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Innovation in Heritage Education: Exploring Immersive Technologies Across European Museum and Heritage Sites

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Abstract. In light of windfalls in more readily accessible immersive media, as well as constraints forced upon the sector by the global COVID-19 pandemic, this short paper seeks to paint a broad picture of the uptake of immersive media in the European GLAM sector at large. Sitting at the nexus of pedagogy, entertainment, and academic interest, museums are constantly evaluating and re-evaluating the requirements of navigating a world in full digital shift. How does the ever-advancing tide of digitalization impact the traditional responsibilities and roles in the GLAM sector, and what, if at all, is the role of the museum in shaping the discourse around immersive media? While it is apparent that there are brand leaders in the sector, there must be greater consideration of how to democratize and utilize immersive media, without either succumbing to populist forms of edutainment, or sacrificing social capital stemming from the erosion of institutional trust. The result of these lines of enquiry entails a need for language development and new relevant terms that directly address immersive media and new technologies for cultural heritage institutions.

Keywords: Digital Museum Learning, Immersive Technologies, Digital Heritage, Digital Pedagogy.

1 Introduction

1.1 A GLAM sector in Rapid Change

Digital knowledge transfer, not least through immersive and interactive technologies, has gained a foothold in the cultural heritage sector as it offers new ways to explore collections and convey context. The digital transition is a much-discussed challenge facing the GLAM sector at large. While new technologies have created possibilities for communicating around existing heritage sites, as well as reconstructed environments and objects, staging past historical events and exploring complex scientific data, they also have created new pressing questions, related but not limited to source criticism, evidence and the handling and safe storing of data.

The Covid-19 pandemic has in several respects accelerated digitization and digitalization in the GLAM sector, which in turn has placed new demands on the sector's professional actors and organizations. Recent studies [1-3] suggest that heritage institutions, holding our collective memory, must work more actively with digital accessibility, while developing new formats for traditional activities, such as those of pedagogical relevance. Indeed, substantial resources are currently invested by museums and galleries to that end, contributing to the digitization of collections and documentation of cultural environments. Simultaneously, for public outreach, *extended reality* (XR) technologies, encompassing *virtual reality* (VR), *augmented reality* (AR), and *mixed reality* (MR), have increasingly become relevant. These technologies offer immersive and interactive platforms and tools for digital mediation of knowledge and are shaping the potential for new pedagogical landscapes to take form. For a fruitful conversation around the pedagogical possibilities and challenges faced to take place in the GLAM sector, a sketching out of the field and its components at large is a necessary starting point in our point of view.

1.2 Immersive Technologies, Heritage Learning and Non-traditional Research Outputs

The foundations of cultural heritage mediation in museum exhibitions or cultural environments are largely produced within classical humanities research. The traditional link is still evident in visitor centers, museum shops, through popular science books, and the continued centrality of the written word. However, new technologies could potentially open a new bridge between research and mediation. Nowadays, researchers extensively utilize cultural institutions' databases with digitized documents and physical collections and environments in 3D. The reverse, that of making research available to cultural heritage mediation, still primarily occurs through traditional media. It is worth mentioning that there is already a range of literature discussing [4,5] physical environments, artifacts, embodied processes, and sensory experiences that benefit from multimodal media such as film, interactive 3D models, and applications, as well as immersive media like VR and AR. These new media are increasingly used, but primarily as tools in the research process rather than in the scientific communication of research results within academia or to a wider public through GLAM institutions [6]. Instead traditional formats for disseminating research continue to be predominantly text-based and include peer-reviewed books, dissertations, scientific articles, conference presentations, research proposals, technical reports, and reviews.

This paper stands behind the view that XR technologies provide a fruitful territory with regards to communicating research outcomes. In the light of the experiences that can be constructed, such benefits may vary from visualizing and contextualizing complex data, objects, and environments by highlighting new dimensions, to bridging historical distance by making available for exploration reconstructions of what has been lost. These new media also bring into play a variety of formats and arenas that haven't been explored before and which hold potential to further develop traditional museum pedagogy. However, even if knowledge mediation can benefit from the technological novelties and the advantages they entail in terms of narration, that in itself does not necessarily mean that the multifaceted character of research outcomes (e.g. methodological pitfalls, source criticism, etc.) are unproblematically included in the narrative. How can we produce meaningful, ethical and engaging immersive experiences for the visitor -experiences that contain, or at least do not undermine, questions of source criticism and transparency in terms of interpretation? How do we begin to describe these experiences or pedagogical starting points by using a common vocabulary, both for the GLAM sector and the visitor? We regard these as complex inquiries that need to be unfolded through a bottom-up analysis of the evolving uses of the technologies from within the sector. Therefore, this study aims at outlining the immersive experiences available in the GLAM sector today. This is done in order to map out the field, to help us comprehend it, before addressing more specific questions around aspects such as pedagogy, source criticism and ethics. In light of this, what follows aspires to contribute to a better understanding of the various and concrete uses of immersive technologies currently available within heritage education in Europe.

1.3 The Museum as an Arena for Learning through Immersion

In Sweden, The National Heritage Board has taken a leading role and operates a portal with a knowledge base and guidance for digital mediation [7]. There are also functioning networks and forums in place both on national and international levels for the exchange of practical experience as well as contact with researchers and businesses in the field. However, as has been identified in previous studies [8], there is a need for practical research to better manage source-critical perspectives and evidence in knowledge transfer through immersive and interactive media. The field of museum studies has long examined visitors' experiences and interactions within exhibitions [9], with recent attention shifting towards digital mediation and immersive media [10]. Archaeology boasts a robust research tradition in digital documentation, analysis, and mediation employing emerging technologies. Research often elucidates, frequently through case studies, how XR technologies complement traditional modes of mediation by facilitating sensory experiences, bodily engagement, and empathy [11,12]. Accessibility emerges as a critical concern, with scholarship demonstrating how immersive media can both broaden access to new demographics and inadvertently exclude others [13]. Nevertheless, research underscores an uncritical embrace of visual realism and immersive experiences as a universal didactic method [14], often neglecting critical perspectives and an exploratory approach to interactivity and criticality [15,16]. Immersiveness should revolve around meaning-making rather than technical perfection, yet an apparent dilemma arises wherein technology can either hinder or facilitate the construction of meaningful content [17,18]. Research advocates for the incorporation of museum pedagogical expertise in projects involving new technologies and the design of immersive experiences [19], emphasizing that technical solutions must stem from clear pedagogical strategies [20].

Hence, there is an expressed need for studies that show i) how new technologies can make visible the interpretations, methods and sources of the underlying research, ii) how the museum can educationally facilitate the audience to adopt the source-critical perspective of research and knowledge with new technology, and iii) methods and "best practice" for how the files and formats used by the new technologies are managed. However,

this demands a greater understanding of the current museum landscape when it comes to the use of XR-technologies as a pedagogical tool. In an effort to bridge this knowledge gap, with this overview of the current landscape we aspire to contribute to ongoing dialogues surrounding the intersection of technology, education, and the GLAM sector.

1.4 Research Methodology and Limitations

In this study, an inductive *network sampling* method was employed as a means to systematically collect data on immersive technologies, -pedagogies and -experiences in projects around Europe. This methodological framework facilitates the systematic mapping of uncharted territories in particular, enabling researchers to maintain flexibility on key concepts while navigating and documenting evolving landscapes within their field of inquiry [21]. The method is commonly used in qualitative research, and consists of systematically expanding a sample or dataset by collecting additional information through referrals or recommendations from the existing sources, expanding the number of "active source threads" with time. This type of inductive method was chosen as it serves as a pragmatic approach to initiate projects that, such as this, are very expansive in scope, all the while maintaining the qualitative aim. The research team purposefully avoided drawing hard boundaries and limitations on the projects collected initially, through too narrow definitions of key concepts such as "immersion" and "heritage". Although, the projects had to make use of some type of digital immersive technology, meaning that other older types of immersive heritage experiences, such as advanced multisensory walks and built-up exhibition spaces, were not accounted for. The sampled projects naturally needed to be connected to a museum and/or heritage site to some extent, ranging from a museum being the producer of the experience, to projects that merely used cultural heritage as their main focus, while actively blurring the line of what a museum is and is not through discourse. Lastly, the immersive experience needed to contain an element of active knowledge transfer, or claim thereof. This means that projects often found in art museums that were merely, albeit exquisitely, artistic in content were not included.

One strength of the research team is that several are active professionals in the Swedish cultural heritage sector through The National Historical Museums of Sweden, thus being able to "capitalize on existing roles" while conducting the research [22]. Naturally, the point of departure was a few of the immersive projects within this museum organisation: *Revisiting Hemse* at the The Historical Museum of Sweden [6], a VR experience that serves as a time travel transporting the learner to a Swedish 11th century stave church, as well as *Dimensions in Testimony* at The Swedish Holocaust Museum [23], an interactive immersive experience that lets a person "meet" and interact with a Holocaust survivor through asking questions and receiving answers.

The data collection process was also centered around conducting preliminary searches on online search platforms, academic and non-academic alike, as well as reaching out to professional networks and colleagues. Keywords such as "museum immersive," "museum experience," and specific technologies such as "museum VR" were utilized to identify initial sources and begin the snowballing. As the initial sources were reviewed, additional leads were identified through key institutions and producers, references, citations, and related articles. Conference proceedings spanning from 2015 to 2023 were explored to capture the latest developments in the field. Moreover, articles from major newspapers and industry publications, as well as top lists in industry blogs, were examined to gain insights from both academic and industry perspectives. Platforms such as *Google Arts & Culture*, *Matterport*, and *Sketchfab* were systematically navigated on a country-by-country basis to capture a comprehensive overview of immersive technologies utilized in cultural institutions worldwide.

To organize the collected data a *thematic analysis* system was employed [24]. Key themes related to technology, experience description, pedagogical approaches and aims were identified, and relevant information was highlighted and categorized accordingly. This process involved using highlighters to mark key excerpts and circling keywords that reflected the core concepts under investigation. While the total number of heritage related projects accounted for was 718, the contents of 93 projects were more thoroughly analysed in this manner, with the aim to begin the formulation of a taxonomy of immersive experiences. At this early stage, the categorizations remain somewhat generalizing, with lose nebulous categorizations through the largest lenses we encountered in the collected data. Our outspoken intention is also to later analytically divide these categorizations into slices cutting through different technologies and museum types, with vrious pedagogical perspectives at the core of each category. This will happen at a later stage of our research project, where we also conduct experimental workshops in GLAM institutions.

It is also important to acknowledge some of the specific limitations of the data collection process. Firstly, the overview, while striving for inclusivity, does not claim to be exhaustive nor comprehensive. The research project's fundin is connected to a focus on European heritage institutions, and where the comparatively small research team also would struggle to cover the whole world in a satisfactory way. Instead, the purpose is to delineate the contours of the emerging immersive GLAM field, and track the various types of new immersive media utilized within the

GLAM sector in Europe. However, it is crucial to recognize that certain factors, such as language barriers, have influenced the breadth and depth of our research even with a strict regional delimitation. For instance, the search parameters were primarily conducted in English, which may have led to the underrepresentation of non-English websites or resources sourced. Consequently, smaller museums or cultural institutions that predominantly utilize their native language on their websites or communication through media and conferences, may be less accounted for in the analysis.

Furthermore, the changing nature of online resources poses another challenge, as some projects may not be documented or accounted for due to the closure or inaccessibility of relevant project websites, perchance due to lack of funding once the project is over. Despite these inherent limitations, the strength of the overview lies in its qualitative approach, focusing on identifying and analyzing the qualitative aspects and nuances of immersive media usage within the GLAM sector. By prioritizing qualitative analysis over quantitative metrics, the charting out of the current territory aims to provide some insights into the possible development of new pedagogical tools and practices in cultural heritage contexts, not the least when it comes to addressing source critical perspectives in the immersive experience industry at large.

2 Navigating the Landscape of Immersive Digital Initiatives

2.1 A Visualization of the Most Recurrent Immersive Experiences Found

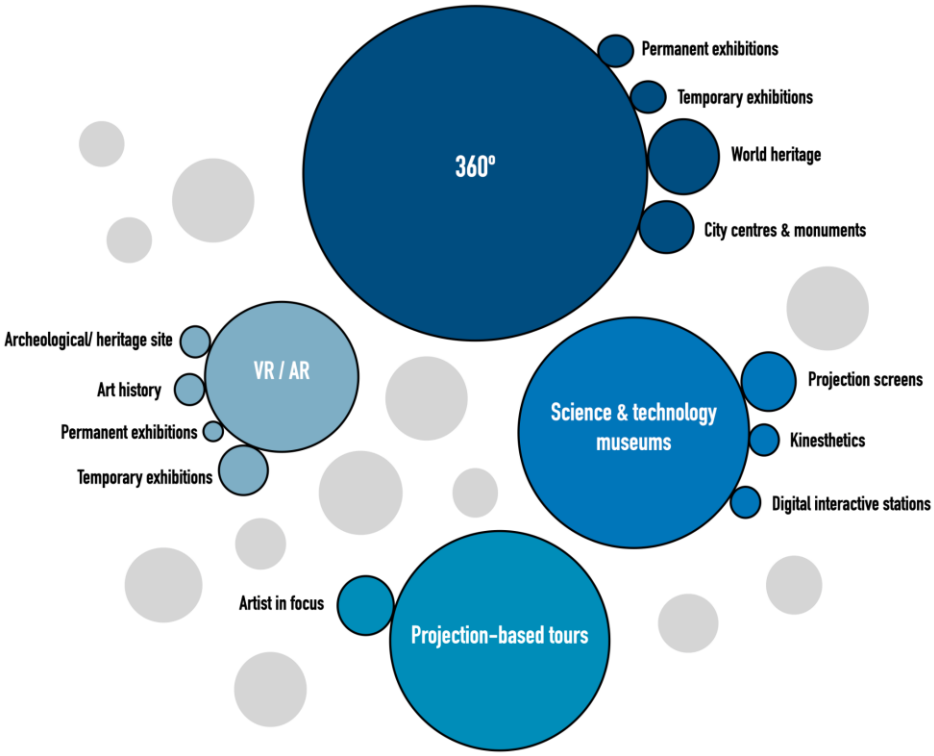

Fig.1: Immersive experiences in the GLAM sector. The model highlights the top four trends connected to immersive experiences found across the 718 sampled GLAM institutions and organizations, and they are presented in different sizes to mark how often they emerge in our dataset. The trends are divided in sub-categories that indicate the most dominant ones; those sub-categories are also marked with larger circles, when necessary, to emphasize their relative frequency.

In the realm of immersive museum experiences, our data collection and further analysis of 718 projects across Europe has illuminated several prominent tendencies. These trends may provide a snapshot image of the evolving and moving field that is digital mediation and immersive learning within the GLAM sector, aiding the process of stoping to reflect to shape the trajectory of future pedagogical developments. Furthermore, based on the sampled data, the visualization serves to highlight four prominent trends in the European heritage sector's and its' peripheral industries use of XR technologies.

2.2 Technical and Science Museums Are Leading the Way

One prominent trend is the dominance of science and technical museums in spearheading immersive experiences through their permanent exhibitions. These exhibitions, characterized by immersive environments enriched with digital elements such as large projection screens, digital learning resources and interactive stations, effectively blur the boundaries between physical and digital realms. Notably, while the use of projection screens in historical, archaeological, and cultural historical houses still remains comparatively rare, it signifies a recent and significant development in immersive technology adoption in the sector at large. This vast discrepancy between the historical and technical museums' level of adoption of immersive technologies underscores a diversity in knowledge and prior experience in the landscape of immersive technologies, across different types of museums and exhibition types in particular.

The historical inclination of technical and science museums to embrace and integrate new technologies into their exhibitions may account for this difference, underscoring the role of institutional context in shaping the immersive experience pedagogies. However, the classification of what constitutes an immersive experience still remains subjective and open to interpretation, an ambiguity that poses challenges in delineating the boundaries of immersion within museum environments. Indeed, one may question whether all museums are inherently immersive at their very core practice. Does a room filled with projection screens and digital interactivity offer a *more* immersive experience than stepping into a 17th-century castle? The answer lies in qualitative assessments rather than absolute distinctions, paving the way for meaningful explorations of various immersion techniques and their pedagogical strengths and challenges. This prompts a deeper reflection on the nature of immersive learning experiences and their impact on museum visitation. What is immersive, and what is not, and how does it matter for different types of learning outcomes?

2.3 Projection-based Touring Exhibitions are Emerging as a Category by Itself

One striking and prevalent trend in the realm of immersive museum experiences is the prevalence of touring projection-based art exhibitions, often celebrated as blockbuster events. These exhibitions attract large crowds and garner significant media attention, boasting a bombastic format and communication style. Featuring renowned artists like Van Gogh, Dalí, Picasso, or Monet, they promise audiences a fresh perspective on artworks, fostering sociability and interaction, and appealing to visitors of all ages. While some exhibitions are developed in collaboration with museums, attendees not accustomed to visiting museums may struggle to discern whether they are in a traditional museum setting or experiencing something entirely different—perchance an inquiry less relevant to those primarily seeking edutainment rather than delving into a source criticism that many museum professionals might take for granted.

Typically organized in a similar fashion, these exhibitions commence with a brief onboarding process, followed by introductory texts or smaller-scale projection screens showcasing the featured artist. Visitors then freely explore expansive spaces where images and animated artwork are projected onto walls, occasionally extending to ceilings and floors, creating an immersive environment. Complementing the visual stimuli is a powerful surround sound system, using music and rhythm to convey information and sentiment about the artist, suggesting interpretations of the artwork or historical context. Unlike traditional museum exhibitions, projection-based shows eschew collections, original artworks, or museum objects, focusing instead on delivering a captivating visual and auditory experience, still arguably managing to draw the vast majority numbers of the audience crowds seeking "an immersive learning experience".

2.4 360-degree Photography, Video and Exhibition Twins as Dominant

360-degree photography and video, along with interactive 360 exhibitions, emerge as the predominant immersive digital initiatives, spanning diverse institution types and production scales. These initiatives exhibit significant variation in production quality, contextualization, and complexity, involving a broad spectrum of contributors ranging from researchers and established museum institutions to individuals and businesses of various sizes. Encompassing a wide range of expressions, this dominant category includes everything from spontaneous documentation of historical sites to meticulously scanned replicas of entire permanent exhibition floors and archival documentation of past exhibitions. Moreover, it incorporates digital replicas of inaccessible heritage sites or fragile environments. While some initiatives provide thorough information and context, extending beyond the physical constraints of the exhibition or heritage site, others lack any contextualization whatsoever. Despite purporting to offer an immersive learning experience, numerous non-contextualized "360 experiences" of historical sites and landmarks are dispersed across the virtual landscape without proper maintenance or attribution to their creators. This disparity raises fundamental questions about the authenticity and reliability of these digital representations, underscoring the urgent need for greater transparency and accountability in virtual heritage

preservation efforts. Such measures are essential to uphold the integrity of evidence-based and source-critical learning, which is foundational to heritage education and the establishment of trust capital within the field.

2.5 Established and High-profile Brands Leading the Way for VR and AR

Although there are scattered examples of smaller and medium sized museums and heritage sites initiating projects to incorporate immersive learning and digital technologies through VR and AR, these efforts frequently encounter several obstacles in their long run maintenance. Challenges such as insufficient funding after the conclusion of specific projects often lead to their untimely termination or "slow death". These initiatives are frequently undertaken in collaboration with the regional tourism sector, or academic institutions within university research projects.

Large well-known museums institutions in capital cities such as London, Paris have been at the forefront of exploring and integrating immersive media learning and visualization technologies for over a decade, and others such as Madrid, Prague and others are immersive nodes with a multitude of advanced productions to choose from. This sustained effort contrasts sharply with the experiences of smaller institutions, which are just beginning to explore digital learning or the digitization of their collections. Contrary to possible expectations of a knowledge trickle-down effect, the gap between institutions capable of developing advanced immersive learning experiences and those merely attempting to digitize appears to be rather widening.

Furthermore, the concentration of VR and AR productions in major cities and institutions may also be attributed to the cultural capital these collaborations with "brand name museums" generate in a Bourdieusian sense. Partnerships with landmark museums such as the Victoria & Albert Museum or Le Louvre offer significant prestige and benefits to the technology companies involved, potentially becoming part of a corporate social sustainability strategy or part of a branding strategy. This being said, these types of win-win collaborations are not necessarily anything bad at all, creating profit, strengthened brands and visibility for all parties included. Large tech companies, in return, support these high-profile projects by providing technical expertise and hardware. This symbiotic relationship underscores the challenges smaller entities face in accessing and implementing cutting-edge technological solutions, highlighting a need for broader support mechanisms to bridge the digital divide within the cultural heritage sector.

3 Bridging Past and Future

3.1 Keeping Trust as Capital

To summarize, science centers and technical museums have to a larger extent incorporated immersive experiences and -learning into their permanent exhibitions. A strong trend in immersive experiences available to wider audiences is the growing prevalence of touring projection-based art exhibitions, often celebrated as blockbusters, attracting large crowds and media attention. When looking at technologies used throughout Europe at large, different types of 360 photography is a dominant category, which includes a vast span of uses and level of production value. The concentration of VR and AR productions to major European cities and well-known institutions and brands could be attributed to the cultural- and technical capital collaborations with other institutions and companies bring with them.

In the evolving landscape of cultural institutions, it is essential to recognize and preserve the foundational value that underpins museums' relationship with the public: trust and confidence in museums as reliable stewards of evidence-based learning about heritage and history. Museums are esteemed globally for their significant trust capital. Particularly in Sweden, museums are consistently acknowledged as among the most trusted institutions, a testament to their role as venerable keepers of cultural heritage and knowledge, and as pivotal platforms for public engagement [25]. This trust is a reflection of museums' enduring commitment to the preservation, interpretation, and dissemination of cultural artifacts, facilitating educational experiences that span generations, and through these qualitative experiences ultimately contributing to democracy, social cohesion, and a sense of community.

As institutions that safeguard collective memory and cultural heritage, museums, archives, libraries and cultural heritage sites are instrumental actors in shaping societal values, nurturing empathy, and encouraging critical thought. They hold a distinctive and long held place of respect and authority in society, influencing public discourse. The trust vested in museums not only empowers the wider heritage sector to effectively pursue educational and cultural objectives, but also at the same time emphasizes the ingrained duty to maintain and uphold the highest of standards of ethics and accountability. Some crucial ethical aspects pertaining to immersive technologies in the GLAM sector, such as data privacy and accessibility, have previously been discussed through the project's case studies [8].

We argue that as museums navigate the digital transition and explore immersive exhibitions, it is imperative to sustain this trust capital by rigorously addressing matters of evidence, source criticism, and credibility in the immersive experience projects and immersive learning discourse. The confidence placed in museums by visitors is a privilege, not a given, and relying solely on historical credibility poses risks. The distinction between exhibitions designed to evoke experience and emotion and those intended to also impart knowledge and understanding is increasingly blurred, necessitating a balanced approach.

Echoing previous research, we thus advocate for a holistic perspective on the role of exhibitions, asserting that all learning engagements should incorporate critical analysis of sources. While resources, such as technical excellence is crucial for creating immersive experiences, it should not overshadow the classic museum pedagogical knowledge and educational goals. In this way immersive experiences set in the GLAM sector become a welcome addition and continuation of over a century of pedagogical learning and development, rather than a taking off to uncharted territories.

3.2 Towards the Crafting of New Terminologies

In conclusion, the study presented encompasses a qualitative study on the use of immersive digital technologies in projects in or connected to museums and heritage sites in Europe. Throughout our study, we encountered a multitude of creative projects, as well as openings for the further development of new pedagogical tools for immersive heritage learning. However, we encountered significant challenges in conducting a systematic review and engaging in discussions due to the absence of both a cohesive terminology and a clearly defined taxonomy tailored to the practical implementation of XR technologies in the GLAM sector as a pedagogical tool. An examination of current terminologies revealed a notable discrepancy and uncertainty regarding the classification of immersive projects and experiences. As the lack of a unified vocabulary for describing and grouping immersive technologies impedes meaningful discourse on pedagogical tools, such as source criticism and evidence evaluation, we advocate for further research aimed at developing a comprehensive lexicon for XR applications in museums. The rapidly evolving landscape of immersive technologies within the GLAM sector growing more prevalent, underscores the urgent necessity for a creation of a terminological framework to discuss pedagogical issues, not the least when it comes to matters of source criticism and evidence in the use of new types of media.

A central concept for many ongoing GLAM projects is to provide “immersive” experiences, which denote the experience of being enveloped by a medium and thereby gaining a sense of presence and active reality. Although the understanding and use of the concept vary greatly, this is not a new concept: the museum's traditional diorama – a composition where authentic but fragmented objects are reunited in reconstructed scenes of a whole – has long been a pedagogical tool aimed at giving visitors an immersive sense of presence and movement through time and space and through that act learn about places and events. However, while museums have a long tradition of deploying new technologies to move their audiences, the digital transition and XR-technologies nonetheless present new challenges, involving both organizational knowledge and audience pre-understandings and expectations, but also new opportunities for scientific research to reach a broader audience.

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