

The *Sacra Infermeria*—a focus group evaluation of an augmented reality cultural heritage experience

Jonathan Barbara, Mattia Bellini, Hartmut Koenitz, Péter Kristóf Makai, Despoina Sampatakou & Shafaq Irshad

To cite this article: Jonathan Barbara, Mattia Bellini, Hartmut Koenitz, Péter Kristóf Makai, Despoina Sampatakou & Shafaq Irshad (2023): The *Sacra Infermeria*—a focus group evaluation of an augmented reality cultural heritage experience, *New Review of Hypermedia and Multimedia*, DOI: [10.1080/13614568.2022.2150324](https://doi.org/10.1080/13614568.2022.2150324)

To link to this article: <https://doi.org/10.1080/13614568.2022.2150324>



Published online: 19 Jan 2023.



Submit your article to this journal [↗](#)



Article views: 143






View related articles [↗](#)



View Crossmark data [↗](#)



The *Sacra Infermeria*—a focus group evaluation of an augmented reality cultural heritage experience

Jonathan Barbara ^a, Mattia Bellini ^b, Hartmut Koenitz ^c,
Péter Kristóf Makai^{d,e}, Despoina Sampatakou^f and Shafaq Irshad^g

^aDepartment of Computing, Saint Martin's Institute of Higher Education, Hamrun, Malta; ^bInstitute of Cultural Research, University of Tartu, Tartu, Estonia; ^cSödertörn University, Huddinge, Sweden; ^dRachel Carson Center for Environment and Society, Ludwig-Maximilians-Universität, München, Germany; ^eDepartment of Social Communication and Media, Kazimierz Wielki University, Poland; ^fDepartment of Digital Archaeology, University of York, York, UK; ^gDepartment of Electronic Systems, Faculty of Information Technology and Electrical Engineering, NTNU, Trondheim, Norway

ABSTRACT

The digital representation of our past has long been an important tool in the interpretation of cultural heritage in museums. The recent rise in the use of Augmented Reality (AR) has seen various approaches to adding dynamic information to existent artefacts. The challenge is even greater when uncertainty further complexifies the represented history. This paper presents a critical analysis of an AR installation in the *Sacra Infermeria* museum in Valletta, Malta. After a description of the AR configuration of the installation, we present a thematic analysis carried out from a multidisciplinary focus group of 11 researchers in the field of Interactive Digital Narratives (IDN), from three perspectives: the technological implementation of the AR experience, the historical accuracy, gamification and the influence of social media-centred design, and the representation of the complexity arising from the uncertainty of history. In the light of the results of the multidisciplinary focus group, we provide a list of recommendations and heuristics.

ARTICLE HISTORY



Received 4 April 2022
Accepted 17 November 2022

KEYWORDS

Cultural heritage;
complexity; uncertainty;
augmented reality; design

1. Introduction

The systematic social and cultural transformations that appeared over the last two decades as a result of technological advances required museums to question and subsequently adjust their approach to the presentation of cultural heritage (Drotner et al., 2018). However, notwithstanding important and sometimes radical technological innovations in museums, narratives always played an important role in the design of exhibitions (Wolff et al., 2012), both when strengthening the role of an exposed object through its story, and in using

CONTACT Jonathan Barbara  jbarbara@stmartins.edu  Saint Martin's Institute of Higher Education, 116, Triq Joe Sciberras, Il-Hamrun HMR 1557, Malta

This article was originally published with errors, which have now been corrected in the online version. Please see Correction (<https://doi.org/10.1080/13614568.2023.2189067>)

narrative as a meaningful sequencing of blocks of information throughout the entire exhibition (cf. Peponis et al., 2003).

The advent of mobile devices, for example, did not change the importance of narratives in museums, but opened the way to countless additional ways to strengthen the interrelation between storytelling, entertainment, and education to serve the information needs and expectations of visitors. As early as 2004, the effect of Personal Digital Assistants (PDAs) to draw attention towards existing non-interactive narratives in museums has been reported (Yatani et al., 2004). Since then mobile technology has been increasingly visible in many expositions and has been discussed in a number of scholarly discussions. Nack and Jones (2008) outlined the challenges of mobile museum environments, where information “does not merely represent static aspects of a concept or event but actively adapts to the experiential space of a user and thus shapes the creative means of social interaction” (p. 256). Lombardo and Damiano (2012) evaluated the impact of digital and mobile-based storytelling for communicating the knowledge of a historical site in Turin, Italy. An approach to mobile-enhanced drama-based museum experiences is adopted by Callaway and colleagues (2011). Their mobile application aimed at fostering inter-group discussions through the delivery of incomplete narrative information to each member of a group. This builds on what Doering and Pekarik (1996) defined as “entrance narratives”, i.e. the personal storylines, expectations, and the resulting experience of each visitor. Different perspectives over the same experience, resulting from different “entrance narratives”, are part of the critical discussion included in the current contribution.

More recent advancements in computing facilitated an even more sophisticated intertwinement of mobile technology, fiction and knowledge, namely Augmented Reality (AR). The use of Mobile Augmented Reality for education (Nincarean et al., 2013) and museums, tourism and heritage (Ding, 2017; Geroimenko, 2021) is rapidly gaining popularity. Since 2017, museums dedicated to natural history, art, space exploration, and others have launched their own AR initiatives, with heightened activity in 2021 (Coates, 2021). In the future, AR museums could be recreated in Virtual Reality (VR), possibly delivered through commercial environments, such as the Facebook “Metaverse” (Kraus et al., 2022). As technology advances, AR will afford more opportunities for interaction, pushing the boundaries of the artificial and the real.

The goal of this paper is to investigate why and how AR narratives can be used to represent complexity in cultural heritage contexts. We start by explaining uncertainty in cultural heritage as a source of complexity, which will help us discuss why complexity makes immersion in museums difficult. We then look at how museums have used digital technology to help visitors immerse themselves into its history representations and look at four different configurations in which museums have employed AR. We then describe the results of a focus group analysis of our case study, the *Reliving the Sacra Infermeria*¹—an AR

experience situated in a medieval hospital turned conference centre in Valletta, Malta—launched in 2020. As an outcome of this analysis, we present a list of general recommendations that should be observed while AR-based narratives are utilised as a communication tool.

2. Contextual background

The literature review starts with an overview of the complexity of uncertainty in cultural heritage, proceeding with its challenges to immersion being offered by museums. We then consider how digital technology, particularly augmented reality, can help represent complexity and how it has been used in museums. This theoretical background provides an analytical framework for our study of the use of AR in museums.

2.1. Complexity of uncertainty in cultural heritage

Ackerman et al. (2022) characterise complexity using three frameworks: material complexity, perspectival complexity and power-based complexity. Material complexity deals with the material aspects of a problem, such as the uncertainty in the measurement of well-identified qualities of a complex object made from multiple interconnected parts that exhibit dynamic interactions (VIGIE, 2020/654, 2022). Perspectival complexity is when a problem exhibits fundamentally different perspectives that give incompatible interpretations, while power-based complexity is where one or more of these conflicting perspectives enjoys dominance over the others (Ackerman et al., 2022). As it could be noted, all these three frameworks of complexity originate from a fundamental uncertainty regarding different aspects of the piece of cultural heritage in question, or regarding its socio-political, cultural, and/or economic context. Perspectival complexity and power-based complexity are the two factors that will be discussed the most throughout this article.

Every piece of cultural heritage (sites and artefacts) has been attributed an economic, artistic, or historical value. This value is for the most part not intrinsic to the artefact itself, but dependent on what we know about its past (Kersel & Luke, 2015). This knowledge is mainly informed through written accounts (Moody, 2015). However, current representations of history prevent a reflection on how the underlying frameworks of this value attribution determine our understanding of history, because their “purpose, social status, ideology and historical location” are opaque (Turina, 2018, p. 125). Therefore, such representations are an “oversimplification” of history. Instead, history should be treated as a complex system of past social, economic, political and cultural interactions working like a “layered network” of causality between parallel decisions made throughout time (Turina, 2018). Building also on this understanding, Knowles challenges the certainty, stability, and objectivity of the historical

record, which, according to him, are always framed within a patriarchal society of the “white men in the global North” (Knowles, 2019, para. 4). As feminist, minority, lower class, and eco-centric views gain importance, the social dimension of history challenges the official record, presenting multiple perspectives that may provide conflicting accounts from contemporary witnesses (Knowles, 2019; Turina, 2018). This exemplifies not only perspectival complexity but, as the predominant historical record is given dominance in the museum experiences, also power-based complexity. These multiple perspectives fuel uncertainty, which might diminish the credibility and authenticity of the historical record and challenge the consistency of its representation, decreasing immersion—a crucial aspect of the museum experience, as we are going to discuss.

2.2. Museums as immersive experiences

Early research has shown that immersive experiences have a significant potential when employed for learning purposes (Bitgood et al., 1988; Harvey et al., 1998, Thompson, 1993). As such, immersion appears to be a crucial aspect in the design of exhibitions with educational purposes, such as those showcased in museums. Other works have shown how exhibition design influences immersion (Harvey et al., 1998). In particular, “consistency of representation” is considered an important design feature in exhibits wanting to provide potential for immersion (Harvey et al., 1998). Lack of consistency in exhibitions may result in confusion and demand a high cognitive effort from museum visitors, potentially leading to cognitive overload and fatigue, particularly when the represented subject is already an interpretation of pieces of cultural heritage (Wickens, 1992).

One such challenge to the consistency of representation is uncertainty, and the complexity it introduces. Considering that visitors treat museums as trusted sources of information (Hede et al., 2014), any uncertainty is bound to result in scepticism towards the provided information and negatively influence the visitor’s immersion (Komarac & Ozretić Došen, 2021). As we are going to discuss in a short while, digital devices offer a new way of addressing the issue (or feature?) of uncertainty. However, the reliance on the digital medium brings forth a number of design choices that go well beyond the organisation of spaces and of physical artefacts, while the consistency of the represented material still needs to be carefully considered to generate immersion, and thus ultimately to achieve the goal of the project in question.

2.3. Digital technology in museums

Already in the early ‘90s, Bitgood had claimed that the use of an interactive realistic three-dimensional space (as opposed to two-dimensional) that provides multi-sensory feedback would facilitate “simulated immersion” wherein an

exhibit “creates for visitors the experience of a particular time and space” (Bitgood, 1990, p. 1). According to Liu and Idris (2018), for almost forty years museums have been shifting their focus from the objects presented and represented to the people for whom these objects are being exposed.

Various attempts have been made towards this same direction, and digital technologies have been widely used by museums and heritage institutions to enhance visitors’ experience (Mohd Noor Shah & Ghazali, 2018, p. 35). They maintain that expectations have to be carefully investigated to improve digital applications that focus on the user’s needs (Mohd Noor Shah & Ghazali, 2018, pp. 35–36). According to them,

user experience has also been defined as a variety of feeling and ongoing reflection on the events that one is going through, fulfilling the human needs and consequence of [the] user’s internal state while using a product, system or service in a specific context. (Mohd Noor Shah & Ghazali, 2018, p. 36)

Roussou and Katifori (2018) also noted that understanding user experience design—and particularly, the elements that make it effective—is a complex matter that needs further and meticulous exploration. For these reasons, later in the text we will discuss a number of aspects of user experience design that could be useful to evaluate applications of digital technologies in educational exhibitions.

Among the different digital technologies often employed by museums, it has been suggested (Nack & Jones, 2008; Shaer & Hornecker, 2010) that tangible interface technologies can create a fun environment for learning, since it allows interaction between the physical and the digitally enhanced world. Indeed, the most common tools used by museums to achieve their goals are smartphones and tablets, as they are easily portable and already available to most visitors (Vaz et al., 2017). These are usually employed in combination with other technologies, among which is AR (Mohd Noor Shah & Ghazali, 2018, p. 44), which is used to immerse the visitors into the theme of the museum, thus enhancing their experience and increasing the pedagogical outcome of the visit.

2.4. Augmented reality and museum spaces

An AR system “combines real and virtual objects in a real environment; registers (aligns) real and virtual objects with each other; runs interactively, in three dimensions, and in real time” (Van Krevelen & Poelman, 2010). Mobile AR normally achieves this by providing a layer of digitisation over the mobile phone’s live camera feed, which allows the user to access the AR experience on their mobile phone’s screen (Azuma et al., 2001).

Milgram et al. (1995, p. 283) position AR within the mixed-reality continuum, placing it closer to reality in a continuum between the real and the fully virtual environment (see Figure 1). At the time this continuum was first theorised, AR was implemented either as a see-through device or a monitor-

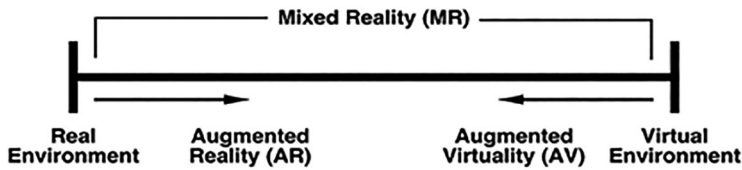


Figure 1. The reality–virtuality continuum (Milgram et al., 1995, p. 283).

based experience. With technological advancements and portability, mobile-based and tablet-based AR fused the two approaches together providing a “Window-on-the-World” approach that still affords “real-space imaging” (Malinverni et al., 2017; Naimark, 1991).

However, there is a fundamental issue with Milgram et al.’s continuum in that it locates AR as a step towards virtuality, essentially as ‘less real’ than the real environment. However, AR adds elements to the real environment and does not subtract from it. Instead, the real, unmodified environment is a threshold in the trajectory between augmented and virtual environments, as we explain below. Therefore, AR should be placed beyond the real as a *hyper reality* (see Figure 2). We take *hyper reality* as a state in which the sensory signals from the real environment are augmented with further information about one’s surroundings to provide more details about that reality. In contrast, *virtual reality* closes the audience off from the real environment and takes it into a fully artificial world.

In our case study of an AR experience, being inside a hall that used to be an infirmary but is now a conference room, as is the case with the *Sacra Infermeria*, allows us to see, touch, and hear the room’s present purpose. But if we are able to sense its purpose back in time, our perception of that room goes beyond reality, providing an element of complexity to the cultural heritage artefact or site as it transcends time and purpose. As we shall see in the next subsection, one of AR’s purposes in the context of cultural heritage representation is indeed to augment the interpretation by extending sensory information with visual and aural detail of the past.

Importantly, this distinction between virtual and augmented reality does not concern the ontological and, in some sense, semiotic status of the fictionality of

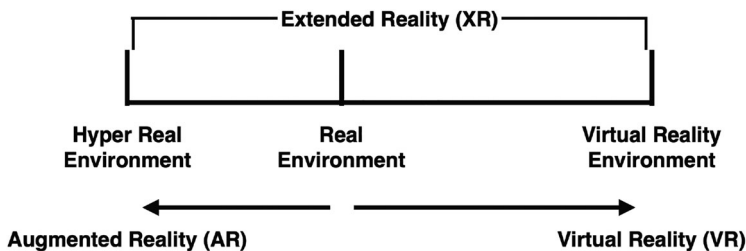


Figure 2. The revised reality–virtuality continuum (adapted from Milgram et al., 1995).

representation. A VR representation can be ‘non-fiction’, e.g. a recreation of the Maltese Hypogeum based on real-life measurements, while an AR experience can be fictional by placing imaginary elements on top of the real environments, as exemplified by the popular AR game Pokémon Go (Niantic, 2016). Beyond these conceptual considerations, there are pragmatic issues with current AR technology that significantly influence the overall user experience, as we will discuss in more detail later on.

Accordingly, Coelho et al. (2005) state that “all spatial knowledge about the world has uncertainty associated with it” and this aspect manifests itself in the case of AR “as registration errors between the graphics and the physical world” (Coelho et al., 2005, p. 1). In other words, the physicality of the real environment needs to be correctly understood for the augmented layer to be positioned above it (Kunze et al., 2018; Su et al., 2013).

2.4.1. Types of Augmented Reality in Museums

As Syahrul et al. (2021) note, AR promotes interaction while maintaining a physical connection with the real artefacts or places. However, there are various ways how AR can be employed to juxtapose the real with the artificial through digital technologies. Coates (2021) presents a review of four different AR configurations that have been used in museums:

- (1) *AR as an additional explanation to existing exhibits*: this kind of AR is strictly bound to a physical place or object, and it serves as an enhancement to the site providing contemporary information. An example is *The Skin and Bone* app, launched by the Smithsonian Institution² in 2017, which provides additional information about a physical skeleton exhibition by overlaying tissue and skin over the bones when seen through the mobile device’s camera.
- (2) *AR as a 3D display of objects or scenes across time*: this kind of AR shows artefacts with information from a different time. Examples of this can be seen using the Microsoft HoloLens in the REVIVRE³ project at the Natural History Museum in Paris, launched in June 2021. This allows visitors to see 3D animated representations of extinct animals and their behaviour. Another example is the ReBlink⁴ project in the Art Gallery of Ontario, which reinterprets artworks into the modern culture of technology and alienation.
- (3) *AR as a 3D representation of a narrator talking about the piece being exhibited*: these experiences provide a non-diegetic character placed between the exhibit and the visitor. One example is the *Heroes and Legends*⁵ exhibit at the Kennedy Space Center, launched in 2016, which uses AR to project astronaut Eugene Andrew Cernan onto the Gemini 9A space capsule as he describes his struggle to get back into the pod after performing the second spacewalk in history.

- (4) *AR as a stand-alone experience within a not pre-defined space*: finally, this configuration is that of an AR designed to not interact with an existing exhibition, but which is self-contained, and which could be experienced as a separated part of a museum (as opposed to type 1 where the exhibition is physically tied to its containing space). An example is the *Invasive Species*⁶ exhibition at the Pérez Art Museum in Miami, which is a stand-alone AR experience that shows what any space could look like if taken over by alien species, in a plight to bring attention to invasive marine species in the waters around Miami.

Note that while type 1 and type 4 are mutually exclusive configurations (it is either building upon a present tangible artefact or it is not), type 2 and 3 can happen in either case, and they are not mutually exclusive. Moreover, all forms of AR are experienced in relation to a tangible artefact (types 1, 2, and 3) or space (type 4) to which additional information is provided by extending its representation into an animated 3D space overlaid onto the existing environment (see the concept of *hyper realism* outlined above). It should also be noted that, whilst seemingly arbitrary, having in mind these configurations while designing an AR experience can significantly enhance the resultant exhibition, as demonstrated by the examples provided above. Further evidence of this will be provided in the discussion of our case study.

The use of digital technologies, and in particular of augmented reality in its four configurations allow the museum to represent the uncertainty of history and the resulting complexity.

2.5. Museums and/as representations of complexity

As stated by the International Council of Museums, museums are an important part of knowledge transmission as well as cultural formation regarding the past (ICOM, 2007). In particular, a recently adopted and renewed definition describes museums as

a not-for-profit, permanent institution in the service of society that researches, collects, conserves, interprets and exhibits tangible and intangible heritage. Open to the public, accessible and inclusive, museums foster diversity and sustainability. They operate and communicate ethically, professionally and with the participation of communities, offering varied experiences for education, enjoyment, reflection and knowledge sharing.⁷

According to this definition, the exhibition of interpretations of cultural heritage is one of the central *raison d'être* of museums, and its design is a critical factor in providing an informative experience and, ultimately, in fulfilling their objective as educational spaces. As was suggested, AR can successfully create an instance of immersive digital storytelling (Syahrul et al., 2021, p. 11) that could be very beneficial to achieve these scopes. However, representing cultural

heritage is not always simple since, as has been discussed, cultural heritage *per se* is rather uncertain and complex. How, then, can museum experiences afford a representation of complexity while maintaining immersion and engagement?

Chang (2020) observed that the theory of interaction developed in the 1960s was taken up in museums in the 1980s, wherein immersive interactive devices can present better looking exhibits and generate dialogue for an enhanced visitor experience. Komarac and Ozretić Došen (2021) went further as to claim that interaction enhances immersion, helping even sceptical visitors to get quickly immersed into the museum experience. Thus, according to recent critical discourse, interaction is a key factor for enhancing visitors' experience by keeping them immersed.

However, interaction has a number of other significant advantages, which we will try to show throughout the article, and which were already discussed in a number of works (e.g. Barbara, 2020; Bellini, 2022; Koenitz et al., 2021). One of the main advantages is that, when properly managed and when joined with narrative structures, interaction affords multi-perceptivity in a simple and cognitively manageable way. When inserted in museums, such interactive, narrative experiences necessarily require digital technology.

Together with the discussion provided in the previous section, this leads us to support the idea that the multi-perceptivity afforded by interactive digital narratives (IDN) allows for accounting and representing perspectival complexity while keeping the visitors involved. This also allows visitors to engage with narratives that challenge the historical record, by providing them with the choice to evaluate competing interpretations. In the remaining part of the article, we provide a discussion of the requirements and implications for implementing interactivity and digital technology in museum experiences through the analysis of a case study by a focus group. The outcomes of the analysis will be summarised in a number of criteria and heuristics for evaluating AR museum experiences, in the hope to help designers and curators develop more informative and engaging installations.

3. Case study: AR for museums

In the following sections, we introduce the analysed Sacra Infermeria AR Experience, outline the methodology of our analysis, and provide details of the participants of the study. The section concludes with the critical analysis of the artefact.

3.1. The Reliving the Sacra Infermeria AR experience

Valletta, the capital city of Malta, was built in the sixteenth century from monies collected throughout Europe by the Knights Hospitallers as a bulwark against Ottoman invasions. As a result, it became filled with buildings

that served the needs of the Order. Many remain erected to this day. Chief amongst these buildings is the *Sacra Infermeria* (Holy Infirmary), the first hospital in Malta, where the Knights tended to their sick, as was their duty. Nowadays, this site is rebranded as the Mediterranean Culture and Conference Centre—with the required amenities, such as a large auditorium, meeting rooms, and a large open hall. Due to this modern function, and in order to accommodate the needs of conference organisers, much of the space is devoid of heritage artefacts or exhibits. Within this site, the experience titled “Reliving the Sacra Infermeria” aims to represent the history of the site in the form of a cultural heritage museum that is delivered mainly through AR.

The *Reliving the Sacra Infermeria* experience is made up of three components: a mobile-based app for an AR-assisted tour, two AR mini-games, and a holographic representation of the Grand Master Jean Parisot de Valette.

3.1.1. The AR-assisted tour

The experience is delivered through a mobile application (called “MCC Tour”) that is either downloaded and installed on the visitor’s mobile device during the onboarding process or pre-installed in one of the provided tablets. A human guide takes care of the onboarding process and leads the visitors around the complex. The app reconstructs the building’s function as a hospital through the use of silent 2D vignettes showing typical hospital events that are positioned by the visitor onto the site’s cleared-up space and then played as an animation. Each room of the venue has specific AR vignettes featuring different characters and furniture that match the room’s function. The AR experience also included a textual description of the venue and of the vignettes, that could be heard through a text-to-speech built-in service. The app enables free placement of the vignettes, allowing the visitor to set up their own scene and to stand within the vignette and take photos or videos of their setup. As the app is downloadable onto personal devices, visitors are allowed to further navigate it and learn about the *Sacra Infermeria* even outside the area of the exhibition.

3.1.2. Rooftop mini-games

The rooftop of the building offers a view of Valletta’s “Grand Harbour”. The AR experience takes advantage of this privileged view to offer a different form of interaction through two mini-games, in which players are required to: (a) shoot cannons at incoming Ottoman boats during the Great Siege of 1565, and (b) fire machine guns at enemy war planes during World War II. The experiences are launched and calibrated by scanning a custom QR code from a rooftop display overlooking the harbour. Then, incoming enemy vessels or aircraft are digitally drawn over the sea or in the sky, respectively, and they can be interacted with by aiming at them through the phone’s camera.

3.1.3. Holographic display room

A third feature of the experience is a holographic display room which presents a digital life-size version of Grand Master de Valette, under whose leadership the city was built and after whom the city was therefore named. This is presented as a 2D projection of a 3D scene onto a transparent screen, halfway down an empty room. As stated in its presentation, this part of the exhibition should have used artificial intelligence (AI) to address visitors' questions. AI for storytelling is a much-felt research topic in the field of IDN (cf. Louchart et al., 2015; Murray, 1997; Riedl & Bulitko, 2013), and it has been already implemented, e.g. at the USC Shoah Foundation's "Dimensions in Testimony" (Traum et al., 2015). Notwithstanding the presentation, no AI was actually involved in the interaction of visitors with the hologram. Indeed, in practice, the projection affords interaction through a touchscreen with a provided set of questions that can be selected, triggering a short clip that addresses the visitors and answers the respective question.

3.2. Method and participants

The critical analysis described in this section is the result of a focus group made up of attendees of a Training School organised by the COST Action INDCOR⁸ and hosted by Saint Martin's Institute of Higher Education in Ħamrun. The theme of the training school was *Interactive Digital Narratives as Representations of Complexity in Cultural Heritage* and its focus was on the complexity of uncertainty, using cultural heritage as an application area. The event took advantage of the rich cultural history of the Maltese islands to tangibly explore the need, challenges and opportunities in using Interactive Digital Narratives (IDNs) to represent complexity.

The group was formed by a total of 11 people: ten attendees of the training school and an instructor—close to the recommended size for a focus group (Krueger, 2006; Nyumba et al., 2018; Wilkinson, 1998). The methodology for our analysis is based on insights of user research in the domain of games (Drachen et al. 2018): the participants first had a chance to try the artefact object of analysis (the *Reliving the Sacra Infermeria* AR experience), and subsequently a group discussion was led, and notes were taken during the discussion. The authors, as coordinators of the group, provided prompts related to the three themes discussed below, and allowed the participants to share their experience of, and the relative thoughts about, the selected object of study.

Participants were prompted with the three distinguishable parts of the AR experience and asked to freely comment on their use as a representation of cultural heritage, and on how these representations accounted for the complexity of the history they portrayed, also in regard to the uncertainty related to them. These comments are presented in section 3.3.2 grouped by theme.

The general profile of the attendees who contributed to this article is that of IDN scholars, but each having his or her own specialisation and diverse perspective over this umbrella topic:

- An archaeologist and heritage management consultant and a Ph.D. student in Digital Archaeology.
- A postdoctoral fellow at a German Cultural Studies institute with research on games and world-building.
- A Ph.D. student in XR research focusing on the UX of immersive media technologies.
- A Ph.D. student in the area of digitally-enhanced reality and narrative architectures for structuring multi-perspective content through mixed reality.
- A Ph.D. student in the area of Artificial Intelligence and Experience Management.
- A Ph.D. student of political science, applying mass communication theories to study media effects on political communication and interaction between media and politicians.
- A Ph.D. student in disability studies, investigating inclusion and accessibility models about video game narratives.
- A Ph.D. student exploring new methodological approaches to understand and measure the learning of complex themes through IDNs artefacts.
- A Ph.D. student in Human–Computer Interaction, applying generative interaction theory to design persistent player narratives in digital game worlds
- A junior researcher at a Centre for Simulation Games and Gamification, Ph.D. student and game designer.
- An associate professor focusing on cultural heritage games, interactive digital storytelling, and feminist and post-human perspectives on digital media.

The diversity in age, career level and, most importantly, participants' background facilitated one of the strengths of focus group investigations, namely "... engagement with participants' own concerns and agendas, in ways that may enhance the research project or generate new and perhaps unexpected findings" (Wilkinson, 1998, p. 190). In this way a broader and more varied perspective could be provided compared to other uni-lateral discussions of case studies. This enables a more thorough overview of the *Reliving the Sacra Infermeria* experience, which is complex in its inner nature of a cultural object representing a piece of cultural heritage—which in turn is complex as well, as was already discussed.

The multiplicity of varied perspectives and knowledge provided by the diverse backgrounds of the participants constitutes both the principal novelty and the main justification of the methodology for the proposed analysis. Rather than relying on a specific methodological framework, adhering to the

univocal view proposed by a single theoretical foundation, or focusing on specific aspects of the experience that are close to one or another discipline, in this article we try to tie together expertise in different fields and discuss sometimes conflicting opinions in an attempt to synthesise even discordant views.

This helps us to provide a critical reflection and a more all-encompassing list of good practices in AR user experience design, which does not claim to be exhaustive, but which surely benefits from the multidisciplinary of the analysis it is based on. We strongly believe that the unified view coming from this synthesis is obtainable only via a broad collaboration of disciplines, and we equally believe that it generates an understanding that is more than the sum of the individual focus group members' grasps of the object of study here discussed. We align here with Wilkinson (1998), namely that "... the opportunity they offer to observe the process of collective sense-making as it actually happens, within the focus group interaction itself". Similar approaches, juxtaposing different analytical lenses and many insights from different disciplines, are sprouting in many instances of IDN studies and game studies (e.g. in the "Multi-Method Analysis" (MMA) proposed by Koenitz et al. (2022)).

The final outcomes of the observations and discussions are summarised in the next section.

3.3. Critical analysis

In this section, we report the outcomes of the focus group discussion on our case study, the AR experience "Reliving the Sacra Infermeria", in three regards:

- (1) As a significantly enhanced experience component that enables an interaction with the site in a way not possible through other means; given the use of AR in this experience, the authors measure this in terms of the value offered by the four AR configurations listed in section 2.3.1.1. Is this experience qualifying as one of the four configurations? And what does this entail?
- (2) Its technical implementations need to provide an experience of a production standard that meets expectations—instilled and attended by the design of the experience as a whole. These are inferred from the participants' respective entrance narratives (cf. Doering & Pekarik, 1996) and from the announced museum experience. What are the issues if this standard is not met?
- (3) It should foreground the historical complexities of the site in a way that provokes thought, since the uncertainty of historiography means that history should be presented as a complex phenomenon. How does the experience deal with complexity coming from the uncertainty of history, given its gamified and "social media-centred design"⁹?

In the analysis, participants were asked to take into account all the interactions between real world and fictional elements. This broader perspective is necessary for a critical reflection on a product that is not merely digital or merely real, neither the sum of the two, but a richer, stronger experience that emerges from their combination, from the digitally-achieved augmentation of reality.

The focus group was, therefore, asked to what extent this museum experience could provide access to the complexity of the cultural heritage housed in its site. We investigated this question also in light of the gamification and social media-centred design approach which, for the reasons that we are going to describe below, appeared to be the main focus of the AR experience in question. In analysing this case study, we asked the group whether such approaches can also represent complexity intrinsically, i.e. whether the complexity of a piece of cultural heritage could emerge spontaneously from a (possibly inaccurate) representation of its history.

In more general terms, the critical analysis that is presented in the upcoming sections is going to highlight a possible “trap”, or a misuse of AR technologies for delivering museum experiences, which is overstressed gamification and social media-centred design. When this verifies, as we are going to discuss, the playfulness and the shareability/appeal as social media content of the experience can overtake other matters that are more substantial and important—at least according to the definition of the “museum aims” provided above.

3.3.1. AR configurations

In section 2.3.1.1., we presented the four AR configurations outlined by Coates (2021). We summarise them here: (1) AR as an additional explanation to existing exhibits, (2) AR as a 3D display of objects or scenes, (3) AR as a 3D representation of a narrator talking about the piece being exhibited, and (4) AR as a stand-alone experience within a not pre-defined space. In this section, we analyse each part of the experience in relation to these configurations.

The AR-Assisted Tour accompanies the visitor as they explore the different rooms of the *Sacra Infermeria*. While this should have resulted in a clear and perfect example of type-1 AR, it mostly fails to be so. The AR experience was expected to unveil the role of the building (and of its rooms) in medieval history. However, as the designers chose a markerless approach, the experience does not rely on the actual space of the exhibition. This lack of grounding, fostered by the absence of props and other installations, generated a non-correlation between the AR experience and the site. This severed link between the physical and the digital augmentation causes the experience to be closer to a type-4 configuration, which have been found alienating for the whole experience to the point of claiming a uselessness of the AR component. Furthermore, while it is true that the vignettes add a historical layer to the empty rooms, therefore making the experience tend towards type-2 configuration, these short silent videos are two-dimensional, thus partly negating the type-

2 AR status. The experience does not qualify as a type-3 AR either, as there is no presentation of a character, nor a voiceover, but only a text description transformed into speech on-demand.

The rooftop mini-games effectively make use of the space they are located in, employing a mechanic that asks players to scan the horizon. This suggests a type-1 configuration, as the experience indirectly shows the role and benefits of settling around harbours on the island. However, there are substantial historical inaccuracies in particular in terms of framing of the experience: the city of Valletta did not exist in Ottoman times, and no anti-aircraft weapons were reported to be installed on the building in WWII, which pose issues to this configuration. The AR experience also points towards a type-2 configuration, as it presents historical objects in the form of boats, aeroplanes, and defending machinery. However, this is problematised once more by the historical inaccuracy of the representation (in particular regarding the Ottoman part, the representation is not aligned with historical reports). The interactive nature of the mini-games allows the visitor to re-enact the narration of the experience, providing something similar to a type-3 configuration, though with the further issue of missing to represent the hardship of the task portrayed. In the absence of the above three configurations, the need for the watery context provides the ability to situate the AR installation in a space with access to the Grand Harbour, as offered by the roof of the *Sacra Infermeria* irrespective of its irrelevance, making it a type-4 configuration. However, the games could not be played in other locations, as a specific QR code had to be scanned for their activation. As such, it does not qualify as a proper type-4 either.

The Hologram Room does not rely on mobile devices, but it still qualifies as an AR installation as it mixes reality and digital representations (cf. Elmahal et al., 2020; Milgram et al., 1995). The approach chosen by the designers for this room is projecting a 2D render of a 3D scene onto a transparent screen with the viewers restricted to a specific distance. As the room behind the screen on which the video is projected is empty, this does not qualify as a type-1 configuration, since there is no exhibit being explained. The video shows the scene of a historical figure (the *Grand Master de Vallette*) explaining his role, and introducing a sort of interactive narrative provided via pre-recorded responses to a predefined list of questions. This can qualify the Hologram Room as both a type-2 and a type-3 configuration, even though it fails in representing the character and his environment in three dimensions. Historical inaccuracy still hinders the representation: the happenings portrayed in the holographic display room have no connection to the *Sacra Infermeria* (the site of the exhibition), which somehow qualify the experience as closer to a type-4 configuration.

As per the analyses above, each of the three aspects of the experience have significant issues in qualifying entirely as defined types of configuration. As mentioned, this is not problematic per se, but having in mind the four

configurations while designing an AR experience can significantly enhance the resultant exhibition, the representation it portrays, and the historical knowledge it tries to convey. In the examples, we have shown how design decisions and historical inaccuracies hinder such classification, and, consequently but also more importantly, how they prevent a successful representation of the history of the site and of its complexity for the sake of exploring a gamification and social media-centred design, as we will discuss shortly.

3.3.2. Thematic analysis of the focus group outcomes

The individual technical, historical, social and representational aspects that will be touched below received more thorough contribution by the participants with relevant knowledge and expertise, such that the resultant analysis is a distillation of the different informed perspectives involved.

3.3.2.1. Reflections on the technical implementation. Vosmeer and Roth (2021) identify a burden placed on VR technology by science fiction, with public expectations being fuelled by “technological fantasies” rather than “technical possibilities”. They also cite Graves (2018) who

... pointed out how the fictional representations of VR as a wondrous technology affected how the public perceived the medium and warned that since these fictional accounts on the possibilities of VR were often strongly positive, the public may become disappointed with their actual experiences of VR. (Vosmeer and Roth, 2021, p. 436)

The advantage of having such a critical analysis made by a team of IDN scholars with interdisciplinary specialisations is that any criticism expressed here is in relation to known technical possibilities rather than romanticised expectations.

With respect to the 2D vignette placement in the AR experience of the MCC Tour app, the focus group participants concluded that the use of free placement had significant downsides compared to the usage of placement markers. This includes imprecision of placement, significant sensibility to noise (particularly in a situation with a number of people walking in the room), lowered usability and accessibility issues, in particular for older or digitally illiterate visitors. Even more, the absence of markers was found to open up to a number of misinterpretations by the visitors as too little guidance in vignette placing (and thus in their interpretation) was provided. However, on the other hand, the free placement has the advantage of allowing the possibility of accessing part of the AR experience also outside the heritage site, according to our participants.

The audio descriptions were found as being possibly beneficial for improving the accessibility of the application (e.g. for visually impaired visitors). However, the group found that interpretation of the text by a human voice instead of a text-to-speech actor would have significantly improved immersion. The use

of audio to deliver sound effects that aurally support the visually animated vignettes, such as the moaning patients, or the sound of writing on parchment, was suggested as an additional possible room for improvement as it would further enhance the sensorial immersion of the experience. In both cases, however, the group agreed that hardware means for audio delivery should be provided (in the form of ear plugs, headphones etc.) or installed in the venues (with in-room loudspeakers).

On a content level, the participants noticed a significant tone-down of the atmosphere and ambient of the hospital represented, to the point of seeming a mis-representation of the heritage site itself. For example, it was felt that the well-dressed caregivers with clean clothes attending to injured people represented in the AR experience did not sufficiently convey the expected aura of pain and suffering of the hospital. This also caused feelings of technological alienation and emotional distance from the content portrayed. The same feelings were reported regarding the venue of the experience, which comprised no props, as said: in the participants' eyes, the deprivation of such details denuded the site of its meaning, a gap that was not fulfilled by the AR experience. Similar concerns on historical accuracy have been detected regarding the two rooftop mini-games.

In terms of general technical implementation, the participants noticed a severe lack regarding the "Hologram Room". Focus group members commented on a substantial gap between expectation resulting from the term "Hologram" (cf Elmahal et al., 2020) and the actual implementation of the technology related to this part of the exhibition. In addition, a number of other elements have been mentioned as possible improvement areas: a better use of the 3D environment that allows circumnavigation of the character, and heightened freedom through less constrained interaction mechanisms (to avoid a simple "interactivisation" of a movie (cf. Koenitz, 2010)).

This analysis outlines the unease with which the participants looked at issues that address accessibility and usability. The group clearly shows that in case usability and accessibility issues are not considered and designed carefully, an enhanced immersion and best possible experience to all visitors can easily be missed, resulting in side effects that also influence the credibility of those explanations that are supposed to make the understanding of complexity of the historical space possible.

3.3.2.2. Historical accuracy, gamification, and social media. As anticipated in various parts of the analysis provided above, the focus group participants identified a number of attempts aimed specifically at a gamification of the museum experience. The clearest example of this resides obviously in what we have called the rooftop mini-games. As mentioned, concerns were raised regarding their historical accuracy being sacrificed for the sake of entertainment. Indeed, several participants of the study noted that gamification overtaking the

representation of the complexity of cultural heritage is a danger of such thematic games. In general, the motivation behind introducing gaming elements seems to be to engage the younger generations rather than to inform them, which participants found to be only partly justified for a museum experience.

The discrepancy between gamification and representations of the complexity of history was also found explicit in the holographic display room: a second part mentioned as an evident attempt at gamifying the museum experience. Given the technical realisation and the advertising with which this part is presented, it seemed to the participants that the Grand Master had been intentionally framed as a figure that could entertain and teach basic knowledge to youngsters. The limited interactivity and the simplicity of the information provided, together with their mode of presentation, pointed towards pure engagement purposes, according to the group. This was also found to be a clear example of design freedom that does not help in representing the complexity of history, but rather makes its presentation ambiguous for engagement purposes. The group noted that presenting a diegetic character attracts a degree of certainty in their words, and thus improves their authority. However, the character's script was perceived as disrupting the historical status of the personage and diminishes the visitor's trust in the character's perspective, and undermines the certainty of their account.

Finally, the reportedly scarce historical accuracy of the AR experience was found aggravated by the empty environment in which the vignettes were intended to be placed, which could hamper immersion and which might be misleading for the average visitor looking for a representation of history, as the group highlighted. This was found as underserving the cultural purpose of the AR experience. Participants noted that the social media-centred design choices turned a historical place of suffering into an attraction for children, drawing to mind parallels with the debated practice of taking selfies in Auschwitz (Feldman & Musih, 2022). Visits to sites related to suffering are classified as "dark tourism" and Fisher and Schoemann (2018) have used dark tourism studies to shed light onto ethical VR representations of such places. They provide some guidelines to achieve a fulfilling experience of dark tourism, and one such guideline is that "experiences should not [...] create or facilitate experiences that make light of survivors' pain or desecrate lost lives for commercial purposes" (Fisher & Schoemann, 2018, pg 587). The act of taking one's photo within the AR experience was also encouraged by part of the advertising material on the museum's website.¹⁰ A participant to the focus group, speaking from her experience as an archaeologist and heritage management consultant, clearly voiced that the experience did not give the sense of the Infermeria being a military hospital.

Looking at these instances, the participants agreed to catalogue them as good examples of gamification, design for engagement purposes, and social media-centred design. All three placements of the AR experience were found as

being designed in a way that could easily attract the attention of youngsters and even engage the young-at-heart. However, there was unanimous agreement that the design decisions and the resultant AR experience largely failed in representing history and the complexity coming from the uncertainty it brings forth.

3.3.2.3. *The AR experience as a representation of complexity.* A caveat is needed at the onset of this section: we have already mentioned how, depending on the *entrance narrative*, the audience can establish different expectations regarding this museum. Most of the expectations of our focus group members point towards historical accuracy and technical aspects, due to the AR focus of the museum. Even more, what the focus group was seeking to identify was an example of a representation of the complexity of a historical cultural heritage site.

As authors, we do acknowledge however that, even in the best exhibitions, historical accuracy and representation of complexity are neither necessarily mutually required nor reinforcing. The designers' freedom can (and sometimes should, or even have to) supplement the historical fidelity for the sake of clarity, comprehensibility, and representability. Sometimes the design is influenced by, or responds to, technical or economic constraints. This relates also to the issue of the uncertainty of authenticity: as the case of the *Donation of Constantine* proves, even the most official and unquestioned documents can turn out to be inauthentic (cf. Duffy, 2006). We are also not arguing that gamification necessarily precludes the capability of an artefact to represent a complex topic. Similarly, we are not maintaining that its family-friendliness, accessibility, and it being fun for children does avoid representation of complexity. Rather, with this case study we meant to highlight that each of these features have to be purposefully crafted to be mutually reinforcing and not mutually subtracting.

From the point of view of the focus group, the mini-games, notwithstanding their status as games, their loose relationship to the rest of the experience, and their evident historical inaccuracy, resulted as the most successful part in representing the complex history of the site *Sacra Infermeria*. The games involuntarily represented the complex situations of overt conflict that can sometimes cause hospitals to become active war structures by wounding people rather than (or at times before) healing them. According to the group, the different shooting mechanics of the mini-games also accounted for the differences in war technology between the two battles, at least to some extent: bombarding the Ottoman ships during the Great Siege and shooting down enemy aircraft during the air raids of World War II.

Even if the mini-games have been found to show at least some level of complexity, the question whether the complexity layer was intended, or whether it has been an over-interpretation of the focus group, remains open. The participants suggested that the complex history of a rich cultural heritage site could exude from a non-dedicated representation. However, this example was

found as clearly showing that careful and purposeful design is necessary for this complexity to be properly acknowledged, sometimes even to be perceived, and surely for being easily understood.

Another aspect should be considered in the design process. In the analysed AR experience, nothing precludes visitors from digging deeper into the history of the site themselves. Design choices could have positively impacted this important and useful attitude of reflective curiosity. Here, all participants felt that the onus of digging deeper was shifted onto the visitors, who could rely on their aesthetic judgement parameterised by their technical proficiency in using the device to portray their intentions, rather than disclosing the historical depth of the museum area. The participants felt that the design choices, both of the mobile application and of the experience as a whole, somehow discouraged actual learning and reflection during the experience in the hospital: while the authored story was the narration of historical facts, the facilitated player's story was rather one of photo-taking and shooting down enemies.

However, on the positive side, it was acknowledged by all participants that the AR environments allowed additional time for learning and reflection, essential to understanding complex matters, as the AR application was not tied specifically to the museum. Indeed, replay is mentioned by Murray (1997) and others (Knoller et al., 2021; Koenitz, 2010; Mateas, 2001; Mitchell & McGee, 2012) as a crucial aspect of digital artefacts, that enables a deeper exploration of a given topic and that allows a transformation in the interactor's understanding. It is a good practice to allow repetition and give time for reflection when we represent complex topics, as they help others to get acquainted with the subject matter, to ultimately help disclose the too often disregarded complexity of the cultural, social or political phenomena represented (cf. on this Koenitz et al., 2021).

Again, it is not obvious if the option of returning to a location within the place and then revisit the relevant artefacts has been part of the design or accidentally emerged. In any case, if it was planned then the execution has been questionable, as no incentives have been provided. Incentives do not necessarily have to be computationally expensive, such as user activity monitoring and analysis based recommendations, as they can be also hardcoded in form of links into the available material. Yet, those decisions need to be done during the planning phase according to audience needs and skills, and technical as well as budget constraints.

The challenge of representing complexity is indeed in providing means for reducing complex topics to a point where they become comprehensible. This is also where narrative serves an important function. As humans, we use narratives to communicate, remember and create as well as preserve our identity (Ricoeur, 1991). Furthermore, narrative has been described as a basic function of our brain, complementing mathematical logic (Herman, 2002). What happens when we do not understand, when we are overwhelmed by complexity,

is that we are not able to create a coherent narrative. What is missing in the AR depiction of the *Sacra Infermeria*, according to the focus group, is a framing that would facilitate a linearising narrative experience. Instead, the visitors encounter a series of disjointed historical vignettes that do not form a coherent, unified narrative. To foster comprehension, the exhibition could have included a stronger narrative element guiding the experience, for example, by putting the visitor in the shoes of a patient, of a doctor, or of a soldier, or of all the three interchangeably. This could also enhance immersion (Green et al., 2019).

The participants voiced a possible solution to tie together all of these perspectives and needs: stratification. This is an early-stage design decision, but it could retain the benefits of gamification, engagement and social media-friendliness without hindering the representation of the complexity of cultural heritage. An AR experience could be designed in a way to account for different age groups' needs and interests by layering the depth of information provided. Designing different levels of detail, an experience might be able to cater for a wider range of visitors with selective (or even adaptive) filters for information. Visitors with less interest in the site could stop at the surface layer, in which the main purpose is placing vignettes and taking funny photos. More interested audiences could dig deeper to find more historically accurate descriptions and representations, which could allow a better understanding of the site and of its history (see an example of this in Nisi et al., 2019). Furthermore, one could end up discovering the controversial nature of cultural heritage, where often opposing views are equally true, and where the uncertainty of historical authenticity is intertwined with the uncertainty of representational accuracy in a complex whole. According to the group, all of these could still be tied together in a gamified manner, e.g. by means of an achievement system that could track fully-read information. Even in a so-stratified experience, encouraging positive engagement should be a major design concern, and this gamified approach is just one way of addressing it.

From these discussions and speculation on the gamified *Reliving the Sacra Infermeria AR experience* and on the representation of history and of its complexity, we can conclude that AR can be used both to provide an engaging gamified experience and to capture the complexity of cultural heritage. These two functions can be included in the same artefact and do not automatically overlap. One needs to carefully design a product with a specific intent in mind, particularly if the intent is to represent and make understandable complex topics. Taking into consideration the outcomes of the focus group, we did not find our case study to be a convincing representation of the complex cultural heritage housed in the *Sacra Infermeria*, but rather, a simple gamified experience that does not speak much of the historical and cultural value of the site. On the other hand, we do acknowledge the suitability for children and the entertaining nature of the experience.

4. General recommendations

The *Reliving the Sacra Infermeria* experience is an example of a fully AR experience that addresses a historical site and its cultural heritage. Situated within a modern-day conference centre, it allows visitors to place animations into its rooms and learn about the role of the Hospitallers Knights within the hospital's function. The description included provides a progression through the site while the free placement of the 2D vignettes enables player agency and fun interactions that can be taken home as a souvenir. This main experience is supplemented by interactive mini-games on the roof and a characterisation of the Grand Master answering a set of questions in the Holographic Display Room.

An analysis by eleven IDN scholars seeking the representation of the site's history presented a number of shortcomings, mostly due to the site's vacancy from furniture and artefacts typical of the period, unmet technological expectations, and an inauthentic representation of history. Paying more attention to the historical accuracy of the depicted scenes, situated correctly, and combined together in a cohesive narrative would better serve its cultural heritage promise of reliving the *Sacra Infermeria*.

Given the chosen strategy of presenting the history of the *Sacra Infermeria* through the means of a stand-alone AR experience, we identify four points of improvements that can be generalised for exhibitions using AR narratives as a communication tool:

- (1) Provide an experience not possible through other means.

The depictions of a site need to create a compelling connection between the real world and the digital one which feels authentic. Showing historical figures in their actual environment, assisting with a medieval brain surgery, using the controls of machinery that has long ceased to function, directing armies, and taking cover from World War 2 bombing raids, are examples of such experiences.

- (2) Foreground the historical complexities of the site in a way that provokes thought.

The *Reliving the Sacra Infermeria* is an interesting example of gamification of a cultural heritage site, but it falls short as a satisfying representation of the complex history of the hospital and its Knights—one of its stated purposes. Just as interactivity is not an add-on that can be simply embedded in a finished artefact (cf. “interactivisation”, Koenitz, 2015), nor is the representation of complexity. Designers and developers intending to represent a complex topic or situation, need to carefully design their artefact from the

ground up for this purpose. A narrative organisation of the experience can provide a meaningful framing and an understandable reduction of the complexity of the history of the site (as supported by Koenitz (2023)). For this, a grounding within the site can provide the necessary factual evidence around which a narrative can be developed that could enhance visitors' understanding of the complexity of the history of the represented subject. In general terms, the design of the experience should support learning and de-complexification (Koenitz et al., 2021).

(3) Understand the opportunities and challenges of AR as Hyper Reality.

AR experiences augment a real environment resulting in hyper reality. This type of environment is only partially under the control of the designer in contrast to VR environments where every aspect is purposefully created to support the experience. *Reliving the Sacra Infermeria* is a particular example of how this challenge was not fully addressed by its creators. The clean, empty halls of the former hospital, sanitized and ready for use as a conference center, are a considerable obstacle in the way of creating a believable experience of what must have been a crowded, noisy, smelly and partially dirty historical situation. Potential solutions to this issue could be digital or real backdrops (or a combination of both) to hide the empty space around the AR vignettes. Location-based sound could enhance the experience further. To improve immersion (and therefore the educational outcomes (cf. Harvey et al., 1998)), objects in the AR layer should be placed with as great precision as is technically possible – simple placement on the ground is not sufficient. Thus, we recommend the use of fixed spatial placement for AR elements.

(4) Deliver production standards that meet user expectations.

There are three main factors that influence this aspect: design, realisation, and user expectation. Usability and accessibility should be priorities in design decisions, also to reduce the barrier-to-entry of AR experiences—a significant issue identified in literature (Petrie, 2009). What should be kept in mind are the objectives of the designed artefact. The realisation must support these objectives and principles, which should be properly communicated, as meeting expectations is an important factor in visitors' satisfaction. For example, giving priority to children should not diminish the experience for other paying visitors who choose to dedicate their time to the experience. Layering information (as mentioned in Moyo et al. (2015), and implicitly supported by a number of studies discussing the personalisation of learning materials, like Essalmi et al., 2010) and letting visitors choose what interests them goes a long way towards meeting the varied expectations of people visiting the site.

From this rather practical and specific analysis, we could also draw more abstract and general design practices for representing the complexity of the history of a cultural heritage site using Augmented Reality. The following heuristics are the summary of such conclusions:

- (1) Usability and accessibility are critical factors that can enhance or disrupt any experience. As such, they should be designed with appropriate care.
- (2) Further reading and individual learning should be encouraged by all means, as it can significantly impact the educational outcomes of the experience.
- (3) In order to have an AR experience significantly enhance its hosting site, a type-1 AR configuration that connects the digitally augmented and the physical worlds can be achieved through on-site placement of AR objects guided by fiducial markers for authentic representations. This will also reduce the user experience's dependency on the user's technical skill in handling placement and scaling of AR elements. Free placement can be used in the post-experience part of the application when these can be placed around one's own environment wherever they are.
- (4) VR and AR require specific design approaches. As we have explained, AR and VR do not exist on the same side of a spectrum between virtual and real environments, but extend real environments into hyper reality. This aspect should not be confused with fictionality, as both types of experiences can make use of fictional elements. The authors plan a follow-up publication that will provide a classification of different aspects of AR and VR.
- (5) Considering that the general public's expectations may be fuelled by science fiction, caution should be exercised with advertising to make sure the experience delivery does not fall short of promised expectations. Using appropriate terminology for the technology being used will help raise the quality of the experience as well as provide an authentic technological experience.
- (6) Whether an experience is believable and feels authentic depends on the depth and breadth of the research made, in tandem with the affordances shared by the technology and the site. History is complex and comes with uncertainty caused by the absence of documentary evidence, but historical inaccuracy should be avoided, and fictional aspects marked as such unless there are specific design purposes.
- (7) To cater to the needs of different target groups, stratification of the presented (and represented) complexity can be considered.
- (8) Interaction should not be provided only at the level of animation placement but also at the level of narration. This move can significantly help represent the complexity of history while fostering immersion and engagement in a productive way.

Finally, on a methodological note, we firmly encourage more collaborative studies like the one proposed here, as well as a tighter cooperation between

distantly-related fields of study. We believe that such a practice allows for a deeper analysis of cultural objects like IDNs, which often are multifaceted, and whose study is doomed to be partial if it is not approached both by different perspectives and as a unicum.

Notes

1. <https://www.guidememalta.com/en/attraction/reliving-the-sacra-infermeria>.
2. <https://www.youtube.com/watch?v=7agVb4IG16M>.
3. <https://www.mnhn.fr/en/experience/revivre-extinct-animals-in-augmented-reality>.
4. <https://www.impossiblethings.co/project/reblink/>.
5. <https://www.kennedyspacecenter.com/explore-attractions/heroes-and-legends/featured-attraction/heroes-and-legends>.
6. <https://www.artrabbit.com/events/felice-grodin-invasive-species>.
7. <https://icom.museum/en/resources/standards-guidelines/museum-definition/>.
8. <https://indcor.eu/>.
9. The focus group concluded that a number of design decisions encourage visitors of the experience to take pictures and share them on social media rather than to explore a cultural heritage site and its history. For this reason, we will refer to these apparent design decisions as “social media-centred design”.
10. <https://mcc.com.mt/ar-museum/>.

Acknowledgements

This article results form a training school funded by the European Cooperation in Science and Technology (COST), through the COST Action 18230—Interactive Narrative Design for Complexity Representations (INDCOR). The authors thank the participants of the training school for the insightful discussions, without which this article would not have been possible: Dr. Viktor Gustafsson, Prof. Lissa Holloway-Attaway, Giulio Mori, Christoforos Pavlakis, Breanne Pitt, Lāsma Skestere, Julio Daniel Suarez Espinosa, and Weronika Szatkowska. We also thank Mr Charles Theuma and the staff at Saint Martin’s Institute of Higher Education for their hospitality.

Disclosure statement

No potential conflict of interest was reported by the author(s).

ORCID

Jonathan Barbara  <http://orcid.org/0000-0001-6207-170X>

Mattia Bellini  <http://orcid.org/0000-0003-4050-5970>

Hartmut Koenitz  <http://orcid.org/0000-0002-3390-831X>

References

- Ackerman, A., Koudelka, C., Hirsch, P., & Zaengle, O. (2022). Problematizing realism: Confronting colonial perspectives and engaging complexities of landscape through ‘ghost textures’. *PRESENCE: Virtual and Augmented Reality*, (forthcoming).

- Azuma, R., Baillot, Y., Behringer, R., Feiner, S., Julier, S., & MacIntyre, B. (2001). Recent advances in augmented reality. *IEEE Computer Graphics and Applications*, 21(6), 34–47. <https://doi.org/10.1109/38.963459>
- Barbara, J. (2020). Classification of gameplay interaction in digital cultural heritage. In *Proceedings of the Digital Games Research Association Conference*.
- Bellini, M. (2022). Interactive digital narratives as complex expressive means. *Frontiers in Virtual Reality*, 3. <https://doi.org/10.3389/frvir.2022.854960>
- Bitgood, S. (1990). *The role of simulated immersion in exhibition*. Center for Social Design.
- Bitgood, S., Patterson, D., & Benefield, A. (1988). Exhibit design and visitor behavior: Empirical relationships. *Environment and Behavior*, 20(4), 474–491. <https://doi.org/10.1177/0013916588204006>
- Callaway, C., Stock, O., Dekoven, E., Noy, K., Citron, Y., & Dobrin, Y. (2011). Mobile drama in an instrumented museum: Inducing group conversation via coordinated narratives. *Proceedings of the 16th International Conference on Intelligent User Interfaces* (pp. 73–82). <https://doi.org/10.1145/1943403.1943416>
- Chang, C. W. (2020, July). Museum immersion interactive design. In *International Conference on Human-Computer Interaction* (pp. 224–236). Springer.
- Coates, C. (2021). How museums are using augmented reality. *Museum Next*. <https://www.museumnext.com/article/how-museums-are-using-augmented-reality/>
- Coelho, E. M., MacIntyre, B., & Julier, S. J. (2005). Supporting interaction in augmented reality in the presence of uncertain spatial knowledge. *Proceedings of the 18th annual ACM symposium on User interface software and technology* (pp. 111–114). <https://doi.org/10.1145/1095034.1095052>
- Ding, M. (2017). Augmented reality in museums. *Museums & augmented reality—A collection of essays from the arts management and technology laboratory* (pp. 1–15).
- Doering, Z., & Pekarik, A. (1996). Questioning the entrance narrative. *Journal of Museum Education*, 21(3), 20–23. <https://doi.org/10.1080/10598650.1996.11510333>
- Drachen, A., Mirza-Babaei, P., & Nacke, L. E. (Eds.). (2018). *Games user research*. Oxford University Press.
- Drotner, K., Dziekan, V., Parry, R., & Schröder, K. (2018). Media, mediatisation and museums: A new ensemble. *The Routledge Handbook of Museums, Media and Communication*, 1–12. <https://doi.org/10.4324/9781315560168>
- Duffy, E. (2006). *Saints & sinners: A history of the Popes*. Yale University Press.
- Elmahal, D. M., Ahmad, A. S., Alomaier, A. T., Abdlfatah, R. F., & Hussein, D. M. (2020). Comparative study between Hologram technology and augmented reality. *Journal of Information Technology Management*, 12(2), 90–106. <https://doi.org/10.22059/JITM.2020.75794>
- Essalmi, F., Ayed, L. J. B., Jemni, M., Kinshuk, K., & Graf, S. (2010). A fully personalization strategy of E-learning scenarios. *Computers in Human Behavior*, 26(4), 581–591. <https://doi.org/10.1016/j.chb.2009.12.010>
- Feldman, J., & Musih, N. (2022). Selfies in Auschwitz: Popular and contested representations in a digital generation. *Memory Studies*. <https://doi.org/10.1177/17506980221101111>
- Fisher, J. A., & Schoemann, S. (2018, December). Toward an ethics of interactive storytelling at dark tourism sites in virtual reality. In *International Conference on Interactive Digital Storytelling* (pp. 577–590). Springer.
- Geroimenko, V. (2021). *Augmented reality in tourism, museums and heritage: A new technology to inform and entertain*. Springer Nature.
- Graves, E. (2018). Media influence on expectations of virtual reality. *Refractory*, 30.
- Green, M., Bilandzic, H., Fitzgerald, K., & Paravati, E. (2019). Narrative effects. In M. B. Oliver, A. A. Raney, & J. Bryant (Eds.), *Media effects* (pp. 130–145). Routledge.

- Harvey, M. L., Loomis, R. J., Bell, P. A., & Marino, M. (1998). The influence of museum exhibit design on immersion and psychological flow. *Environment and Behavior*, 30(5), 601–627. <https://doi.org/10.1177/001391659803000502>
- Hede, A. M., Garma, R., Josiassen, A., & Thyne, M. (2014). Perceived authenticity of the visitor experience in museums: Conceptualization and initial empirical findings. *European Journal of Marketing*. <https://doi.org/10.1108/EJM-12-2011-0771>
- Herman, D. (2002). *Story logic*. University of Nebraska Press.
- ICOM. (2007). Museum definition, international council of museums. <https://icom.museum/en/resources/standards-guidelines/museum-definition/>
- Kersel, M. M., & Luke, C. (2015). Civil societies? Heritage diplomacy and neo-imperialism. In L. Meskell (Ed.), *Global heritage: A reader* (1st ed., pp. 70–93). Wiley.
- Knoller, N., Roth, C., & Haak, D. (2021, December). The complexity analysis matrix. In *International Conference on Interactive Digital Storytelling* (pp. 478–487). Springer.
- Knowles, S. G. (2019). *The other uncertainty: The view from disaster history. Insights from the social sciences*. Social Science Research Council. <https://items.ssrc.org/chancing-the-storm/the-other-uncertainty-the-view-from-disaster-history/>
- Koenitz, H. (2010). *Reframing interactive digital narrative: An inclusive open-ended iterative process for research and practice* (PhD Thesis, Georgia Institute of Technology).
- Koenitz, H. (2015, November). Design approaches for interactive digital narrative. In *International Conference on Interactive Digital Storytelling* (pp. 50–57). Springer.
- Koenitz, H. (2023). *Understanding interactive digital narrative*. Routledge. Forthcoming.
- Koenitz, H., Barbara, J., & Eladhari, M. P. (2021, December). Interactive digital narratives (IDN) as representations of complexity: Lineage, opportunities and future work. In *International Conference on Interactive Digital Storytelling* (pp. 488–498). Springer.
- Koenitz, H., Eladhari, M. P., Glas, R., Van Vught, J., Lankoski, P., & Kultima, A. (2022). MMAJam. Workshop at DIGRA 2022, Krakow.
- Komarac, T., & Ozretić Došen, Đ. (2021). Discovering the determinants of museum visitors' immersion into experience: The impact of interactivity, expectations, and skepticism. *Current Issues in Tourism*, 25(2), 1–19. <https://doi.org/10.1080/13683500.2021.1952941>
- Kraus, S., Kanbach, D. K., Krysta, P. M., Steinhoff, M. M., & Tomini, N. (2022). Facebook and the creation of the metaverse: Radical business model innovation or incremental transformation? *International Journal of Entrepreneurial Behavior & Research*, 28(9), 52–77.
- Krueger, R. A. (2006). Is it a focus group? Tips on how to tell. *Journal of Wound Ostomy & Continence Nursing*, 33(4), 363–366. <https://doi.org/10.1097/00152192-200607000-00003>
- Kunze, A., Summerskill, S. J., Marshall, R., & Filtness, A. J. (2018, September). Augmented reality displays for communicating uncertainty information in automated driving. In *Proceedings of the 10th international conference on automotive user interfaces and interactive vehicular applications* (pp. 164–175).
- Liu, S., & Idris, M. Z. (2018). Constructing a framework of user experience for museum based on gamification and service design. In *MATEC web of conferences* (Vol. 176, p. 04007). EDP Sciences.
- Lombardo, V., & Damiano, R. (2012). Storytelling on mobile devices for cultural heritage. *New Review of Hypermedia and Multimedia*, 18(1–2), 11–35. <https://doi.org/10.1080/13614568.2012.617846>
- Louchart, S., Truesdale, J., Suttie, N., & Aylett, R. (2015). Emergent narrative: Past, present and future of an interactive storytelling approach. In H. Koenitz, G. Ferri, M. Haahr, D. Sezen, & T. İ. Sezen (Eds.), *Interactive digital narrative* (pp. 185–199). Routledge.

- Malinverni, L., Maya, J., Schaper, M. M., & Pares, N. (2017, May). The world-as-support: Embodied exploration, understanding and meaning-making of the augmented world. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (pp. 5132–5144).
- Mateas, M. (2001). A preliminary poetics for interactive drama and games. *Digital Creativity*, 12(3), 140–152. <https://doi.org/10.1076/digc.12.3.140.3224>
- Milgram, P., Takemura, H., Utsumi, A., & Kishino, F. (1995, December). Augmented reality: A class of displays on the reality-virtuality continuum. In *Telemanipulator and telepresence technologies* (Vol. 2351, pp. 282–292). International Society for Optics and Photonics.
- Mitchell, A., & McGee, K. (2012). Reading again for the first time: A model of rereading in interactive stories. In D. Oyarzun, F. Peinado, R. M. Young, A. Elizalde, & G. Méndez (Eds.), *Interactive storytelling: 5th international conference, ICIDS 2012, san sebastián, spain, november 12-15, 2012*. Proceedings. Springer Berlin Heidelberg. <https://doi.org/10.1007/978-3-642-34851-8.pdf>
- Mohd Noor Shah, N. F., & Ghazali, M. (2018, August). A systematic review on digital technology for enhancing user experience in museums. In *International Conference on User Science and Engineering* (pp. 35–46). Springer.
- Moody, J. (2015). Heritage and history. In E. Waterton & S. Watson (Eds.), *The Palgrave handbook of contemporary heritage research* (pp. 113–129). Palgrave Macmillan.
- Moyo, M., Madzima, K., Chikerema, T., & Abdullah, H. (2015). Layering information literacy: a taxonomy of literacies for academic and lifelong learning. In *Proceedings of the International Conference on e-Learning, e-Business, Enterprise Information Systems, and e-Government (EEE)* (p. 116). The Steering Committee of The World Congress in Computer Science, Computer Engineering and Applied Computing (WorldComp).
- Murray, J. H. (1997). *Hamlet on the Holodeck: The future of narrative in cyberspace*. Free Press.
- Nack, F., & Jones, S. (2008). Nomadic information in social environments. *Proceedings of the Taiwanese-French Conference on Information Technology (TFIT2008), Taipei, Taiwan, March 3–5* (pp. 256–266).
- Naimark, M. (1991, August). Elements of real-space imaging: A proposed taxonomy. In J. O. Merritt & S. S. Fisher (Eds.), *Stereoscopic displays and applications II* (pp. 169–179). International Society for Optics and Photonics.
- Niantic. (2016). *Pokémon GO [Mobile app]*. San Francisco, CA.
- Nincarean, D., Alia, M. B., Halim, N. D. A., & Rahman, M. H. A. (2013). Mobile augmented reality: The potential for education. *Procedia-Social and Behavioral Sciences*, 103, 657–664. <https://doi.org/10.1016/j.sbspro.2013.10.385>
- Nisi, V., Cesario, V., & Nunes, N. (2019). Augmented reality museum's gaming for digital natives: Haunted encounters in the Carvalhal's palace. In E. van der Spek, S. Göbel, E. L. Do, E. Clua, & J. Baalsrud Hauge (Eds.), *Entertainment computing and serious games. ICEC-JCSG 2019. Lecture notes in computer science, vol. 11863* (pp. 28–41). Springer. https://doi.org/10.1007/978-3-030-34644-7_3
- Nyumba, T. O., Wilson, K., Derrick, C. J., & Mukherjee, N. (2018). The use of focus group discussion methodology: Insights from two decades of application in conservation. *Methods in Ecology and Evolution*, 9(1), 20–32. <https://doi.org/10.1111/2041-210X.12860>
- Peponis, J., Conroy-Dalton, R., Wineman, J., & Dalton, N. (2003, June). Path, theme and narrative in open plan exhibition settings. In: *(Proceedings) 4th International Space Syntax Symposium. 4th International Space Syntax Symposium*. <https://discovery.ucl.ac.uk/id/eprint/1097/>
- Petrie, H. (2009). The evaluation of accessibility, usability and user experience. *The Universal Access Handbook*.

- Ricoeur, P. (1991). Narrative identity. *Philosophy Today*, 35(1), 73–81. <https://doi.org/10.5840/philtoday199135136>
- Riedl, M. O., & Bulitko, V. (2013). Interactive narrative: An intelligent systems approach. *Ai Magazine*, 34(1), 67–67. <https://doi.org/10.1609/aimag.v34i1.2449>
- Roussou, M., & Katifori, A. (2018). Flow, staging, wayfinding, personalization: Evaluating user experience with mobile museum narratives. *Multimodal Technologies and Interaction (MDPI)*, 2(2), 32. <https://doi.org/10.3390/mti2020032>
- Shaer, O., & Hornecker, E. (2010). Tangible user interfaces: Fast, present and future directions. *Foundations and Trends in Human-Computer Interaction*, 3(1–2), 1–137. <https://doi.org/10.1561/11000000026>
- Su, X., Talmaki, S., Cai, H., & Kamat, V. R. (2013). Uncertainty-aware visualization and proximity monitoring in urban excavation: A geospatial augmented reality approach. *Visualization in Engineering*, 1(1), 1–13. <https://doi.org/10.1186/2213-7459-1-1>
- Syahrul, N. J., Mohamad Faizuan, M., Shanat, M., & Khan, R. U. (2021). Designing augmented reality tools for enhancing art gallery and museum visitors experience: A systematic review of current trends. <https://doi.org/10.13140/RG.2.2.31709.95200>.
- Thompson, D. R. (1993). *Considering the museum visitor: An interactional approach to environmental design*. The University of Wisconsin-Milwaukee.
- Traum, D., Jones, A., Hays, K., Maio, H., Alexander, O., Artstein, R., & Swartout, W. (2015, November). New dimensions in testimony: Digitally preserving a Holocaust survivor's interactive storytelling. In *International Conference on Interactive Digital Storytelling* (pp. 269–281). Springer.
- Turina, R. (2018). Narrative experiences of history and complex systems in narrating complexity. Edited by R. Walsh and S. Stepney.
- Van Krevelen, D. W. F., & Poelman, R. (2010). A survey of augmented reality technologies, applications and limitations. *International Journal of Virtual Reality*, 9(2), 1–20. <https://doi.org/10.20870/IJVR.2010.9.2.2767>
- Vaz, R., Fernandes, P. O., & Veiga, A. C. N. R. (2017). Interactive technologies in museums: how digital installations and media are enhancing the visitors, chapter 2. Experience, *Handbook of research on technological developments for cultural heritage and e-tourism applications*. <https://doi.org/10.4018/978-1-5225-2927-9.ch002>
- VIGIE 2020/654. (2022). *Study on quality in 3D digitisation of tangible cultural heritage: mapping parameters, formats, standards, benchmarks, methodologies, and guidelines. Shaping Europe's Digital Future*. European Commission. <https://digital-strategy.ec.europa.eu/en/library/study-quality-3d-digitisation-tangible-cultural-heritage>
- Vosmeer, M., & Roth, C. (2021, December). Exploring narrative novelties in VR. In *International conference on Interactive Digital Storytelling* (pp. 435–444). Springer. https://doi.org/10.1007/978-3-030-92300-6_44
- Wickens, C. D. (1992, October). Virtual reality and education. In *[Proceedings] 1992 IEEE International Conference on Systems, Man, and Cybernetics* (pp. 842–847). IEEE.
- Wilkinson, S. (1998). Focus group methodology: A review. *International Journal of Social Research Methodology*, 1(3), 181–203. <https://doi.org/10.1080/13645579.1998.10846874>
- Wolff, A., Mulholland, P., & Collins, T. (2012). Storyspace: A story-driven approach for creating museum narratives. *Proceedings of the 23rd ACM Conference on Hypertext and Social Media* (pp. 89–98). <https://doi.org/10.1145/2309996.2310012>
- Yatani, K., Onuma, M., Sugimoto, M., & Kusunoki, F. (2004). Musex: A system for supporting children's collaborative learning in a museum with PDAs. *Systems and Computers in Japan*, 35(14), 54–63. <https://doi.org/10.1002/scj.10696>