soms commissie voor museum)

Ticketverkoop, museumshop etc

Welke voorwaarden stel jij aan een museum om ermee in zee te kunnen gaan?

Makers hebben een heel goed beeld van wat ze willen delen, dus hoe dat over te brengen daar moet het museum goed naar luisteren en daar moet ruimte voor zijn, binnen het budget dat er beschikbaar is.

Kunstenaars met naamsbekendheid kunnen eerder volledige autonomie eisen.

Museum employee Development

E. Boreel is a Development employee at the Amsterdam Museum, meaning she works to develop proposals, raise funds and direct income flows related to the realisation of exhibitions in the museum. The Amsterdam Museum, which focuses on being a 'network museum', collaborates extensively with external curators for most of its exhibitions, and sees a steady rotation rate for its temporary exhibitions.

(Documented in Dutch)

Hoe wordt de totstandbrenging van een tentoonstelling gefinancierd? Hoeveel kan zoiets kosten?

Er zijn 3 takken:

1) fondsen PB Cultuurfonds, Fonds 21, Mondriaanfonds

Daar kunnen we met een voorstel naartoe waarin uitgelegd wordt welke toegevoegde waarde het zou hebben om uit te voeren

Programma wordt samengesteld door curatoren, en met begroting en andere details doorgestuurd

Bijdrage van fonds wordt vermeld op bordje en flyers van de tentoonstelling

2) Sponsoring door bedrijven

- Imago 'corporate social responsibility'
- Bedrijven krijgen er vaak iets concreets voor terug (benefits)

3) Particuliere 'patronage'

- Donaties van mensen die het museum graag ondersteunen
- Exclusieve uitjes en evenementen van het museum voor de patrons

Ticketverkoop en de museumshop zijn uiteraard inkomstenbronnen, maar zijn er nog andere verdienmodellen relevant voor het museum?

Geld voor development komt voornamelijk van inkomsten van derden

Daarnaast ticketverkoop, museumshop, zaalverhuur

Musea zijn in het algemeen niet financieel zelfstandig door hun activiteiten, het moet altijd wel gesubsidieerd worden

Cultuurinstanties zijn een ‘merit good’ oftewel het is goed voor de maatschappij dat ze bestaan, en daarom draagt de overheid eraan bij

Musea zouden niet op dezelfde manier kunnen bestaan als het volledig commerciële instellingen waren

Heeft het museum daarmee een soort algemeen vermogen of wordt subsidie alleen toegekend voor specifieke voorstellen?

Bij fondsen voor iets specifieks, bij particulieren is het meestal een algemene gift waar het museum zelf mee kan beslissen wat ze ermee doen.

Wat voor verhouding heeft het museum normaalgesproken met externe partijen? Is het museum een klant die een product afneemt? Is het museum een opdrachtgever die bepaalt hoe iets uitgevoerd moet worden? Geeft het museum enkel toestemming voor het gebruik van de eigen collectie of de ruimtes? Is er samenwerking met gelijk partnership en gedeelde belangen/opbrengsten?

De mate verschilt per museum, maar er wordt bijna altijd op bepaalde vlakken wel samengewerkt met externe curatoren

De uitvoering van tentoonstellingen gaat ook altijd samen met aannemers, art handlers etc.

Externe curatoren worden vaker uitgenodigd voor tijdelijke tentoonstellingen, en werken dan op sommige vlakken samen met de eigen curatoren om het allemaal rond te maken

Vaste tentoonstellingen zijn meestal de verantwoordelijkheid van de eigen curatoren van het museum, die hebben het dan ook inhoudelijk helemaal voor het zeggen

Externe curatoren delen niet mee in de opbrengsten van de tentoonstelling, maar het realiseren van de tentoonstelling wordt wel (deels) gefinancierd en ze krijgen uitgebreide exposure.

Voor intern gecureerde tentoonstellingen waarvoor bepaalde expertise nodig is (uitheems cultureel erfgoed bijv.) worden regelmatig zzp’ers in dienst genomen om mee te werken, maar er zijn ook nog musea die dit enigszins nalaten en het vanuit hun eigen perspectief cureren.

Ik zou graag wat beter willen inschatten of concepten die ik ontwikkel commercieel viable zijn. Hoe groot zijn in het algemeen de investeringsbudgetten en operationele budgetten voor een vernieuwde tentoonstelling? Voor hoeveel jaar worden zulke investeringen gedaan?

Verschilt enorm per tentoonstelling, maar 100.000 euro budget voor een tentoonstelling is niet ongehoord

Fondsenwerving is altijd nodig, investeringen worden nooit gedaan met het uitgangspunt om break-even te draaien op omzet die gegenereerd wordt door die investering.

Kijk naar jaarcijfers voor inkomsten en uitgaven

Richt het museum zich voor commercieel succes eerder op het omzetten van populariteit in hogere bezoekersaantallen of in het kunnen vragen van een hogere entreeprijs?

De entreeprijs blijft hetzelfde, om het museum niet nog minder toegankelijk te maken voor mensen met een kleine portemonnee ten opzichte van meer vermogende mensen. De prijzen zijn al erg hoog daarvoor, met een heel gezin ben je al met al zo 80 euro verder.

Appendix D - Introduction to pre-Columbian adornment

The ways in which humans shape jewellery, and in which it shapes us, are an expression of society, and continuously evolve along with said society. Thus, contemporary jewellery and adornment habits are often an embodiment of ages of cultural heritage.
For example, the Western tradition of wedding rings can be traced back all the way to ancient Egypt, Greece and Rome (Chesser, 1980), and has been carried into the modern day through Christianity (Vikan, 1987).
When renaissance painter Albrecht Dürer, in service of Holy Roman Emperor and King of Spain Charles V, was presented with jewellery artefacts from the New World sent over by conquistador Hernán Cortés, the artist was deeply impressed by these artefacts. He admired them not only for the objects' quantities of gold and alien provenance, but also especially for their beauty and craftsmanship. Most other Europeans only saw the potential riches though, and set to melting down whatever gold and silver artefact they could get their hands on. Only since the establishment of the field of archaeology in the late modern period of history have many pre-Columbian indigenous jewellery artefacts been excavated. Throughout the twentieth century they were often seen as decorative trinkets and many ended up in homes and private collections. It took until the 1970s before the recognition of these artefacts' significance as pieces of cultural heritage resulted in them being exhibited in museums, garnering awe from the wider public for their opulence and craftsmanship (Colburn, 2005).

Varieties

With the continent of the Americas having been home to countless different cultures throughout the millennia, there were of course many different forms of jewellery and adornment customs. What members of a society produced, wore and practised depended on the available materials and crafting technologies or skills, the society's hierarchical structure and the symbolic meaning attributed to certain forms or materials, among other factors. Pre-Columbian jewellery is thus actually a very broad umbrella term, that disregards the huge differences which one may expect between societies across all of human history on an enormous continent.
Generally however, it is safe to say that pre-Columbian adornment habits were far more lavish than most present-day Western counterparts, with some jewellery the product of craftsmanship unparalleled anywhere in the world, especially at the time.

Types of jewellery include necklaces, bracelets, ear ornaments and headdresses, but also nose ornaments, lip plugs, pectoral plates, belts and masks. Additionally, adornment practices in the way of body stamping with ceramic stamps and paint was commonplace in many cultures across the Americas.
Adornment also had several societal functions across pre-Columbian cultures. The most obvious of these is to serve as a status marker, but objects, shapes and patterns could also carry a range of symbolic meanings, be these ceremonial or spiritual, or even to instil fear among others.

Notable cultures throughout history

Though adornment practices are as old as human civilisation, the oldest archaeological finds of what we could call jewellery in the Americas date from around 5000 years ago. Perhaps unexpectedly, the first jewellers of the Americas were not those of a South American or Mesoamerican society, but of the Old Copper Complex, which existed from about 4000 - 1000 BC around the area of the Great Lakes in North America. All metal

jewellery originating from pre-Columbian North America was copper. Indigenous North American societies did not have knowledge of metal smelting, but the exceptionally high purity copper ore found in the region could be pounded into shape. Old Copper Complex jewellery is relatively rudimentary, but it laid the groundwork for later civilisations, most notably the Mississippian culture (800 - 1600 CE), to craft far more refined copper jewellery.

The continent's earliest evidence suggesting copper smelting into jewellery around 2000 BC was found in the central Andes, in modern-day Bolivia (Eichler et al., 2017). It was also around this time that the earliest gold jewellery artefacts were made through cold-hammering around Lake Titicaca, nowadays on the border of Bolivia and Peru (Aldenderfer et al., 2008). Successive societies in the central Andes would further develop goldworking techniques, but it was not until the 1st century AD that the Moche of present-day coastal northern Peru fully mastered smelting (Hörz & Kallfass, 2000). Their knowhow of goldworking spread to peoples in the northern Andes and eventually Mesoamerica, with many a society that attained it developing and spreading novel techniques for making higher quality and more intricate jewellery.

Moche (0 - 700 CE)
The Moche were the first masters of gold smelting, which also enabled them to produce tumbaga, an alloy of gold with copper and sometimes silver. Tumbaga facilitated more accessible crafting of quality jewellery, and was adopted by all the goldsmithing societies of the continent (Hörz & Kallfass, 2000).

Sicán (750 - 1375 CE) **/ Chimú** (900 - 1470 CE)
The Sicán and their neighbours (and eventual conquerors) the Chimú built upon the legacy of the Moche and produced jewellery on an increased scale compared to their predecessors (Shimada & Merkel, 1991).

Figure x: Sicán gold ear flares (source: Metropolitan Museum of Art).

Figure x: Chimú silver nose ornament (source: Museo Larco).

Muisca (800 - 1540 CE)
The Muisca, along with other peoples of present-day Colombia, would be the ones to adopt lost-wax casting technology on a wide scale. This process facilitated the production of jewellery with far more intricate and three-dimensional features.

Figure x: Muisca gold bracelets, at the Museo del Oro, Bogotá (source: Wikimedia Commons).

Tairona (900 - 1600 CE)
Jewellery made by the Tairona people can be characterised by an emphasis on three-dimensional forms, and their works are among the most intricately detailed and finished of all pre-Columbian artefacts (Metropolitan Museum of Art, n.d.).

Figure x: Tairona tumbaga pendant of a richly decorated figure (source: Metropolitan Museum of Art).

Mixtec (1000 - 1450 AD) **/ Aztec** (1300 - 1521 CE)

Many artefacts of the Aztec and Mixtec of Mesoamerica did not survive the sixteenth century, as the region bore the brunt of Spanish looting in the Americas perhaps more than any other. The artefacts that did survive show the extent to which jewellery smithing developed further since knowhow spread from South America and was established in Mesoamerica (Metropolitan Museum of Art, 2016).

Figure x: Aztec gold serpent lip plug with movable tongue (source: Metropolitan Museum of Art).

Figure x: Mixtec gold necklace with beads in the shape of jaguar teeth (source: Metropolitan Museum of Art).

Maya (1000 BC - 1511 CE)
The Maya are a cultural grouping of peoples that built many different cities and societies throughout most of Mesoamerican history. The heyday of the classical Maya civilisation however, took place long before knowledge of metalworking would spread to Mesoamerica. Thus instead of gold or silver, to the Maya the most esteemed and symbolically significant material to make jewellery with was the mineral jadeite, better known as jade (Taube, 2005).

Figure x: Maya jade pendant depicting a ruler wearing the headdress of a supernatural being (source: Metropolitan Museum of Art).

Taíno (0 - 1500 CE)

The Taíno did not have the knowhow to smelt metal, though they did import tumbaga from the Caribbean mainland and cold-hammered it into ornaments (Fitzpatrick, 2015; Martinón-Torres et al., 2012).

That said, the Taíno were exceptionally skilful craftsmen when it came to shell carving, which was a very delicate process. (Mol, personal interview, October 2021). They also made widespread use of paints and ceramic stamps to decorate the body (Fitzpatrick, 2015).

Figure x: Taíno shell carved pendant depicting face (source: Mol, 2011).

Figure x: Illustration of Taíno adorned with body paint and shell jewellery (source: Fitzpatrick, 2015).

Symbolism and indigenous values

Upon the arrival of the Spanish in the Americas the natives might not have been familiar with the Eurasian concept of precious metals and stones having monetary value as currency (King, 2002), but adornment in these societies did always have a certain meaning and was practised for several different motives.

The most obvious of such motives is to adorn oneself in order to signal one's status. While less prohibitive forms of adornment such as body paint, wooden beads and woven ornaments were widely prevalent, jewellery made out of metals or precious stones, like jade, turquoise and obsidian, universally served as status markers (King, 2002).
Gold jewellery was considered especially prestigious due to the material's rarity as well as intricate crafting processes, and was reserved for royalty and nobility in several Mesoamerican and South American cultures (King, 2002). Groups like the elite warrior class of the Muisca confederation in present-day Colombia, the Guecha, earned the privilege to wear gold jewellery and could expand this privilege to wear more jewellery as a reward for valiant acts in battle (De Piedrahita, 1881).

Figure x: Illustration depicting a Muiscan Guecha warrior (source: Stronghold Nation).

A prevalent theme in the adornment practices of essentially every pre-Columbian society is zoomorphism; incorporating animal shapes, figures and attributes, to refer to a symbolic

meaning or power attributed to the animals in question by these societies. In some instances humans would adorn themselves to take on the appearance and image of a certain animal, to embody its power. Among many societies zoomorphic elements were popular with jewellery of all classes due to their symbolic and aesthetic value, but it was not uncommon for zoomorphic elements to be reserved for artefacts with a ritualistic purpose, such as jewellery worn by shamans during religious ceremonies (Paz, 1995; Red Cultural del Banco de la República, 2017).

Figure x: Tairona golden nose ornament, zoomorphic (butterfly). Likely worn by a member of the Tairona's powerful shaman elite class (source: Red Cultural del Banco de la República, 2017).
Butterflies were seen as the reincarnation of fallen warriors, and were omens of good fortune, transformation and change. Shamans would call upon the power of the butterfly to look at problems on a small scale and understand its details, to subsequently find a solution and bring about a positive change (Talismanes y Amuletos, n.d.).

Figure x a & b: Chimú gold headdress and ear ornaments (source: Museo Larco).
This set includes several zoomorphic features: a feline face, a bird's beak and wings, and serpents. These are the three sacred animals of this society of present-day northern Peru. By wearing this jewellery their ruler would embody the symbolic power of these sacred animals and display his own supreme power (Museo Larco, n.d.).

Figure x: Aztec or Mixtec gold necklace ornaments, zoomorphic (frogs) (source: The Metropolitan Museum of Art).
Frogs, as well as shells and turtles, are animals the Aztecs associated with water and rain, and the life it sustained. Adding to this the fact that frogs are known for laying large quantities of eggs and "assume a squatting position similar to that of women in childbirth", made them be regarded as symbols of fertility (The Metropolitan Museum of Art, n.d.).

The adornment of warriors oftentimes served an additional purpose in battle. A warrior decked out in an impressive attire, such as the aforementioned Guecha, was seen as transcending the state of a mere mortal, boosting the morale of the warrior himself. His imposing appearance was meant to strike fear into the hearts of his enemies.
To give another example, the elite military forces of the Aztecs consisted of eagle and jaguar warriors, their ranks reserved for the nobility. The Aztecs saw the eagle as the ultimate warrior symbol, and also associated it with the Sun at its peak. The eagles warriors were seen as the divine chosen ones to feed the Sun through the sacrifice of their own blood; this made them immune to pain and capable of risking their lives unconditionally. The eagle warriors' armour was covered in real eagle feathers, and dog fangs were sometimes worn through holes in a warrior's mouth to intimidate enemies and to display the strength and ferocity of the warrior (Aguilar-Moreno, 2006).

Figure x: Aztec stone statue of eagle warrior head, at the National Museum of Anthropology in Mexico City (source: Instituto Nacional de Antropología e Historia, n.d.).
The holes in the corners of the statue's mouth support the suggestion that dog fangs would be inserted (Aguilar-Moreno, 2006).

Figure x: Aztec terracotta statue of eagle warrior, at the National Museum of Anthropology in Mexico City (source: Jarvis, 2015).

Aside from the religious significance placed on animals, the precious metals and stones out of which artefacts were crafted bore divine connotations for most pre-Columbian societies. To the Maya, jade was closely associated with the spirit of wind, breath and life, and the mineral played an important role during funerary rites as well as rituals for conjuring and embodying ancestors (Taube, 2005). The Aztec word for gold literally

translates to ‘excrement of the gods’ (King, 2002), while the Inca saw gold as ‘the sweat of the Sun’ and silver as ‘the tears of the Moon’ (Davies & Fini, 1995).

Figure x: Maya flower-shaped ear flares of stone and jade, at the Los Angeles County Museum of Art (source: LACMA, n.d.).
Jade ear spools with floral forms were seen as supernatural sources or passageways for the breath spirit, which could be embodied by the wearer (Taube, 2005).

The Muisca were another people who saw gold not as simply a token of prosperity, but a spiritually powerful matter. They believed gold strengthened the connection to their gods and sacrificed it to encourage the gods to bring harmony and balance to their society, their environment and the universe. For the Muisca the sacrifice of gold and emeralds played a big role in important rituals such as the initiation ceremony of a new chief. The initiation would be finalised by the new chief and the four highest priests paddling out to the centre of their sacred lake, Lake Guatavita in central Colombia. The naked chief would be covered in gold dust and would throw gold artefacts, gemstones and other precious objects into the water as an offering to the gods (Cooper, 2013; Museo del Oro et al., 2013).

Figure x: Muisca golden model of the ritual raft, the chief, priests and rowers, found in 1969 and displayed at the Museo del Oro in Bogotá (source: National Geographic España, 2019).
This artefact representing the chief inauguration ceremony is the primary piece of supporting evidence to the accuracy of 16th-century Spanish sources, which were the only ones who had described the ritual (Museo del Oro et al., 2013).

Appendix E - Notes of observational study

Observations on exhibitions:
everything is categorised based on geographical origin, displayed out of context.

Context in exhibition rooms sometimes added with sounds and imagery typical of region.

[Indonesia:]

The participants cluster together and interact with all the others on topic of exhibition, even though they just met.

They draw parallels to (their own) modern-day culture:

- insert memes and jokes
- not only serious

“The middle one is compensating for something with his big gun”

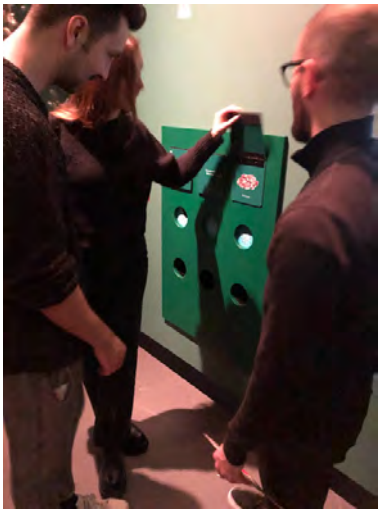
Initially they don't ask a lot of questions, but mainly just take it in.

Participants remark:
"Not a coincidence that there is so much stuff from Indonesia here"
[Dutch participant]: "Slightly uneasy feeling"
[Spanish participant]: "Yeah, I wonder how all the Aztec artefacts in the next room will make me feel"

- They show sensitivity to contested heritage.

[Aztecs:]

Interactive pieces in exhibition are obviously intended for children (children's height, only in Dutch, cartoons), but the participants show more engagement with the interactive 'children's' exhibits than with most of the authentic artefacts in the display cases.


They do read main texts, but not small signs of most individual pieces.

“Shame that the obsidian mirror isn’t positioned to show how it reflects”

They do note small details of the collection items: “All of the ceramics are three-legged”.

They don’t give up on trying to understand something that confuses them initially but looks very intriguing (Aztec book). Speculations for 2 minutes, everybody joins to check it out.
1: “It’s like a comic with all the pictures”
2: “Yeah I’m not sure what I’m seeing”
1: “Do you think the pictures have a linear narrative?”
2: “Maybe, but then it doesn’t make any sense to me.”
2: “Here it says it’s part of a larger series on how possible marriage practices are performed”
1: “Ah, so it does have a narrative.”

- Interest shown by one participant attracts the interest of other participants.
- QR codes beneath display case are completely ignored.
- A second book in the next room gets far less attention.

No music or audio in some rooms; silence is not broken as much with discussion or talking.

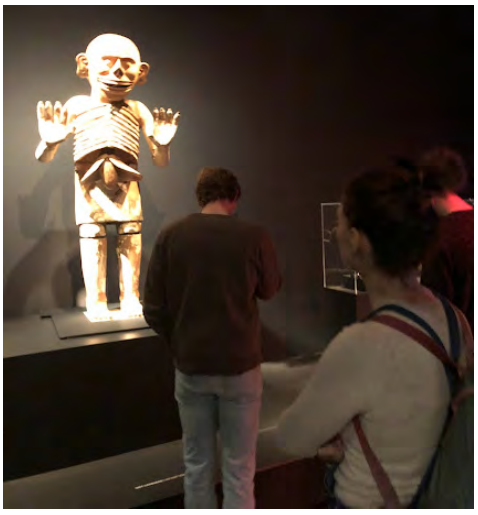
“What [building] do these [stone structure] pieces belong to?”

From their own accord they don’t wonder or question much about artefacts’ symbolism or background mythology, but in instanced when it is well-presented they do find it engaging.

The participants are shocked by a statue depicting a figure wearing the skin of another person.

They don’t seem particularly impressed or interested in the only pieces of gold jewellery of the exhibition.

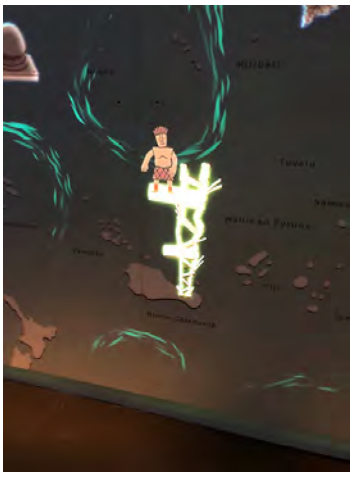
They are impressed by a statue and decorated skulls (displayed out of context): “pretty creepy”



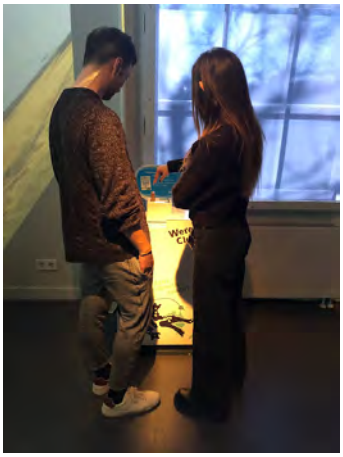
[Oceania:]

Projection of button - “Is this for nukes? Oh it is!”
Everyone presses at some point.

“Oh cool, I read about this jumping ritual once!” - interest from recognition.

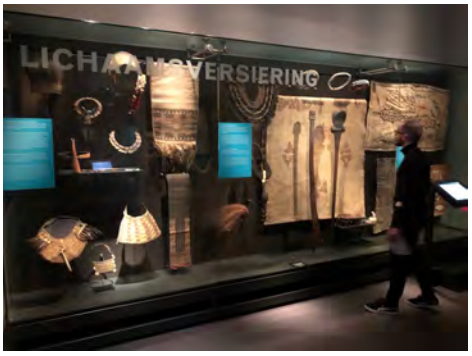


Participants show interest in interactive stamp collection machine, but it turns out that it is intended for children and participants had not received stamping card at ticket desk.



Every participant seems very aware of when the others are (not) moving on.

Little attention for adornment objects in display case.



Music and sounds seem to have an activating effect on the participants.

Hesitation to even enter 'Australian art' room, little curiosity.

[Japan:]

Participants moved through this exhibition quickly, but enjoyed seeing a maquette of Dutch trading post in Japan.

Quote on wall noted as interesting impression of cultural values

- Discussion about value in question, Nissan GTR vs Ferrari comparison

"Confusing to miss context, like with these dolls next to ornamental daggers"

[North America/Arctic:]

"I wonder how the salmon skin raincoat feels!"

"Oh, but that's metal, so not super old", shows awareness about culture's history, but has to deduct from the object itself to speculate.

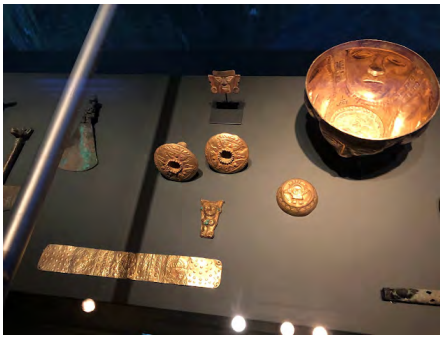
[Middle & South America:]

Participants are intrigued by syncretism Christianity and indigenous art.

At display case with adornments and outfits with silhouettes on the glass to show how it was worn, participants stand in shape of silhouettes jokingly embodying the outfit.

Around end:

- Participants claim to be desensitised to all the objects
- Few impressions made
- Sitting down
- Barely a glance at golden pre-Columbian artefacts in display case



Short show of curiosity to find out what pins were used for.

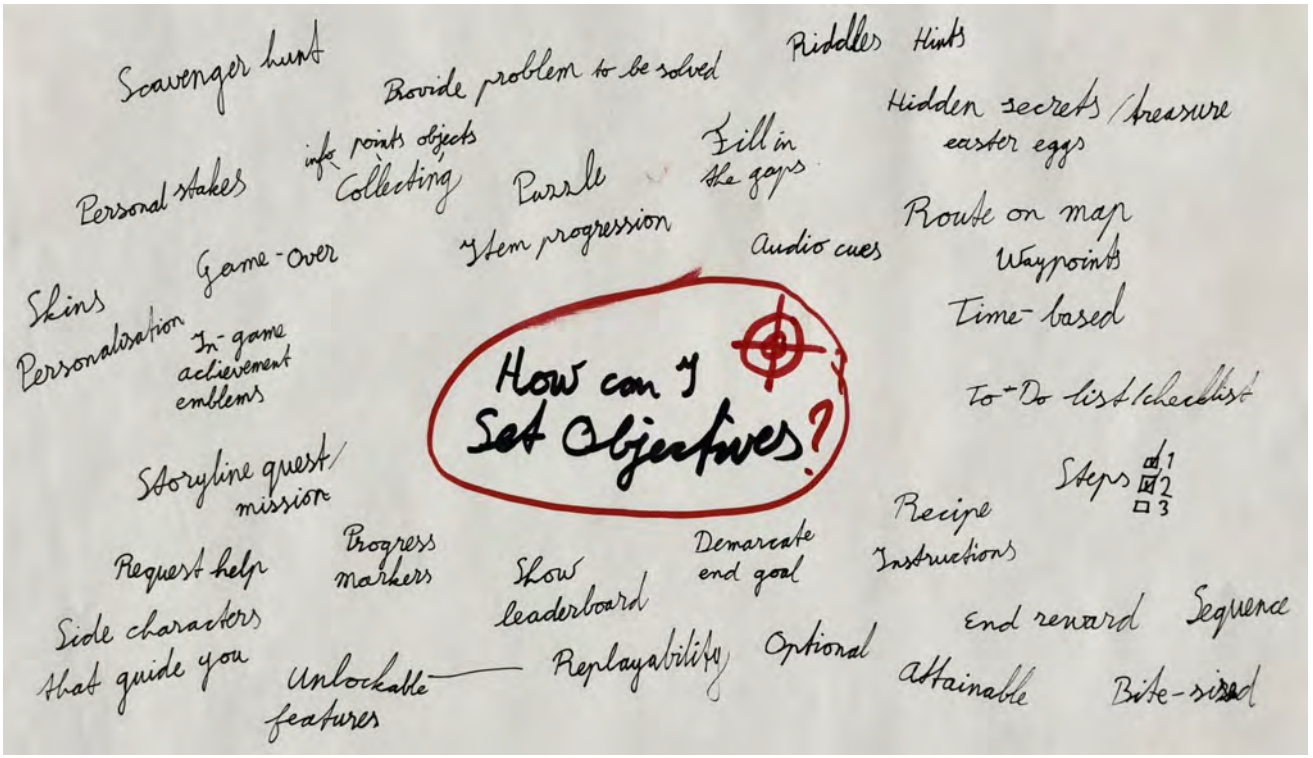
Shortly renewed interest when passing through another exhibit on way out, they slow down to see but they don't stop.

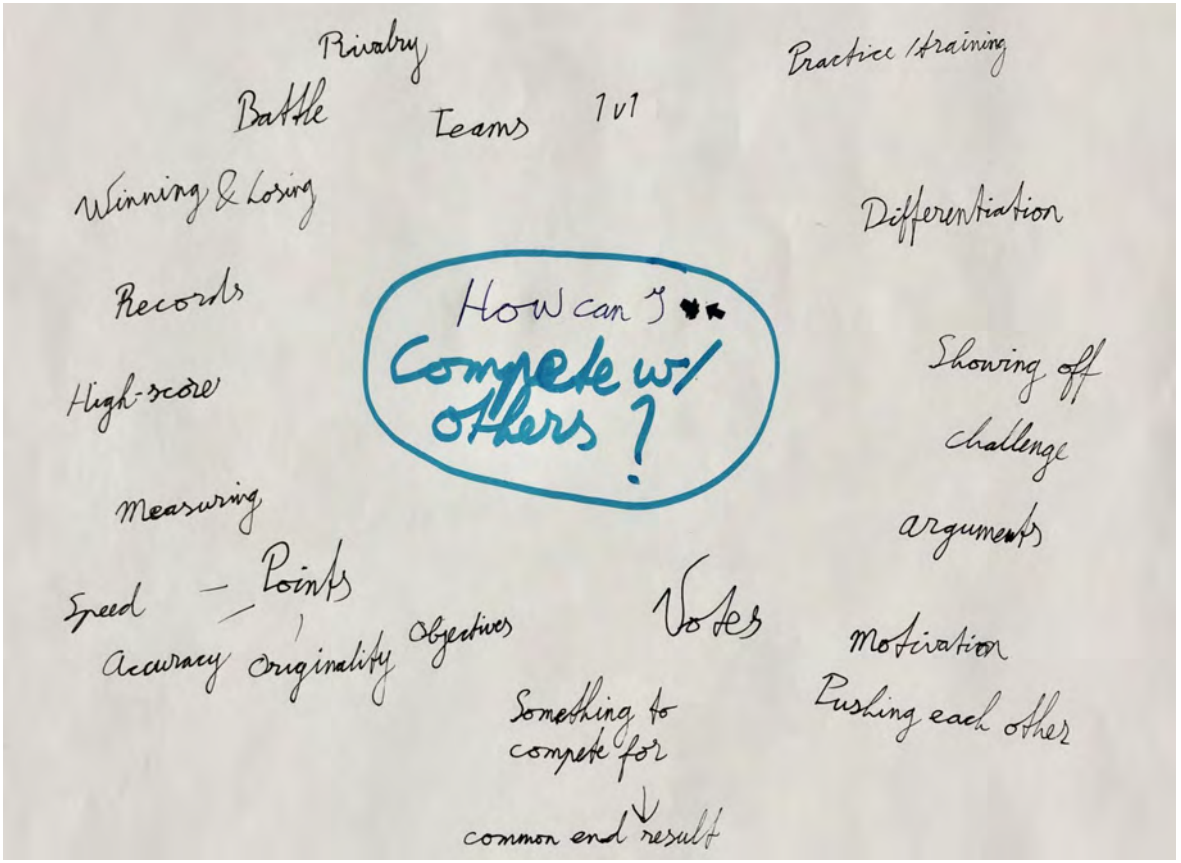
Museum employee at exit about Aztec pendant replica: "They are for the children's route at the exhibition. Almost all children take it home, after first coming to us with a sad face thinking they have to hand it in."
While taking photo of pendant a little girl walks by and instantly shifts her attention to it.

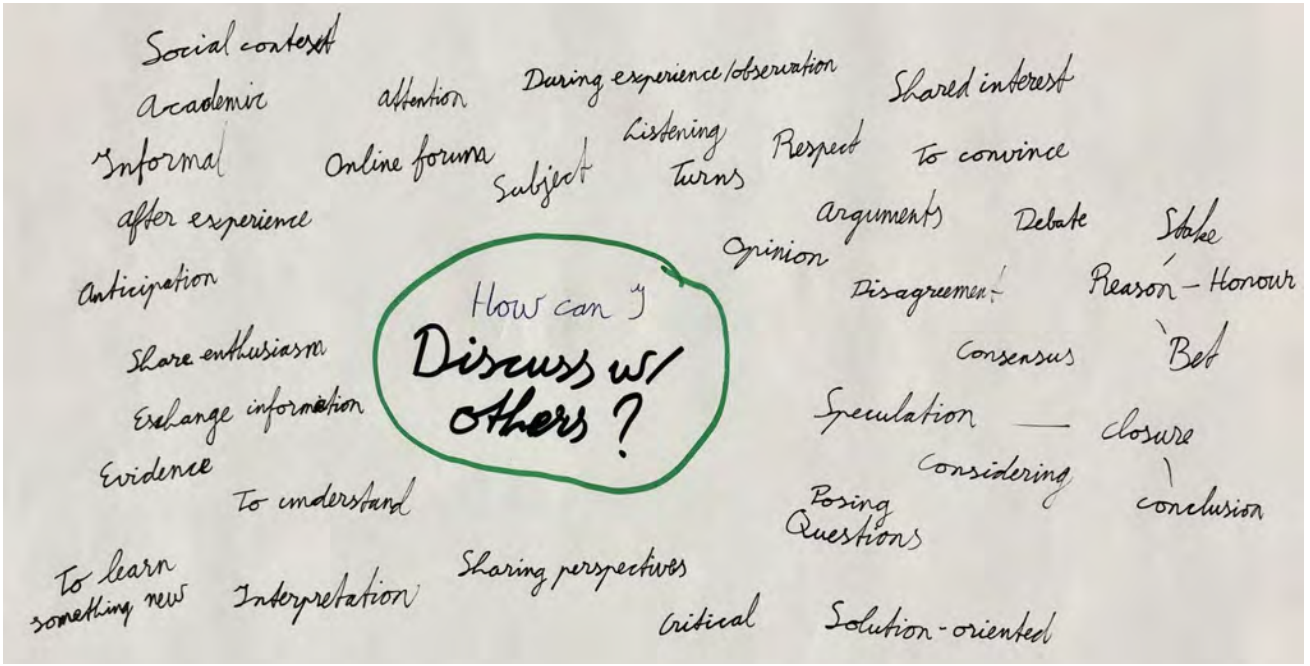
Appendix G - 'How-to' mind maps

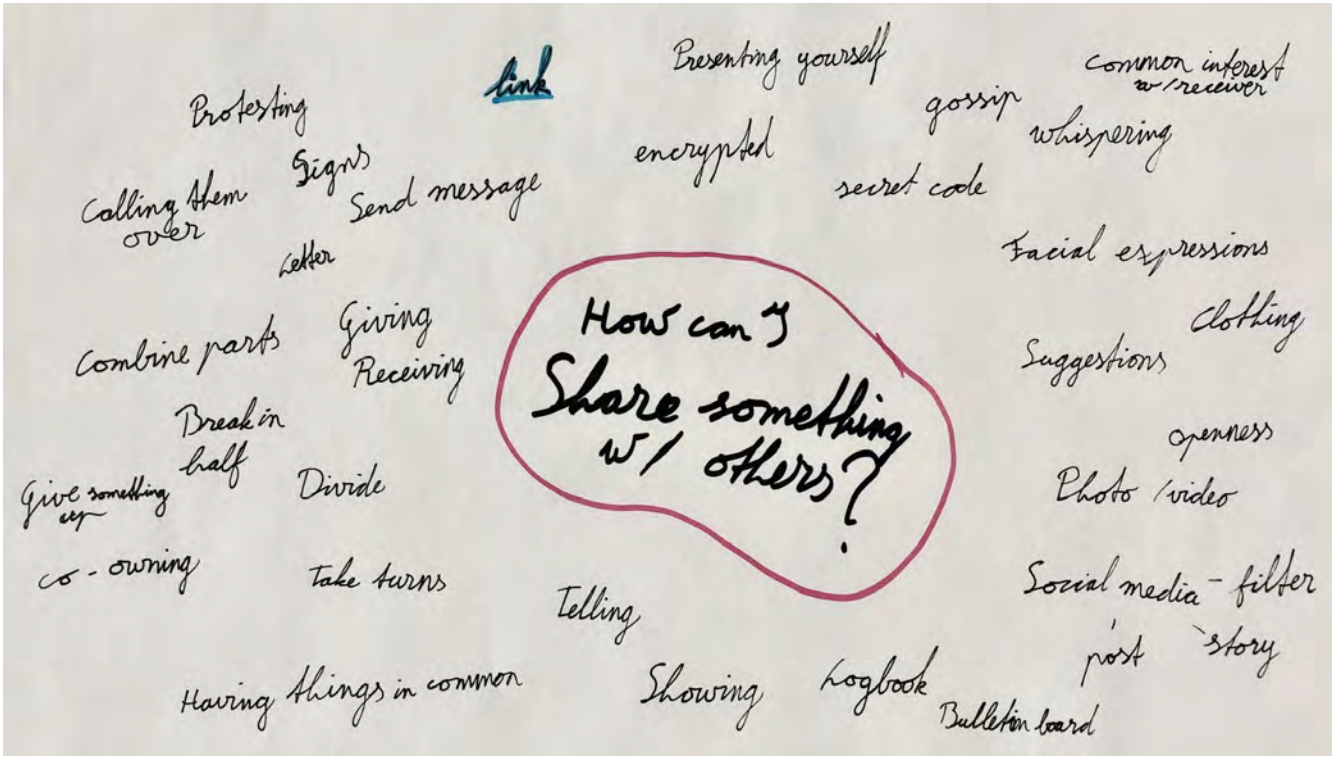
the mind map topics explored were:

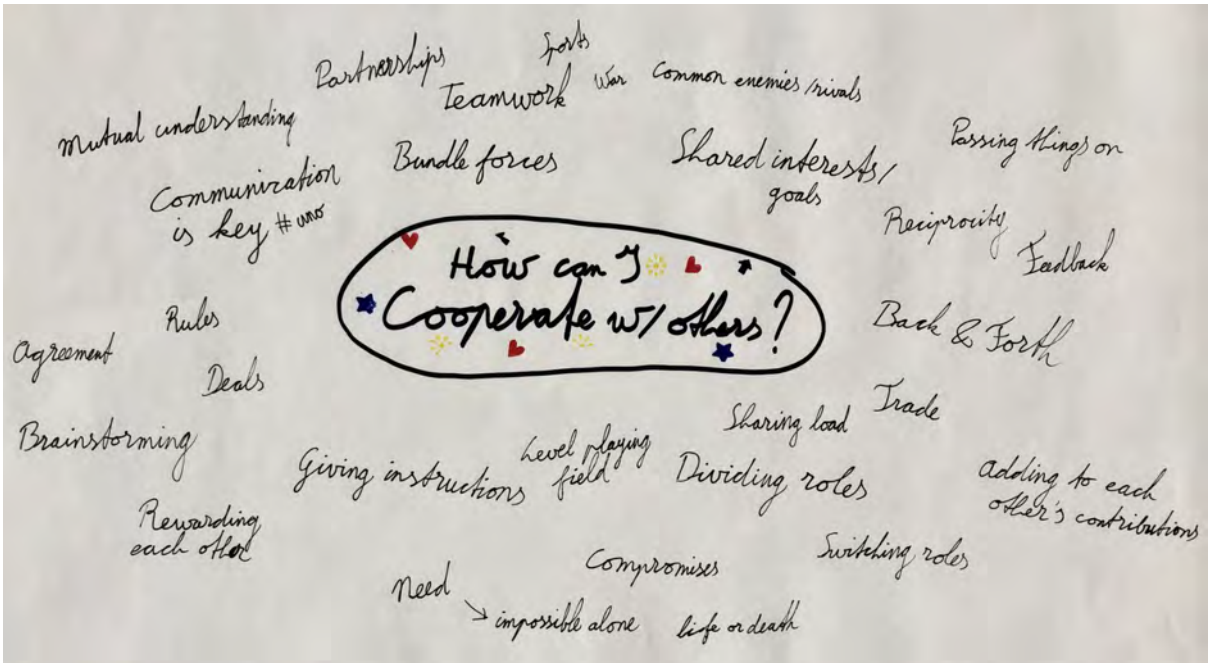
- How can I set objectives?
- How can I compete with others?
- How can I discuss with others?
- How can I share something with others?
- How can I cooperate with others?
- How can I interact with things?
- How can I play?
- How can I feel tempted/invited?
- How can I feel rewarded?
- How can I relate to things/people?
- How can I tell a story?
- How can I embody something?

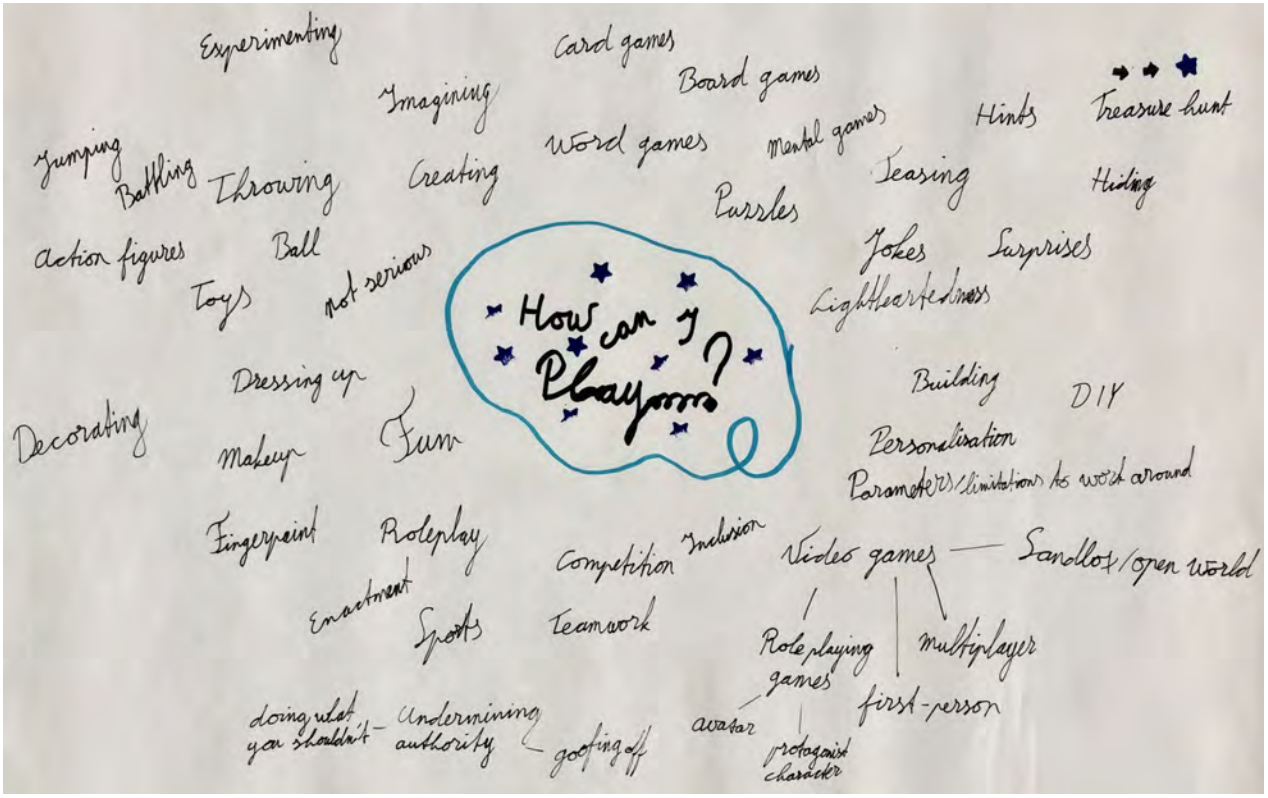


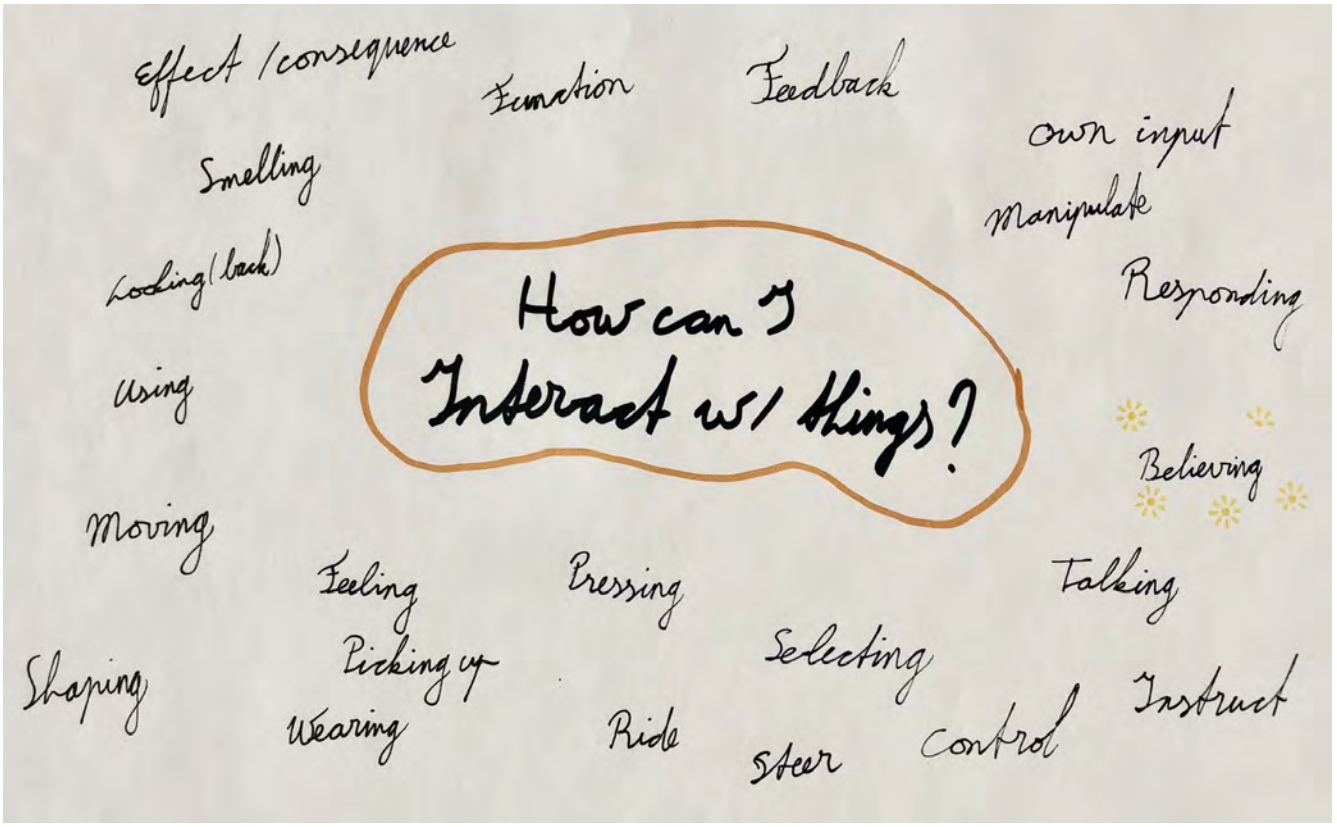

How can I
Compete w/ others?
Rivalry
Battle
Teams
1v1
Practice / training
Winning & Losing
Differentiation
Records
High-score
Showing off
challenge
arguments
Measuring
Speed
Points
Accuracy
Originality
Objectives
Voters
Motivation
Pushing each other
Something to compete for
common end result

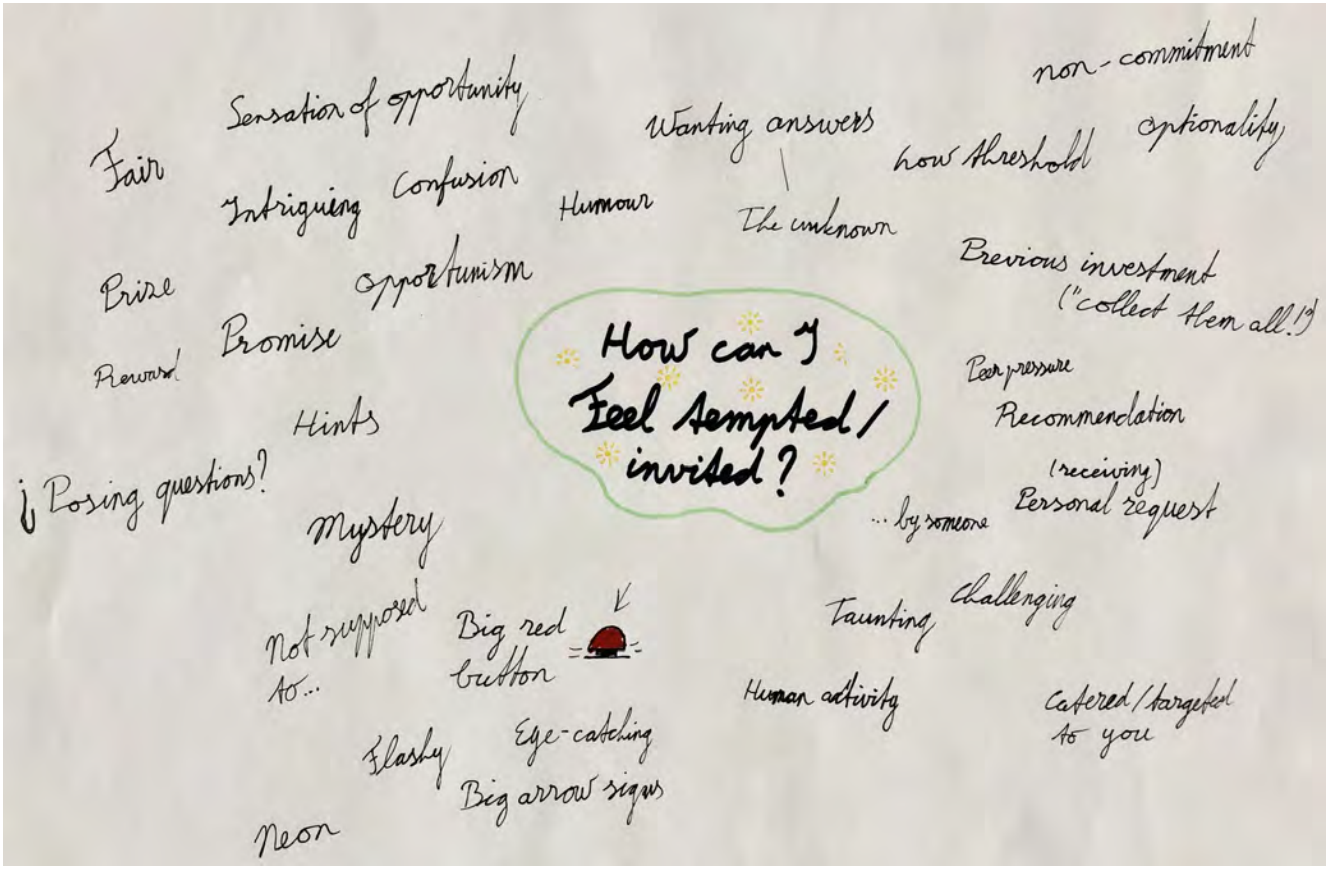

How can I
Discuss w/ others?
Social context
academic
attention
During experience / observation
Shared interest
Informal
Online forums
Subject
Listening
Turns
Respect
to convince
after experience
arguments
Debate
Stake
Opinion
Anticipation
Disagreement
Reason
Honour
Bet
Share enthusiasm
Consensus
Exchange information
Speculation
closure
Considering
Evidence
conclusion
To understand
Posing Questions
To learn something new
Interpretation
Sharing perspectives
Critical
Solution-oriented

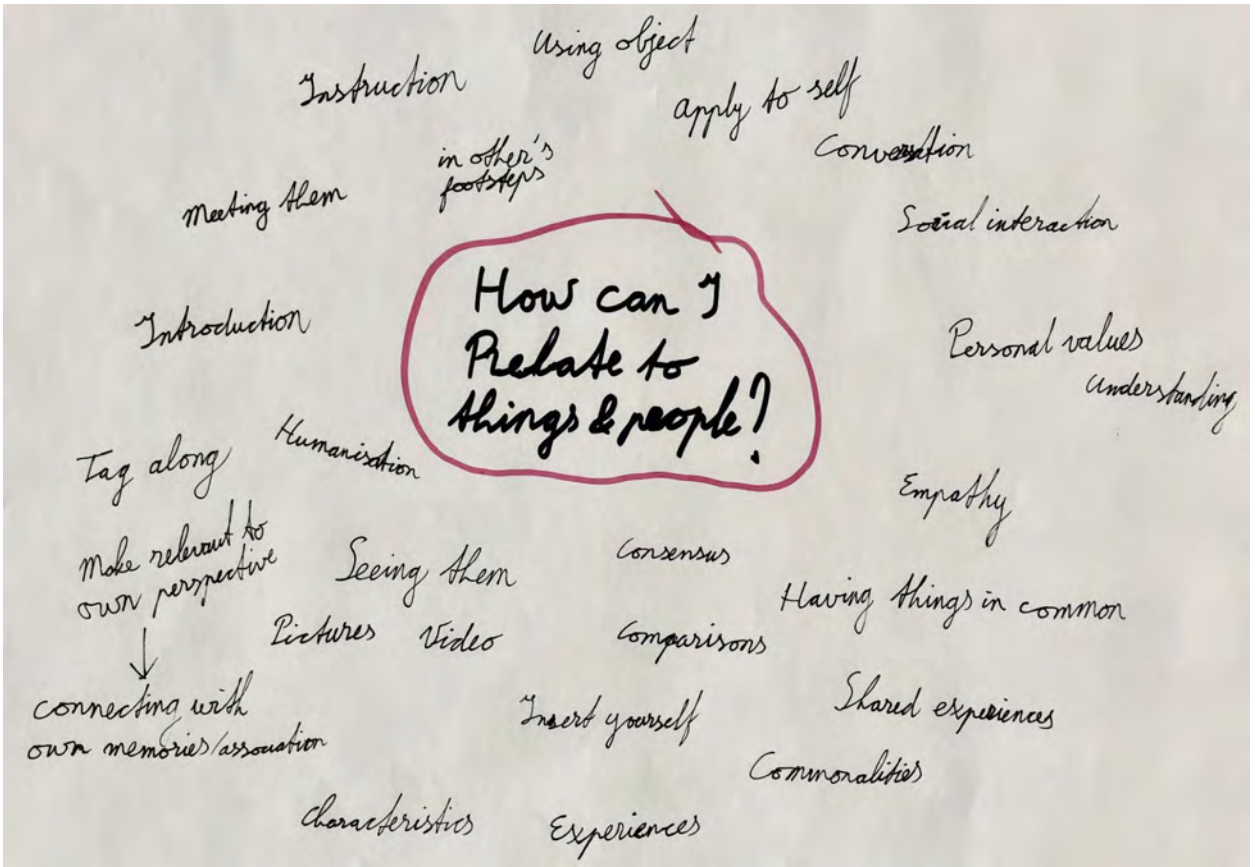

How can I
Share something w/ others?
link
Presenting yourself
common interest w/ receiver
gossip
whispering
encrypted
secret code
Protesting
Signs
Send message
Calling them over
letter
Facial expressions
Clothing
Suggestions
Combine parts
Giving
Receiving
Break in half
openness
Photo / video
Give something up
Divide
co - owning
Take turns
Telling
Social media - filter
post
story
Having things in common
Showing
Logbook
Bulletin board

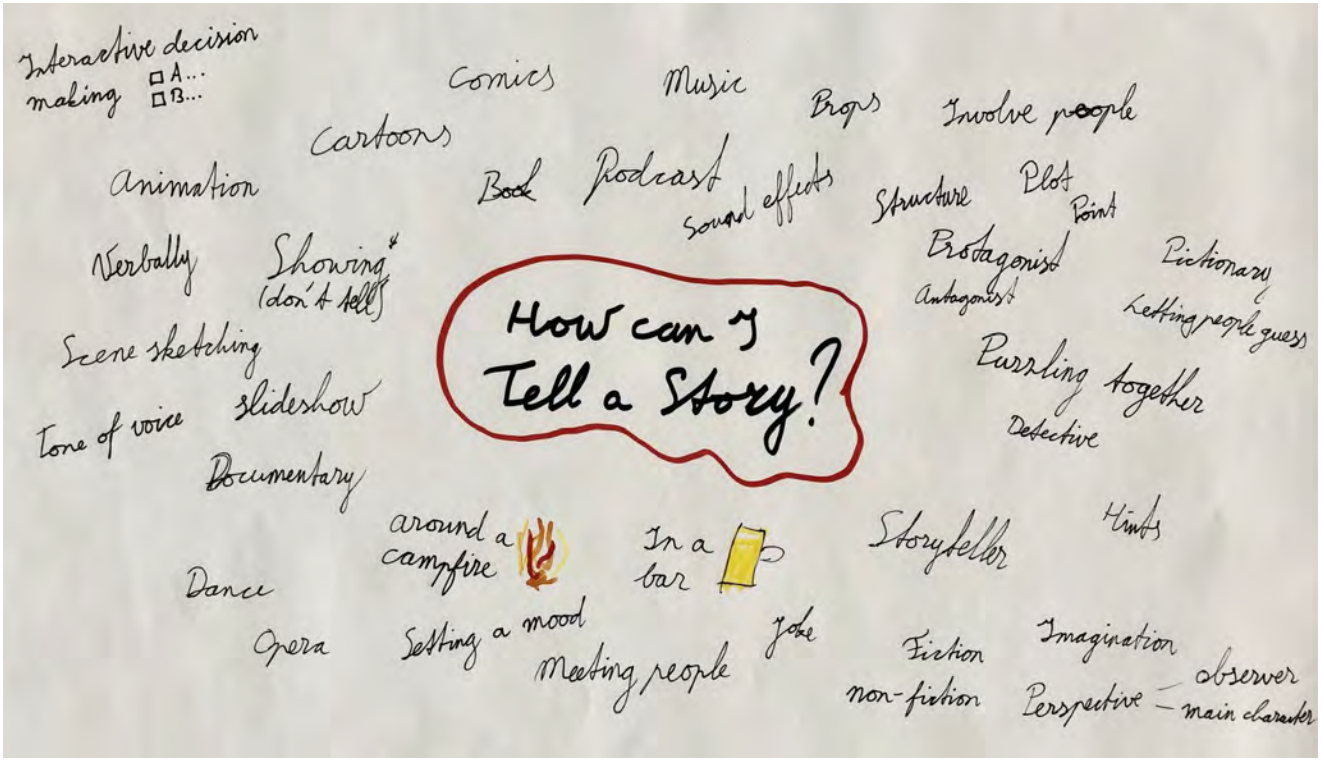

How can I
Cooperate w/ others?
Partnerships
Sports
Teamwork
War
Common enemies / rivals
mutual understanding
Bundle forces
Shared interests / goals
Passing things on
Communication is key
Reciprocity
Feedback
Rules
Agreement
Back & Forth
Deals
Trade
Sharing load
Brainstorming
Level playing field
Giving instructions
Dividing roles
Adding to each other's contributions
Rewarding each other
Compromises
Switching roles
Need
impossible alone
life or death

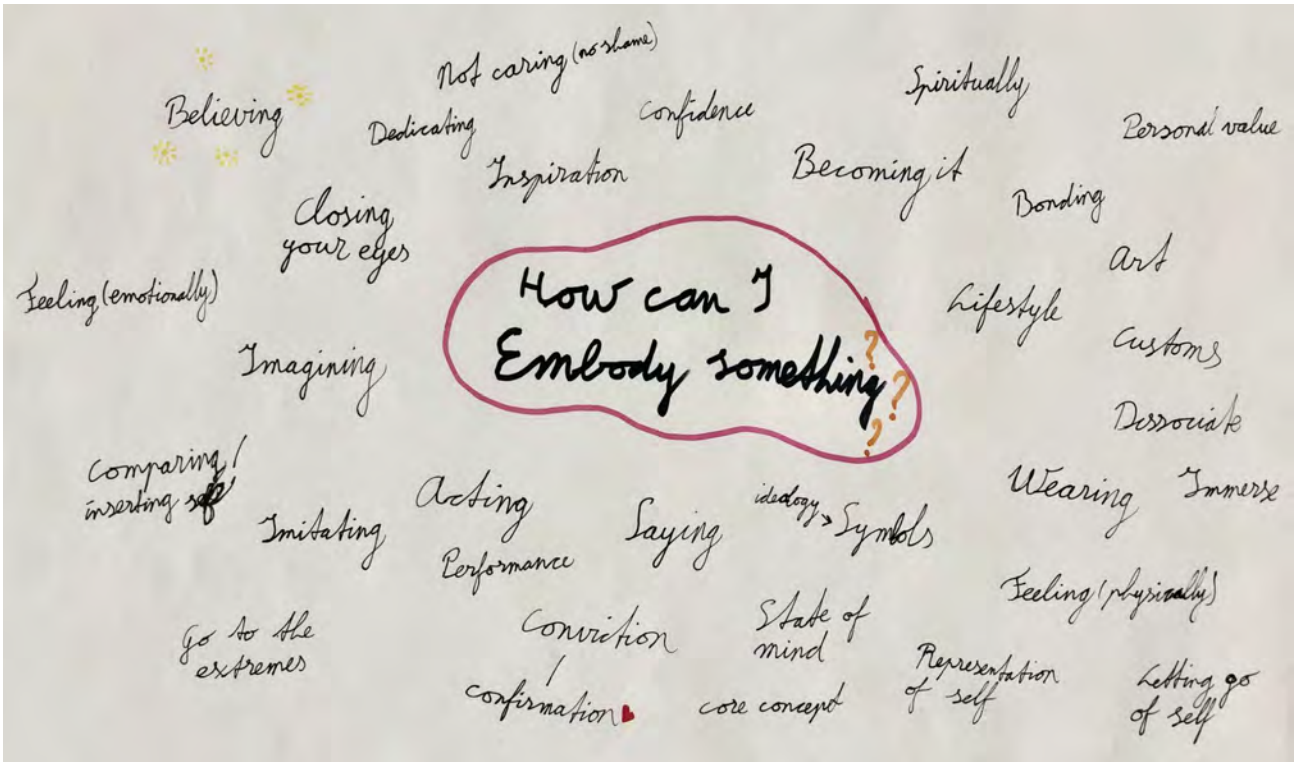

How can I Play?
Experimenting
Imagining
Card games
Board games
Word games
Mental games
Hints
Treasure hunt
Jumping
Batting
Throwing
Creating
Teasing
Hiding
Puzzles
Action figures
Ball
Toys
not serious
Jokes
Surprises
Lightheartedness
Dressing up
Building
DIY
Decorating
Make up
Fun
Personalisation
Parameters/limitations to work around
Fingerpaint
Roleplay
Competition
Inclusion
Video games
Sandbox/open world
Enactment
Sports
Teamwork
Role playing games
multiplayer
first-person
doing what you shouldn't
Undermining authority
goofing off
avatar
protagonist character


How can I Interact w/ things?
effect/consequence
Function
Feedback
own input
Smelling
Manipulate
Looking (back)
Responding
Using
Believing
Moving
Feeling
Pressing
Talking
Shaping
Picking up
Selecting
Instruct
Wearing
Ride
Steer
Control


How can I Feel tempted / invited?
Sensation of opportunity
Fair
Intriguing
Confusion
Humour
Wanting answers
The unknown
non-commitment
how threshold
optionality
Prize
opportunism
Previous investment ("collect them all!")
Promise
Reward
Hints
Posing questions?
Mystery
Peer pressure
Recommendation
(receiving) Personal request
... by someone
Not supposed to...
Big red button
Taunting
Challenging
Human activity
Catered / targeted to you
Flashy
Eye-catching
Big arrow signs
Neon


How can I Relate to things & people?
Using object
Instruction
apply to self
Conversation
in other's footsteps
Meeting them
Social interaction
Introduction
Personal values
understanding
Humanisation
Tag along
Empathy
Make relevant to own perspective
Seeing them
Consensus
Having things in common
Pictures
Video
Comparisons
connecting with own memories/association
Insert yourself
Shared experiences
Commonalities
characteristics
Experiences


How can I Tell a Story?
Interactive decision making
A...
B...
Comics
Music
Props
Involve people
Cartoons
Animation
Book
Podcast
Sound effects
Structure
Plot
Point
Verbally
Showing (don't tell)
Protagonist
Antagonist
Fictionary
Letting people guess
Scene sketching
Puzzling together
Slideshow
Tone of voice
Detective
Documentary
Around a campfire
In a bar
Storyteller
Hints
Dance
Opera
Setting a mood
Meeting people
Joke
Fiction
non-fiction
Imagination
Perspective
observer
main character


How can I Embody something??
Not caring (no shame)
Believing
Dedicating
Confidence
Spiritually
Personal value
Inspiration
Becoming it
Bonding
Closing your eyes
Art
Feeling (emotionally)
Lifestyle
Imagining
Customs
Dissociate
Comparing / inserting self
Acting
Wearing
Immerse
Imitating
Saying
ideology
Symbols
Performance
Feeling (physically)
Go to the extremes
Conviction / confirmation
State of mind
Representation of self
Letting go of self
core concept

Appendix H - Forced-fit ideation tables

Playing	3D printing	AR	VR	Digital object
Puzzle	Putting parts of artefact replica together Treasure hunt with artefact replicas as props	Figuring out the appropriate look on yourself to match historical scenario		
Experimenting	Figuring out object use through trying out physically		VR open world to mess around in historical context	
Decorating	Trying on jewellery replicas Dressing a mannequin for certain historical scenario			
DIY	Creating your own digital jewellery object; printable 3D file (buy in museum shop?)	Creating your own adornment style based on selectable elements		Creating your own adornment style based on selectable elements within a metaverse

Storytelling	3D printing	AR	VR	Digital object
Protagonist perspective			Visitor as 1st person main character in virtual scenario	
Props	Adding replicas of complementary objects to exhibit with artefact for more complete picture			

Cooperation	3D printing	AR	VR	Digital object
Building upon earlier contributions		Real-time interactive crafting process (completed by subsequent visitors)		
Exchange	Museum partnerships to complete each other's exhibitions with replicas			Online trading of goods to craft
Helping	Adorning peers with replicas	Adorning peers digitally	co-op multiplayer game challenge	

Discussion	3D printing	AR	VR	Digital object
Questions		Interactive question / answer board		
Exchange views				Open fig behind object in metaverse for community discourse
Speculation	Figuring / trying out intended function / purpose of object			

Sharing/notifying	3D printing	AR	VR	Digital object
Social media		Realistic photo of person wearing jewellery artefact Playful filter of dynamic body paint / adornment		
Giving			VR story 'life' to share as recommendation	

Embodiment	3D printing	AR	VR	Digital object
Spiritual			Make symbolic/ritual representation come to life	

Tempting/inviting	3D printing	AR	VR	Digital object
(previous) investment (getting people hooked by beginning)	Series of collectable items to be found throughout exhibition		"featured in VR experience" mention at physical exhibits	Free ownership trial in metaverse

Relating	3D printing	AR	VR	Digital object
Comparison			Teleport from modern-day scenario at a location to historical scenario there Show animate history of [illegible]	

Appendix I - Notes idea evaluation session

(Documented in Dutch)

1) Wearable 3D printed hi-fi artefact replica
Ook interessant voor jongeren.

Interactiviteit en spelen ook heel leuk voor volwassenen.

Eerdere ervaring van kleding aantrekken werd als leuk en memorabel beschreven.

Wel belangrijk om hufterproof te maken.

2) Museum escape room
Leuk idee, maar qua uitvoerbaarheid lijkt het geen optie: voor een kleine groep mensen die een best lange tijd in een ruimte besteedt, niet geschikt voor de doorstroom in een museum.
Per puzzel zeker een aantal minuten bezig, ervaring vervelend als een andere groep achter je zit of voor je en er moet gewacht worden.

Zou alleen extreem simpel kunnen worden uitgevoerd.

Een op zichzelf staande escaperoom met historisch/cultureel thema in samenwerking met museum is wel een goede optie; dit verandert echter niks aan de museumtentoonstelling zelf.

In tentoonstelling zelf is kleinere puzzelelementen gebruiken wel interessant; makkelijker te implementeren en aan deel te nemen, vrijblijvend en interactief. “Mogelijk een soort speurtocht bijna”.

3) Exhibition treasure hunt
Erg aantrekkelijk.

Puzzels/challenges moeten niet verplicht of in een vaste volgorde zijn; wel een verband maar je moet alles los van elkaar kunnen doen en ook iets kunnen overslaan als het je niet echt aanspreekt.

Gemengde gevoelens wegens gedachte dat het misschien teveel moeite is en dat je denkt “geen zin in, laat maar zitten”.

Je gaat niet per se naar het museum om alles helemaal te doorkruisen, dus je moet geen speurtocht hebben die je af moet maken om het waardevol te ervaren.

Een journey / evolutie / verhaallijn lijkt goed in stappen in kaart te brengen met zo’n treasure hunt.

Puzzelidee: artefacten in juiste volgorde op tijdlijn plaatsen.

4) Complementary objects for exhibited artefact through museum partnership
Beeldvorming van complete outfit is wel waardevol, belangrijk om voorwerpen te kunnen plaatsen.

Geklooi met telefoon is ongewenst als onderdeel van de core museumervaring.

Leuker als je het in een oogopslag kan zien, direct door de vitrine of met een scherm of door een kijker.

Moet optioneel zijn, niet essentieel.
Afhankelijk van de uitvoering kan AR een goede aanvulling zijn, maar het moet ook zonder kunnen.

5) Collectable elements throughout exhibition for AR self-adornment mirror at end
“Shoppen in het museum!” erg positief ontvangen.

Wens om eigen voorkeuren mee te kunnen nemen in de experience, om zelf te zien dragen.

Je verdiept je meer in objecten om voor jezelf een voorkeur te bepalen.

De rode draad van de hele tentoonstelling experience wordt ondersteund, in plaats van dat je slechts één moment opleukt.

6) AR mirror for creating personalised adornment look
Komt over als een Instagram-activiteit,
‘Buzzfeed quiz’ voor ‘astrologie-tienermeisjes’.

Vervelend om hele quiz in te vullen op einde,

Zoekt persoonlijk gerelateerde betekenis waar hij er niet per se is.

7) AR mirror cultural guessing game
AR wordt hier al snel een gimmick.

Van zo’n makkelijk raadspelletje krijg je niet echt een diepere beleving achter de artefacten; al snel te oppervlakkig.

Geef meer inzicht in wat je toont, niet alleen meer interactiviteit op zich.

8) VR interactive experience of mystical dream state / animal transformation ritual for which the artefact served a ritual purpose
Toegevoegde waarde om de mystiek uit te beelden waar een volk in geloofde.

9) VR interactive experience of Muisca ceremony at Lake Guatavita
Het Archeon doet dit in het echt met veel succes, maar interactief en coöperatief met een VR bril op wordt als limiterend gezien.

Immersie en aanwezigheid is wel waardevol, maar actie moeten nemen in die wereld zal blootstellen dat het ergens toch beperkt is dus daar ligt de meerwaarde niet.

Drempel voor VR is voor de meesten nog erg hoog, geen sprake van vrijblijvendheid.

Uitvoering komt erg kritisch, kan makkelijk de plank misslaan.

10) Creating personalised adornment look in exhibition to transfer to wearable look for personal metaverse avatar
Unanieme afwijzing (ook van eerder concept personalisatie).

Dit is anno 2022 nog niet relevant.

Spreekt een kleine niche van het publiek dan heel erg aan, maar niet de meeste bezoekers.

11) Artefacts as unique digitally owned (NFT) wearables in metaverse
Eerste indruk NFT erg afkeurend.

Een artefact moet geen dom digitaal verdienobject worden.

Wel overeenstemming dat het (in de toekomst) waardevol kan zijn om in het museum toegang tot een digitaal bruikbaar object te krijgen of te kopen, om het vervolgens in een metaverse te bezitten en gebruiken.

“Een soort Pokémon Go kan natuurlijk wel aanslaan”.

Moet ergens beginnen, maar is succesvoller hoe meer musea meedoen.

Nog enigszins moeilijk voor te stellen, maar wel mogelijk dat er waarde mee gecreëerd kan worden.
Herkenning van potentieel als business model.

Op zich geen (juiste) reden om naar een museum te gaan om zo’n digitaal object te bemachtigen.

Het is geen manier om mensen tijdens hun bezoek meer te engagen met de tentoonstelling en diepgang te creëren.

“Men moet vermijden dat het een soort voetbalplaatjes hype wordt met kinderen die om digitale artefacten bedelen voor de uitgang van het museum”.

Hoe kan het museum garanderen dat zo’n digitaal object in de metaverse wel in een cultureel appropriate context bestaat?

12) Partnership with online multiplayer game; artefact as 'skin' or item in inventory
Heeft niks met de experience in een museum te maken.

Enthousiasme voor museumbezoek kan wellicht wel aangewakkerd worden door enthousiasme over artefacten in de videogame.

“Wij staan hier als generatie denk ik nog net niet voor open, maar mensen die in de toekomst onze leeftijd zullen hebben eerder wel”.

In-game effecten of speciale power-ups van artefacten als ‘items’ is niet te balanceren, omdat er in de praktijk altijd een paar artefacten zullen zijn die beter zijn dan andere, of voor gameplay-exploits gebruikt zullen worden en dat is niet het doel.

Kennis van museum kan wel worden verspreid via game partnership; maar zal op zich heel weinig mensen bewegen om daardoor naar het museum te komen.

Herkenning uit game zal wel enthousiasme voor de originele artefacten vergroten, dat zal wel bijdragen aan de museumervaring.

Appendix J - System tree of deconstructed concept

[system tree]

Appendix K - Notes of interview on RFID bracelet museum experience

Interview conducted on 03-05-2022, Amsterdam.

- *When did you first find out that you would get a bracelet to use throughout the exhibition?*

When you get into the museum, after showing your museumkaart, the girls working in reception explain about the museum, the purpose that it has and they give you the bracelet and explain how it works.

- *When exactly did you get the bracelet? (at building entrance, at ticket booth, first room of exhibition, etc)*

In the reception of the museum.

- *How was the bracelet presented to you? (given by employee, grab from a bin, you took it from a rack full of them, etc.)*

Given by an employee.

- *How did you learn what the bracelet was for and how to use it?*

Employees explained to me.

- *Was using the bracelet system similar to something you were already familiar with before?*

It was like the bracelet of the festival that you use for paying, or like that kind of keychain that you use to open doors.

- *How did they make you interested to use it? Why did you want to?*

The final purpose of the museum is to make the visitors aware of the bad parts of the fashion industry and show them tips to make them more conscious. So the bracelet is kind of mandatory because you collect the tips that you're going to implement in your daily life and at the end they show you how you're going to improve the environment with that.

- *Was taking and using a bracelet optional or was it an unmissable part of the exhibition?*

Not optional.

- *What was the last action you took to use the bracelet? How did you receive your result?*

You put the bracelet in one of the sensors and they show you on a screen which tips you decided to follow.

- *Was it mandatory to hand the bracelet back in at the end?*

The bracelet was made with recycled materials, which makes sense considering the museum's purpose. After showing you the tips that you collected, the final room of the exhibition was next to the reception, so you put the bracelet in a box in the same spot where you received it at the beginning.

- *When exactly did you hand the bracelet back in? (at building exit, at ticket booth, in final room of exhibition, etc)*

Next to the reception.

- *How did you hand the bracelet back in? (give to staff, put in bin, hang back on rack, etc)*

In a return box.

- *Did you want to keep the bracelet and take it home?*

No, the bracelet was too big and the idea was reusing it and not making more waste.

- *How did you experience wearing the bracelet the entire visit?*

It was an easy way to force you to read everything and pay attention to the exhibition.

- *What would you think of having received a single-use 'festival'-type bracelet that you can keep, compared to the one you got?*

It could be a nice 'souvenir' if it's just a paper band, but in this case the idea of reusing bracelets made more sense.

Appendix L - Guide and notes evaluative interview with exhibition maker

Session guide

Aims

- Gather feedback on the concept from an insider of the museum sector with practical experience in exhibition making.
- Document first impressions and attitudes, and the basis for them.
- Identify pain points of the current concept, to identify what to improve upon.

Briefing & consent

“

First of all, thank you for helping me evaluate the value creation strategy and concept implementation that I have been working on.

I would like to document you on video and audio for the entire session, do I have your consent for that?

May I also use what will be said for the purposes of evaluating and improving my design, and documenting my design process in my graduation report?

I will be walking you through the strategic framework that I created for designing the experience of museum exhibitions, as well as a hypothetical example of what implementing this model for an exhibition design might result in concretely.

I would like to discuss the content that I will be sharing with you as we go through it, and also ask you some questions afterwards.

For me, the aims for this session are: [session aims]

So by all means, please interrupt me at any point to react and share your thoughts on what I will be showing you; that is actually the whole point.

“

Presenting strategic model & showcasing concept example

“

This framework serves as a general model for designing add-on features for (museum) exhibitions, aimed at stimulating visitor engagement and cognitive processing as a means to enable visitors to co-produce their own exhibition experience to be more enjoyable and satisfactory.

The groundwork for this model are the insights that I gathered on the different drivers of engagement, interest and cognitive processing in museum visitors (aged 20-30).

An envisioned exhibition experience modelled after this framework may serve as a point of departure for exhibition makers to consider the usefulness and requirements of novel facilitative solutions, notably 3D technologies, to accomplish their desired features effectively.

Of course such concepts can go in many directions, depending on the exhibition subject-matter and contents, the wishes of a collection holder, the budget available, and more, but to give you a concrete example: [walk through concept example]

“

Questions (semi-structured interview)

- *Which part of the framework provides the most relevant and useful insights in your view?*
- *Is there any aspect of the framework of which you do not recognise the added value to include it?*
- *To what extent do you think the framework could be helpful in guiding curators in the process of exhibition making?*
- *How do you see it being used in the exhibition making process?*
- *What do you imagine the limitations of this framework to be in practice?*
- *To what extent does the example of an implemented exhibition concept enable you to get an idea of the range of potential features that could be conceptualised for different exhibition experiences applying this framework?*
- *To what extent did the framework by itself already enable you to do so?*

Are there any aspects of the example concept that you think would be generally unfeasible or undesirable?

Summary notes of interview

Showing strategic framework

- Maker does not seem to 'read' the framework along the lines of its main stages; perhaps visualise stages more distinctly from top to bottom?

- Had never considered this aspect of exhibition making to such an extent, since for him the starting point is usually the content itself, and not the desired experience of visiting an exhibition with that content.
  Good identification of potential gaps in the exhibition making process.

- Doubts on usability with every type of exhibited content, and that it might not be what every visitor looks for at their museum visit.

Initial thoughts on framework's potential uses and outcomes

"It seems like a useful guide on how to make an exhibition even more attractive to more people, which is great if you want to focus on catering to a larger and broader audience. When adding features to lower the threshold for that audience to submit to a more profound exhibition experience, I think it is important to avoid making the presentation of the content less natural, considering the niche of visitors that do not need or want anything extra to delve deeper, but are already so interested in the subject-matter that they do that by themselves."

Showing concept example

- Especially positive reaction to the proposed challenges; effective way to highlight some deeper insights and focus visitors' attention on it.

- AR mirror interaction is judged to be very impactful on the visitor; linking the activities they did to a tangible result [the collected items appearing] and including them in the narrative so tangibly makes people feel more strongly associated with the content. It is an interesting way to make the involved content stand out.
  Moment in the mirror, when the visitor is inserted in the original context, evokes an expression of excitement in the maker.

"A reward like that is fitting if you want to show more to certain people, but it is more important to make sure the content of the general exhibition appeals to the audience, that should not be discounted as a result"

Initial thoughts on concept example

“Reminds me of a live art experience at Het Hem, in Amsterdam, in which one visitor takes part in a drone video game, and when they are successful enough in the ‘practice’ level, they can continue to a level ‘in the field’. Afterwards the visitors enter another space in which all the people that were targeted by the drone strikes are actually present (as real actors) and personally confront the gamer with the consequences.
The dynamic is similar and the level of personal involvement makes for a powerful impression, especially for the gamer themself, but also for the other spectators.”

- If the interaction is quite elaborate, then it is probably not suitable for large masses, unless perhaps being a spectator of someone else’s interaction also reaches the intended effect on the visitor to a certain extent.

Semi-structured interview

- *Which part of the framework provides the most relevant and useful insights in your view?*

“I definitely think that the guideline of giving visitors challenges, and to a lesser extent also the motive that you define for those challenges, can make exhibitions more interesting in many different ways. As an exhibition maker, my primary focus is to put the work and content that you have out there, and share the story, information and impressions that you envision and think are important. However, I do see how it is also important to make it easier for visitors to take things in and connect with the things you decide to exhibit.”

- *Is there any aspect of the framework of which you do not recognise the added value to include it?*

“Having to assess visitors on their level of commitment or ability to complete challenges or a side objective might be a necessary evil to attribute value to doing the activities or attaining a reward, but I would personally want to avoid it. It might come across as a bit patronising to set such rigid requirements, and I want a calm atmosphere at my exhibition, that is not influenced by any notion of performance or achievement. I do admit that my aims for my exhibition line up with a niche audience, so I would not discount this part of the framework in general. It depends on the exhibition in question.”

- *To what extent do you think the framework could be helpful in guiding curators in the process of exhibition making?*

“I think that perhaps about 20% of exhibition makers focus on catering to an audience that comes just to be exposed to as many new impressions of whatever content has been selected to be shared with them. Both this audience and these makers can be labeled as more ‘purist’. Those exhibitions revolve more around exposing the content and less so around catering a visitor experience. But for the majority of exhibition makers, who do want to share new impressions with the largest possible audience, and perhaps attract more people to make an exhibition more financially viable, I think this framework could certainly be helpful. I do think that the majority of museums’ audiences are underserved.”

- *How do you see it being used in the exhibition making process?*

“When the work of artists or researchers is involved, it will have to be a balancing act for museum curators to find a compromise between what they themselves might envision as a result of this model to make the content more accessible for visitors to engage with, and what the content creator might envision to make the content come fully into its own.”

- *What do you imagine the limitations of this framework to be in practice?*

“Ideally we would live in a society where everyone has such a big interest in art and culture that there would be no need for a framework like this to help museums increase visitor engagement. But in practice, improving the visitor experience does result in more impressions per person and more people in general to gain new impressions, which is important. I do think the effectiveness of designing with this framework still depends largely on the topic of the exhibition; if people are just not into the subject of an exhibition then I do not think engaging features will go a long way to convince them otherwise.”

- *To what extent does the example of an implemented exhibition concept enable you to get an idea of the range of potential features that could be conceptualised for different exhibition experiences applying this framework?*

“My impression is that this framework is more easily and completely applicable to designing exhibitions that revolve around artefacts, because such exhibits can often benefit from more context to place them and make them more relevant in the moment, and the content is generally not as interpretative. However, concerning an exhibition with artworks, I think that making people question what they see, like with riddles or a mysterious experience, could also move them to look more intently and critically at the exhibits.”

Appendix M - Prototype testing session guide and notes

Session guide

Aims

- Observe whether participants recognise the indicated and/or intended functionality of touchpoints.
- Observe whether participants behave in line with the intentions of the exhibition's design.
- Observe if and how participants (try to) complete the collectable challenges.
- Gather feedback from participants afterwards on how they experienced their visit.

Assumptions

- Having the participants go over the 'pre-visit explainer webpage' before their session, together with the testing setup design itself, will provide them sufficient understanding to participate as the concept intends.
- Participants will not appear unsure as to what they should be doing in the space.
- The icons on the scanning points and the bracelet are effective use-cues to have the participants interact as intended.
- The interactive challenges presented will prompt the majority of participants to want to find out more on the topics.
- All participants that are (at first) confronted with denied entry to the additional exhibit will be accepting of this and not express frustration.
- All participants will complete the challenges required to gain access to the additional exhibition space.
- The participants will not disengage from the AR mirror for the duration of the scene.
- Participants will recognise both the connection and the separation between the exhibition space with historical artefacts and the exhibition space with contemporary works.
- None of the participants will forget to take off their bracelet before leaving the exhibition.

Research setup requirements

- Smartphone or other video & audio recording device
- Paper prints of ‘museum website’ with pre-visit explainer
- movable barriers (e.g. wheeled tables, cabinets, whiteboards; to divide up the space)
- Benches or chairs (for a seating area)
- Tables or stands, preferably at approximately 1.1m height (to place exhibits on)
- Stand-up cardboard cutouts of a series of artefacts
- Cardboard sign cutouts for exhibit descriptions
- Double-sided tape
- String (to rig up in front of exhibits; indicate restricted access / display case)
- Reusable bracelet with distinctive icon on it
- 3 small cardboard signs with distinctive icon on it
- 2 cardboard stands with tablet frames
- Paper cutouts of every tablet interface frame
- cardboard sign cutout (for wall-mounted sign with search & find challenge)
- Large monitor or other screening device, covering at least the vertical distance between approximately 1.2m to 1.9m above the ground.
- Animated slides (to provide scripted scene)

Briefing & consent

“
First of all, thank you for helping me test my concept prototype.

The concept is a strategic design model that serves as a general blueprint for the design of museum exhibitions, to enhance the visitor experience and stimulate active engagement with the exhibition.

The prototype is a lo-fi setup of a hypothetical exhibition that follows the principles of this model. It is an exhibition of a collection of pre-Columbian jewellery and adornment. All the technological features of the exhibition are represented by lo-fi props, to facilitate role-playing to act out what the actual interactions and experience at an exhibition might be like. I will be following you around to film the session, and occasionally produce sound effects myself and fill in some other technological gaps. Aside from that though, just ignore me as best as you can. After your ‘visit’, I would like to conduct a short interview with you about your experiences.

I would like to document you on video and audio for the entire session, do I have your consent for that?

May I also take two photos of you right now, to use as input for the prototype that you are going to be testing?

May I include all of the session documentation and prototype content that includes imagery of you in my graduation report?

”

Test actions

- Each participant is given a printed sheet of paper with the ‘webpage’ showing the exhibition activity’s step-by-step explainer, to emulate them being introduced to the offered experience before their visit, when checking out the museum's website.

- The researcher instructs the participant to enter the exhibition, with the request to think out loud.

- Whenever a participant enters a wrong answer on an interface or scans at a ‘locked’ scanning point, a negative sound is vocalised by the researcher.
- Whenever a participant enters a correct answer on an interface or scans at an ‘unlocked’ scanning point, an affirmative sound is vocalised by the researcher.

- Whenever a participant adds a collectable to their inventory, the researcher puts a corresponding sticker on the bracelet. During this short pause the video camera needs to be put down to free up the researcher’s hands.

- When the participant scans their bracelet to initiate interaction with the AR mirror, after collecting all three of the collectables, the researcher activates the sequence emulating the AR mirror interaction, with the laptop connected to the screen .

- When the participant approaches the demarcated entrance of the additional exhibition space after having gained access to it, the researcher unblocks the entrance.

Post-session questions to participants (semi-structured interview)

- How would you summarise your experience visiting this exhibition?

- To what extent did doing the challenges impact your perception of the exhibits?

- How do you feel about the things you found out?

- How was it to use the bracelet? And to wear it?

- How did you experience the interaction with the augmented reality mirror? (as far as this lo-fi prototype allowed you to get an idea of what it is supposed to be like)

- How do you feel about the actions that were required to take in order to unlock access to the additional exhibition?

- How did it feel to enter the additional exhibition and find out the contents?

- How would you compare the contents of the general exhibition and the contents of the additional exhibition?

- What did you think of the additional exhibition as a supplement to the general exhibition?

- If you think back to a museum that you visited, to what extent do you feel like having a concept such as this implemented there would have influenced the experience of your visit?

- To what extent do you think learning of such activities being present at a museum would make you more interested to go visit it?

- After going over the explainer before your visit, did you feel like you knew what to expect from the exhibition experience?

- Broadly speaking, did the exhibition experience turn out like you had expected?

- Which aspects of this exhibition experience do you think are most important to communicate to people before their visit?

- Is there anything you would like to see added to the exhibition experience?

- Do you have any other thoughts or remarks on the concept or your experience of it, which you would like to share?

Call with participant 5 days after the session:

- What is the most memorable moment of your visit looking back? Why?

- Which other things do you recall at first thought?

- What do you remember about the materials the artefacts were made of?

- What can you tell me about the symbolism and meaning surrounding these objects?

Appendix N - Estimated cost buildup of proposed concept: approach and rationale

Approach
In light of this project's design case, Current Obsession was assumed as the exhibition maker and service provider to a museum.
The cost buildup does not include the costs attributed to man-hours of involved CO and museum employees (e.g. for content creation) or assets such as the required exhibition space, but only the required core physical assets for implementation of the concept. Though many companies only disclose the pricing and customisation possibilities of their solutions upon written request of quotations made by prospective clients, general cost estimates could be made based on information received from such companies by inquiring via phone call, as well as a handful of openly published price indications.

Substantiations for estimated cost buildup
As a museum's direct partner, Current Obsession would have to cultivate the necessary trust to be allowed access to the museum's artefacts for 3D scanning, in all likelihood in collaboration with museum curators. Hiring a subcontractor for this is probably less suitable. This means that Current Obsession would have to invest in 3D scanning equipment and specialise in its use specifically for cultural-historical artefacts. The required scanner should be suitable for scanning intricate details and capable of scanning entire objects several decimeters in size; a high-precision handheld device such as the Artec Space Spider would be a suitable option. The example in question has a cost in the range of €18.000 for a new unit, though less than half that for a pre-owned unit. Meanwhile, the current market rate for 3D scanning services specialised in heritage artefacts, including scanning, post-processing 3D files and travel, runs upwards of €85 per hour (Surface Scan, March 2022, personal communication). If an investment in a 3D scanner by CO is not justifiable through extensive use, then hiring a contractor can be considered as a low-threshold alternative.
Supplying museums with 3D printed exhibits, as well as the exhibition's required hardware and corresponding software, would definitely have to be outsourced to contractors.

The cost of producing a high fidelity 3D printed object depends heavily on the dimensions and properties of the object; the required machine, runtime, material and amount of base powder all impact the cost, as well as the amount of post-processing required for a particular shape or finish. Considering the general range of dimensions of pre-Columbian jewellery though, 3D printing has an estimated cost of €1.000 to €5.000 for a metal object, and €200 to €1.000 for a polymer one (B.J.L. Leferink, March 2022, personal communication).

The purchase price for a fully functional augmented reality mirror, including hardware installation, software customisation and support) can amount to around €15.000 (Magic Mirror UK, April 2022, personal communication) up to €30.000 (Let's Nurture, 2022). The price tag mostly depends on the system's level of technological advancedness (i.e. how realistic the digital tryon is) and the degree to which customisation of the system's software is required to serve the concept's purpose. Of this purchase price, an estimated 70% accounts for providing and installing the hardware, while around 30% accounts for

software customisation and licensing (Magic Mirror UK, April 2022, personal communication). Alternatively, leasing an AR mirror hardware plus software system can cost around €300 per day (Viubox, 2021), though software customisation services would logically come at a comparable fee as they would for a purchased system. Considering the fact that even temporary museum exhibitions generally last multiple months, leasing hardware does not seem like a suitable option, though it could be for shorter events.

The required scanning points and bracelets use radio frequency identification (RFID) technology; a passive RFID system specifically. A bracelet contains a passive RFID tag (a small chip without any integrated power source), which can harness the electromagnetic power transmitted by the reader, and receive and store signals from it. A standalone reader is estimated to cost around €500, including system setup and installation (RFID Journal, n.d.), whereas reusable passive RFID bracelets could cost an estimated €7 per unit if bought in bulk (RFID Future, 2020).

Outcomes

The estimated total cost depends on all of the aforementioned variables and business choices, but making some assumptions for a one-off implementation of the concept at a museum exhibition and averaging out earlier cost estimates results in a total cost nearing €30.000, as shown in the figure below.

Designation	Unit cost	Qnt	Cumulative cost
~~3D scanner~~	~~€ 7,000.00~~	~~1~~	~~€ 7,000.00~~
3D scanning services (/hour)	€ 85.00	5	€ 425.00
3D printed object (metal)	€ 3,000.00	1	€ 3,000.00
~~3D printed object (polymer)~~	~~€ 600.00~~	~~1~~	~~€ 600.00~~
AR mirror	€ 22,500.00	1	€ 22,500.00
RFID reader	€ 500.00	4	€ 2,000.00
RFID bracelet	€ 7.00	100	€ 700.00
Total cost			**€ 28,625.00**

An overview of the estimated costs of the proposed concept features.

Appendix bibliography

Appendix figure sources

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: Leferink 5291
initials: B.G. given name: Bas
student number: 4442814
street & no.:
zipcode & city:
country:
phone:
email:

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

IDE master(s): ( ) IPD ( ) DfI (★) 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: Prof. dr. Schoormans, J.P.L. dept. / section: MCR
** mentor: Dr. ir. Elkhuizen, W.S. dept. / section: MD
2nd mentor:
organisation:
city: country:

comments (optional)

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.

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

APPROVAL PROJECT BRIEF

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

chair _____ date 16 - 05 - 2022 signature _____

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: 28 EC

Of which, taking the conditional requirements into account, can be part of the exam programme 28 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 C. van der Bunt date 05 - 10 - 2021 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 Monique von Morgen date 11 - 10 - 2021 signature _____

Initials & Name B.G. Leferink 5291 Student number 4442814

Title of Project A value creation strategy for historical jewellery exhibitions in museums

A value creation strategy for historical jewellery exhibitions in museums 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 27 - 09 - 2021 25 - 02 - 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, ...).

Current Obsession, a jewellery magazine and platform, is interested in finding new ways to have museums tell the stories of historical jewellery and the cultural heritage it represents. They also seek to build connections between historical jewellery and contemporary meanings and practices of adornment, to influence modern jewellery and build on a living legacy of said cultural heritage.

This project will focus on the case of pre-Columbian jewellery from the Americas. The legacy of these cultures' historical adornment habits has ended up notably absent from contemporary adornment habits, even in their region of origin.

For museums it is very relevant to find new ways of exhibiting historical jewellery. Especially when dealing with artefacts of contested heritage, museums in this day and age are regarded to have the responsibility to distance themselves from an exclusively imperialist or Western focus. Many museums aim to tell these stories from multiple perspectives, including that of the artefacts' original creators and users. Exhibition innovation is also a potential gateway to attract more visitors and attain an appealing image among new (e.g. younger) audiences.

Museum visitors, and how to give them a valuable experience, are central to this project. Who exactly will constitute this (new) target audience and what novel technologies can be applied to shape their experience will be explored during the project.

space available for images / figures on next page

Initials & Name B.G. Leferink 5291 Student number 4442814

Title of Project A value creation strategy for historical jewellery exhibitions in museums

introduction (continued): space for images

image / figure 1: An example of pre-Columbian jewellery, Museo del Oro, Bogotá, Colombia (Revista Travesías, 2019).

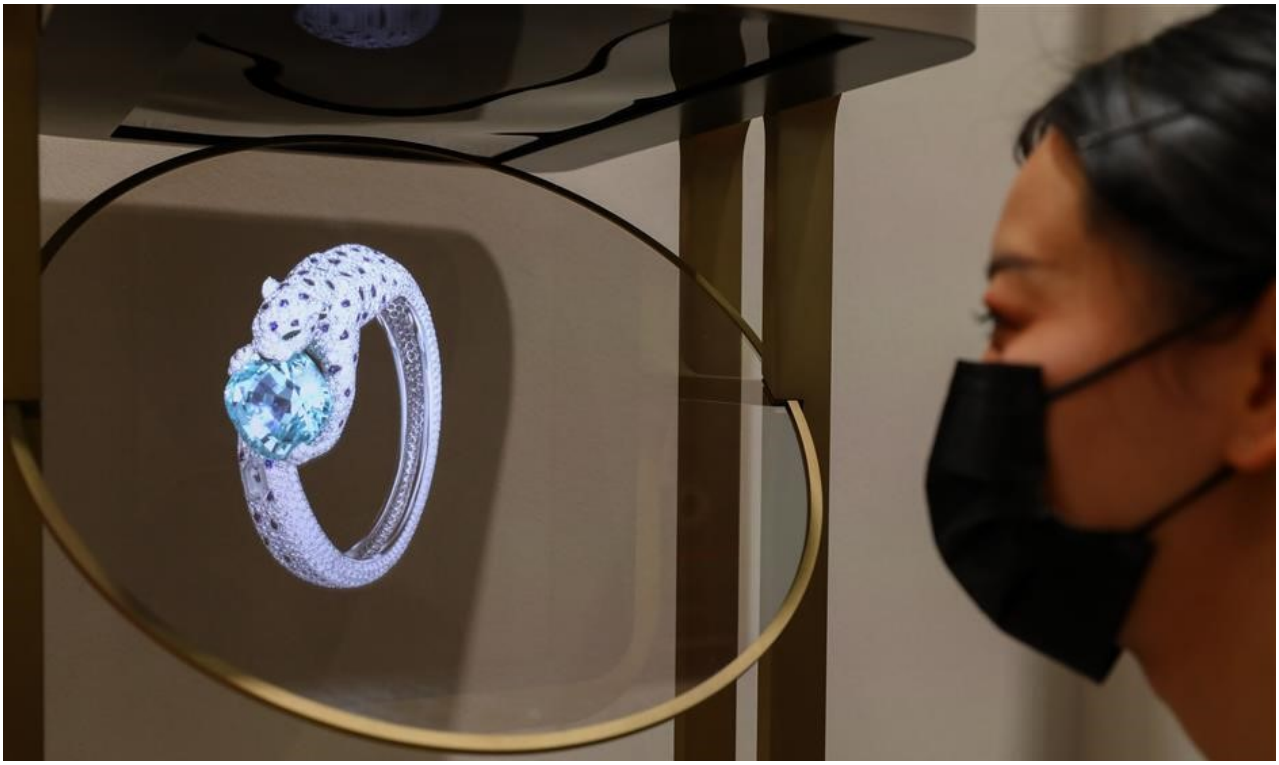


image / figure 2: An interactive holographic jewellery showcasing installation (SHINE - Shanghai Daily, 2020).

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.

Jewellery artefacts by themselves give valuable insight into the societies that created them. However, the manner in which they are traditionally exhibited in museums has its limitations. An artefact behind glass accompanied by a descriptive sign cannot capture the full extent of the jewellery's role and meaning in the societies that made and used it.

Not only should the stories behind these artefacts be told immersively and to their full extent, but an effort should be made to transfer the jewellery's historical societal relevance to the present day. The central challenge here is to create a valuable experience for relevant target audiences; to have them take away more from the exhibition, and attract them to it in the first place. This target audience will have to be defined (museum/jewellery/technology enthusiasts?) and the opportunities (technologies/game elements?) for providing this audience with a valuable experience will have to be explored.

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.

I will be designing a value creation strategy for the enhancement of an interactive museum exhibition experience, particularly related to historical jewellery and adornment. This will be applied to the case of pre-Columbian jewellery of the Americas.

I will research to what extent gaming elements and/or technologies (such as Augmented Reality, 3D scanning and Additive Manufacturing) could serve to add to this value creation, as well as the extent to which museums already use technologies to complement their exhibitions.

In addition to a value creation strategy, I will define an accompanying business model, detailing elements which are key to this business model, and allow the outcome to be implemented and maintained with financial independence. Important beneficiaries should be the collection holders (i.e. usually museums).

The goal is to immerse visitors and inspire more affinity with these artefacts, so that these objects can capture the beholder's imagination to this present day, in order to revive some of the significance that these objects had to their original wearers. Sparking renewed appreciation for historical jewellery could potentially even influence contemporary adornment preferences; fuelling trends and adding to the meaning that modern-day accessories may have to their wearers.

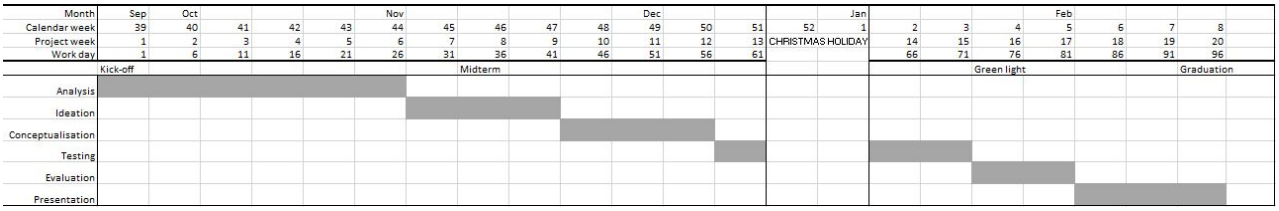
Initials & Name B.G. Leferink 5291 Student number 4442814

Title of Project A value creation strategy for historical jewellery exhibitions in museums

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 27 - 9 - 2021 25 - 2 - 2022 end date



Analysis – Literature study, activities Current Obsession, status quo of museums, current applications of novel technologies for exhibitions

Ideation – Devising potential strategies for value creation

Conceptualisation – Integrating details on most promising idea, fully defined strategy

Testing – Test results with users, potentially with prototypes/other methods

Evaluation – Apply learnings, iterate, draw conclusions

Presentation – Communicate & present final designed strategy and findings

Iterate throughout design phases.

Initials & Name B.G. Leferink 5291 Student number 4442814

Title of Project A value creation strategy for historical jewellery exhibitions in museums

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.

IDE is what I have been educated in, but I know that in order to excel in a semester-long full-time individual project I will need more than just a skillset, I need to be passionate about the work. That is why I jumped at the opportunity to apply my acquired competences in the field of design to dive deeper into a set fields that have captured my imagination for at least a decade now (if not most of my life): accessories, culture and history.

Aside from a self-planned visit to the Gold Museum in Bogotá during my exchange semester in Colombia, I feel like I encountered very little opportunity to have these areas of study meet with design during my time at IDE. That is why I look forward to making use of the freedom and autonomy granted to graduating students in the choice and execution of their project. It is also why I was delighted to learn about the existence of the Museum Futures lab, where (guidance on) more research in this direction could be found.

Creative ideas to be iterated upon usually come quite naturally to me nowadays, but the competence I value the most from my SPD master is being able to take a good idea and implement it in a monetisable manner, without which the concept would usually not be able to stay afloat by itself, in which case its reach to provide value would be very limited. Working on this project I aim to prove my worth as a strategic product designer by defining a suitable business model for the product/experience that I will be designing.

Regarding the prospect of working mostly individually on one big project for 100 working days, the graduation project feels quite intimidating. It will be key for me to create a clear structure and impose strict intermediate deadlines on myself in order to keep track of what to do on a week-to-week basis. However, I am also confident that I will gradually get into a reliable workflow as the project gets under way, especially since I expect to enjoy working on this engaging topic from start to finish.

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.

Initials & Name B.G. Leferink 5291 Student number 4442814

Title of Project A value creation strategy for historical jewellery exhibitions in museums