Augmented Reality for the Presentation of Cultural Heritage: On-Site Application and Evaluation of a Model

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Abstract

This paper comes out of a scientific study concerning development of an AR model for the presentation the archaeological site of Alexandria Troas for the visitor experience, and on-site application of this model, through a case, namely the Podium (or Forum) Temple, to investigate the nature of that experience provided by AR and its implications as well. The study is established upon the proposition that "AR is tailored to fit to provide a compatible, accessible, and sustainable presentation of historical built environments and archeological sites to public experience, while respecting much of the problem(atics) coming along with norms and privileges of historical heritage preservation and conservation." Departing from this ultimate proposition, it sets out a framework of questions to address. This paper provides a summary of the whole research, followed by the detailed description of the methodology and process concerning the developed model's on-site application, and a succinct presentation of its findings, finally, an account of the research as a means of testing the research questions. Findings confirm much of the assumptions deriving from the initial proposition and showed the great potential of AR towards this end as expected. A number of issues and problems were surfaced as well, some of which are oriented from the technologies concerning the AR itself, while others are related to the limitations of the proposed model and its on-site execution. Furthermore, the research indicated a number of matters to address and possible ways to expand such research. All in all, we argue that the research yielded a number of valuable results and insights in addressing the departing problem situation, while it also posed new questions and research paths to follow for new research.

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INTRODUCTION

Today, it might be firmly stated that Augmented Reality (AR) is an increasingly well-established, yet rapidly proliferating and evolving research field. Among its multidisciplinary proliferations, Augmented Reality's adoption for the (re)presentation of cultural heritage poses a special case, that has a great potential towards this end. It is no surprise to see that, almost from its onset, parallel to the studies in AR in general, researchers have been working on AR's specific employment towards this end, and there is a considerable literature stacking up, especially in recent years. The present paper comes out of a larger scientific study that could be embedded within this framework. Its departure point is the proposition that "AR, almost by definition, is tailored to fit to provide a compatible, accessible, and sustainable presentation of historical built environments and archaeological sites to public experience, while respecting much of the problem(atics) coming along with norms and privileges of preservation and conservation." (Anay, Özten, Ünal, & Öztepe, 2022). The study concerns development of an AR model for the presentation of a cultural heritage, namely the archaeological site of Alexandria Troas, for the visitor experience, followed by on-site application of this model, through a case, namely the Podium (or Forum) Temple, to investigate the nature of that experience provided by AR and its implications. Hereby in this paper while summarizing the whole research, we particularly intend to focus on the second part, as follows, on-site application of our model to report and discuss the findings thereunto, consequently a means of addressing our initial proposition.

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AUGMENTED REALITY: A DEFINITION AND A BRIEF INTRODUCTION

Augmented reality could be described as a technology that enhances and extends the real (physical) world by incorporating virtual layers that consist of both (virtual)entities and information, weaved together in real time to constitute a new, unprecedented reality, namely an environment, where active bodily and mental participation and interaction is possible.

In all of its original (and followed by) conceptions, AR is deemed as essentially "distinct" and "different" from VR, in the sense that it requires bodily experience and movement as a part of the equation, and also that it demands both the "real," and the "virtual," weaved together to constitute a new reality (Anay, Özten, Ünal, & Öztepe, 2022). As compared to VR, in AR, total "immersion" in virtual and total "detachment" from the real is not a sine qua non. On the contrary, AR do not require replacing reality with the virtual, and thus a total virtual immersion, but compels reality to exist as an important component, a basis to be enhanced and augmented by the virtual, in total, constituting a "blended," "natural" environment.

As it comes to its history, studies concerning AR are often dated back to the explorations in the late 60s. While these were the pioneers mainly focusing on technological developments and their adoption for practical solutions (such as Head Mounted Display of Ivan Sutherland (1968)), often intermingled with Virtual Reality, the idea might be traced even back to the studies in fields such as computer graphics (i.e. work of

Charles Wheatstone, (1838)) and film (i.e. work of Morton Heilig, 1956). As it was stated, the notion of AR in these early studies were often hidden within the investigations attributed to so-called Virtual Reality, possibly, it was not yet conceived that AR was a different phenomenon, and possibly without being aware of the essential differences between the two. This awareness, together with the theory of AR and its first conceptualization only comes about in 90s: Thomas Caudell and David Mizell (1992) first coined the term, Pierre Wellner, Wendy Mackay and Rich Gold (1993) recognized AR as a distinct phenomenon, and proposed that AR should be placed almost on the opposite side of Virtual Reality. Finally, in congruence, Paul Milgram and Fumio Kishino's (1994) famous Reality–virtuality continuum provided a way of contextualizing AR further in these terms.

In its practical applications, while at the beginning, primary target of AR was industry where AR often found its place in fields such as aviation and military, it started to disseminate other fields about 2000s, and after 2010s, it became mainstream and accessible for all, parallel to the technological developments and particularly due to the availability of tablets and smartphones. This historical trajectory also marks a number of parallel major shifts in its development, since AR's field of applications started to proliferate considerably, notably, to fields such as commerce, advertisement, gaming, and of course it pervaded art, design and architecture finding its specific adoptions in these areas.

RESEARCH ON AUGMENTED REALITY'S SPECIFIC ADOPTION FOR THE (RE)PRESENTATION OF CULTURAL HERITAGE: A DUAL EPISTEMOLOGICAL FRAMEWORK

By nature, AR could be viewed as both multidisciplinary and cross-disciplinary, since on the one hand, it addresses the problems of, and draws upon and incorporates knowledge from distinct fields, on the other, itself being a hybrid field of study, it is a synthesis of technology and knowledge derived from various other fields. As it was already stated in the introduction, among its multidisciplinary proliferations, studies concerning Augmented Reality's adoption for the (re)presentation of cultural heritage, particularly for historical built environments and archeological sites, presents us a special case. This is since, AR almost by definition is tailored to fit to address much of the problem(atics) coming along with norms and privileges of historical preservation and conservation of cultural heritage while providing a potential for a compatible, accessible, and sustainable presentation of these assets to public experience (Anay, Özten, Ünal, & Öztepe, 2022),(Cannella, 2019). It is no surprise to see that, almost from its onset, parallel to the studies in AR in general, researchers have been working on AR's specific employment towards this end, and there is a considerable literature stacking up, especially in recent years. The content of such studies might be roughly divided into two

interconnected categories, implying two overlapping epistemological frameworks under which they could be investigated.

First framework is about conceiving and developing ideas, models (solutions), followed by their application and examination in themselves (i.e. gathering and employing data, conceiving a new approach, an idea, creating models and virtual layers, adopting a new technology, testing its technical aspects, and corresponding performance, etc.) The subject matter here is the AR model itself. A brief overview of such "content" within previous research is as follows:

AR-cheoguide prepared for the presentation of Ancient Olympian city of Greece (Vlahakis, et al., 2002) is one of the earliest examples where both tangible (completion of Temple of Hera) and intangible (illustration of running athletes in an Olympic game) heritage were introduced as an "augmentation." Ancient Pompeii (Papagiannakis et al. 2005) project on the other hand focuses on the intangible part most, using the murals to reanimate the life and people, and through a storytelling technique to create an experience for the visitors. Aside the unique and novel ideas introduced by them, in these studies there is much work and discussion on the development of technology and software and their adaptation to the purpose. A more recent study concerns AR representation of a Roman Villa located in Valladolid (Martínez, Álvarez, Finat, Delgado, & Finat, 2015). While the study provides a virtual model of the villa, originally the problem was to incorporate the complex stratigraphic layers and partial excavations to present visitors an interactive navigation while showing various layers and giving a certain interpretation of the site. This was achieved through interactivity; by asking some simple questions, and assigning minor tasks and puzzles. Study also shares the research process prior to the preparation of the model. So does AR project of Aurelian Wall at Castra Praetoria in Rome (Canciani & Saccone, 2016), where, aside from the AR model provided, the subject matter is the investigations prior to the development of AR application, such as historical research, surveying (documentation), and restitution. One of the most popular examples of use of AR in the presentation of archaeological sites is models developed for Acropolis. AR project of Parthenon Temple (Liestøl, 2011) provides an interactive model, and zooming (and therefore viewing buildings in detail with information) and transparency (i.e. which makes Cella visible from outside). In parallel, Mobil Optical Illusion's (MOPTIL) Acropolis application is publicly available for mobile devices, and they provide restitutions of the buildings both synchronically and diachronically presented. For example, in a time warp, one could see Acropolis in Greek and Ottoman times with an information-rich layer provided as further augmentation. Similarly, the AR application for the Apulian ancient city targets representation of the history and culture of the city by letting visitors engage with the context. The application offers an ancient city experience by combining various types of data (such as 3D model, map, text, and audio) with historical buildings that have been completely

destroyed. A key feature is that the visitor can experience different periods and learn the historical process. Therefore, AR provides an interactive environment where visitors are a part of the ancient city experience (Cisternino, Gatto, & De Paolis, 2018).

Figure.1 Apulian ancient city experiencing 3D models and content in the AR environment (Cisternino, Gatto, & De Paolis, 2018).

A novel use of time warp in AR applications is reported by Liestøl (2011). In AR application of Temple of Deified Julius Caesar, as one approaches the temple, the application opts for a rollback to time to the events that led to the building of the altar, the death of Julius Caesar, through a set of animated scenes. Here augmentation involves the "time," manipulated in two directions, and there is a cinematographic narrative as an augmentation. SensiMAR, on the other hand, is a study in which the remains of a Roman house in the Ruins of Conimbra are experienced in a multi-sensory environment with AR. Here, the visitor experiences Roman urban life in addition to animations, videos and sound effects, as well as smells (e.g. fish market smell for garum). Thus, while the existing structures and ruins can be observed, the ancient city experience is strengthened with elements(audio-visual-fragrance) that work in harmony with virtual scenarios in the AR environment (Marto, Melo, Gonçalves, & Bessa, 2021).

Figure.2a Ancient city experience without AR and with SensiMAR application. **Figure.2b** Animations simulating urban life in Sensimar application (Marto, Melo, Gonçalves, & Bessa, 2021).
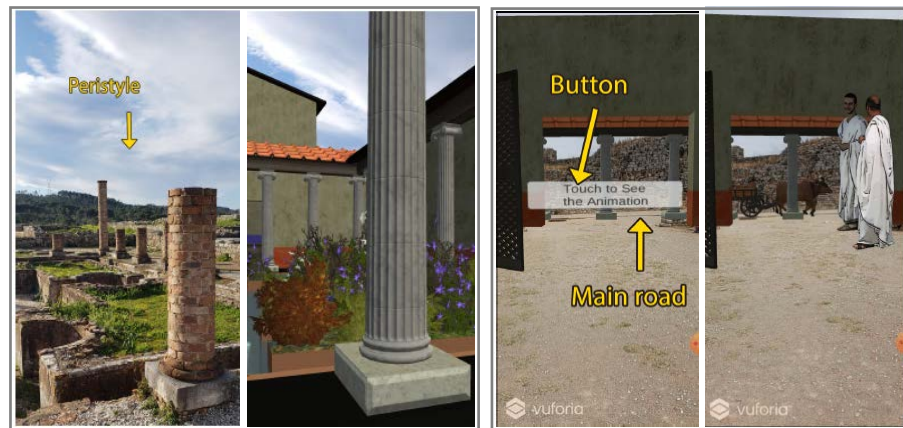
The Scipio Project, on the other hand, uses the application called Espacios Junta to address the visitors coming to the Archaeological Ensemble of Itálica (Seville) to experience the area with AR technology. The main purpose of the study is to analyze the applicability of AR technology in open areas for the presentation of archaeological sites. In this context, the application allows visitors to experience 3D reconstructions of various structures and objects in the area by using

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their location information.This improves the visitor experience and provides a better interpretation of the entire area (Expósito-Barea, Gómez Pérez & Pérez Rufí, 2022).

Another study deals with recontextualization with the virtual reconstruction of a marble monumental element called "Tribuna", which is a special element of Palermo Cathedral. Two AR applications were developed within the scope of the study. The first is the experience of the reconstruction model reflecting the 18th century drawings from the nave, the second is the AR experience that offers a partial but close view of the 'Tribuna'. This work allows visitors to experience a past situation of Tribuna with its AR reconstruction, while helping them understand the meaning and location of the statues on the sides of the nave (Canella, 2022).

Second epistemological framework contains investigation of practical (on-site) application of such models, for understanding the very nature of the experience provided to the target audience, for the evaluation of the model's performance and potentialities towards the ultimate aim. These are not about the model itself, but are the means of addressing the initial conjecture about AR's contribution and potentials for the presentation of cultural heritage, which in turn would shed light on the ultimate questions posed and implied within. Here, the subject matter is the (user) experience with relation to the provided solution. A brief overview of such "content" within previous research is as follows:

The Historical Tour Guide is an AR application that aims to representation of the Trondheim history (via photographs and maps from different periods) to its visitors. In the study, a two-stage survey was conducted to measure the need for an alternative tool (in this case AR) in the representation of cultural heritage and its impact on user experience. While the first stage consists of 200 participants who watched a short video of the AR application, responding to a web survey, in the second stage, 42 participants answered a similar survey after experiencing the application on site. As a result of the comparative study, it has been revealed that the visitors who experience the area with the AR application have more information about the site and such a learning method makes the experience (Haugstvedt & Krogstie, 2012).

Figure.3 The user can get information about the past situation of the city with The Historical Tour Guide application (Haugstvedt & Krogstie, 2012).

Similarly, AR-view is an AR application developed for the representation of Dashuifa Ruins in Yuanmingyuan city. Virtual reconstructions have been presented to the user experience in order to revive the historical and cultural heritage devastated by the wars. According to interviews and survey results with visitors who have

experienced the historical environment, AR enables users to make sense of the area they experience and enjoy the experience (Huang, Liu, & Wang, 2009). AR application for Tamsui District, which has many cultural values in Taiwan, focuses on the sense of belonging in historical environments. In that case AR is a guide for visitors who can access different types of data (visual/literary/audio) related to the historical environment. The application evaluated with 87 participants consisting of 3 different experience groups (with AR application, guided and unguided experience). The results show that users who experience the site with AR are more successful in creating a sense of belonging and perceive the historical and cultural value of the area better. In addition, authors stated that the learning motivation of the participants in the AR guidance group increased (Chang, Hou, Pan, Sung, & Chang, 2015).

Figure.4 Users get more information with the zoom-out function while experiencing the historical environment (Chang, Hou, Pan, Sung, & Chang, 2015).

One of the problem in the presentation of cultural heritage artifacts is their fragile nature and uniqueness, and limited access to artifacts. In this context researchers created an AR application to solve the problems of inaccessibility and lack of interaction with artifacts, thus, visitors can see and interact with virtual reconstructions of the artifacts in the Severis Gallery. As a result of interviews with 60 participants who have experienced the application, it has been revealed that AR is an effective tool in the presentation of cultural heritage and is accepted by all age groups (Kyriakou & Hermon, 2018). Another AR application developed for Casa Battlo focuses on user experience. In this way evaluation was made with 122 people who experienced the places and works in the museum in the AR environment. As a result it is revealed that with the AR, visitors could feel the spirit of that period and get clues about daily life (Gimeno, Portalés, Coma, Fernández, & Martínez, 2017).
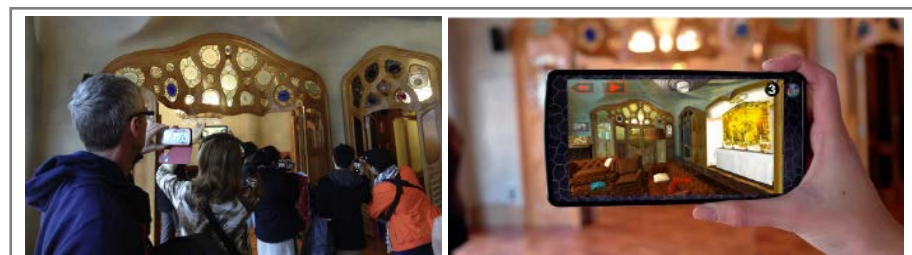
Figure.5 Users experiencing the augmented scene on their smartphones with the Casa Batlló AR application (Gimeno, Portalés, Coma, Fernández, & Martínez, 2017).

A recent study, MTRACR (Malay Traditional Clothing and Textile Augmented Reality Mobile Application), was implemented in the Malay Culture Museum to promote and representation for Malay culture. With the interaction options (such as virtual movements, buttons, games)

offered by the AR application, visitors can experience cultural values such as traditional clothes and documentaries. According to the results of MTRACR interviews and surveys, which were evaluated with a total of 30 people, the experience in the AR environment provides a joyful learning environment (Masduki, Nazarudin, & Ali, 2021). DinofelisAR enables the virtual reconstruction of the Roman forum in the ancient city of Conimbriga. 90 visitors participated in a questionnaire to examine the effect of DinofelisAR application on the archaeological site experience. As a result of this evaluation, it was determined that AR can better represent the forum features (e.g. size, colors and architecture), contribute to the site experience and is an important tool in cultural heritage areas (Marto & Gonçalves, 2019).

Another study carried out in Peru was aimed to present the architectural heritage of the Casa Grande District via improving the visitor experience. Researchers state that visitors come to the site and see only a few buildings, but they do not know the values and history represented by these buildings. With the AR application created within the framework of this problem, they can obtain various types of data (visual, literary) about the structures in their surroundings. In the continuation of the study, the usability of the application was tested with experimental and test groups of 30 people. As a result, it was seen that visitors using AR got positive results in terms of access time and cost of information, number of visits and finally visitor satisfaction (Ganoza-Cabanillas, Gamboa-Cruzado, Moreno, Ruiz & Cruz, 2023).

**A Grand Scenario for the Presentation of Forum of Alexandria Troas**

While the larger research, from which the present study derives, concerns both of the aforementioned frameworks, the present paper could best be embedded within the second, since it involves investigation of practical (on-site) application of an AR model where the subject matter is the (user) experience with "relation" to the proposed AR solution. Therefore, before going into detailed presentation and evaluation of the on-site application and related (user) experience, first we ought to make a concise review of the proposed model as our basis and for making that "relation" apparent and sensible[1].

The research was about the archaeological site of Alexandria Troas, an antique city established in early 4th century BC, in Hellenistic times, but known to be reached its heyday under the Roman reign. Today, a few remains of the city are observable. Doric and Podium temples, Theatre, Maldelik, Odeion, Herodes Atticus Baths, Stadion, Nymphaeum, main street (Decumanus), waterway, port and some of the city walls, are all scattered around a large area, mostly in bad condition and generally not easily accessible for the visitors (Figure.6). As far as both excavations and visitor activity is concerned, present focus is the forum that consists of a number of architectural and urbanistic elements, such as the Podium Temple, Odeion, Sculpture Hall, Dodecagon building, and

[1] A detailed account of this segment of the research is well beyond the scope of the present paper. We already provided a review here (Anay, Özten, Ünal, & Öztepe, 2022).

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the main street (Decumanus), having potential to provide an idea about the architecture and the city fabric of Alexandria Troas. However, it remains as a "hint" rather than a satisfactory experience since the remains were either stripped to the bare foundations, or mostly unearthed, thus not permitting a cohesive view and understanding of the buildings and the forum. We identified this situation as the main problem to be addressed by our study. Apart from this main problem, we also examined the way forum was experienced by the visitors and identified the behaviors, patterns and problems concerning thereunto. General impression was that the visits were short and discontinuous; uninformative and unfulfilling, to a great degree because of missing elements and layers, an adhesion, leading to a set of disjunctions aside the ones presented by the site itself, needed to be augmented into a continuous cohesive whole. Apart from the lack continuity and adhesion, each component (a building, an urbanistic element) that would contribute to holistic experience have had its own specific set of problems and demands to be addressed.
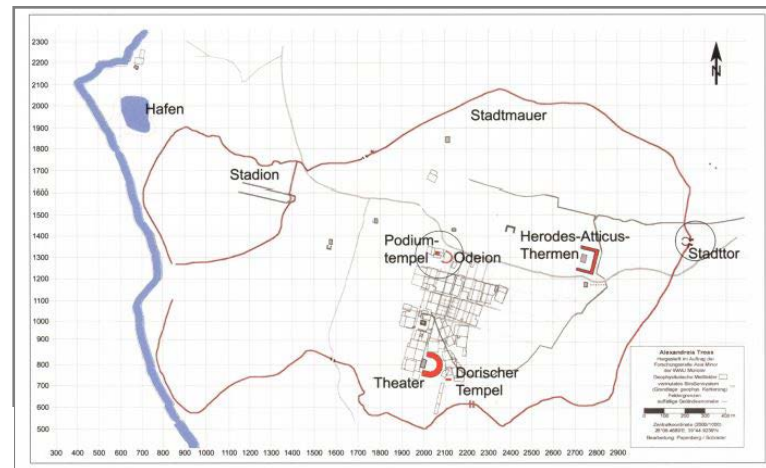
Figure.6 Alexandria Troas ancient city plan (Öztepe, 2017).

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To deal with these problems, we adopted the idea of "montage of attractions" borrowed from Sergei Eisenstein's, early theories on film (Eisenstein & Gerould, 1974), with reference to his parallels between the architectural and cinematic experiences (Eisenstein, 1989) as they involve a sense of spatial and temporal progression that can be deeply immersive and engaging. Apparently such a paradigm would have helped addressing the elements one by one (as scenes or takes), while permitting and help maintaining a cohesive continuity through a cinematic experience (the grand scenario). Incorporating, was the conceptual and theoretical framework of an emerging design field "experience design."[2]

We prepared a "grand" scenario for the visits, consisting of a sequence of (staged) scenes (attractions) focusing on various elements (i.e. buildings), while considering their demands and specificities whether tangible or intangible (Figure7).

[2] For example see (Dewey, 1980)(Hassenzahl et al. 2013), (Shedroff, 2001) (Benz, 2015), (Anay, Özten, & Özten Anay, Towards a Common Framework to Operate with: Mediating Experience Design and Architecture In Designing Experience: The Ballerina on the Elephant, edited by Peter Benz. Hong Kong., 2014), (Özten, 2019).

For example for the Decumanus (S3a-b-c) we thought that since it was a linear element (street) it could be best experienced by movement, by being inside, by walking through it, or watching people doing things and walking around. Virtually augmenting Roman arch at its South end, and completing the shops alongside it would contextualize the street and bring its lost spatial characteristics back. We also proposed an intangible aspect, namely one of St.Paul's visits considered as an important event in time in the city's history (Acts 16:6-8) (Texier, 2002), as an augmentation (Figure.8).
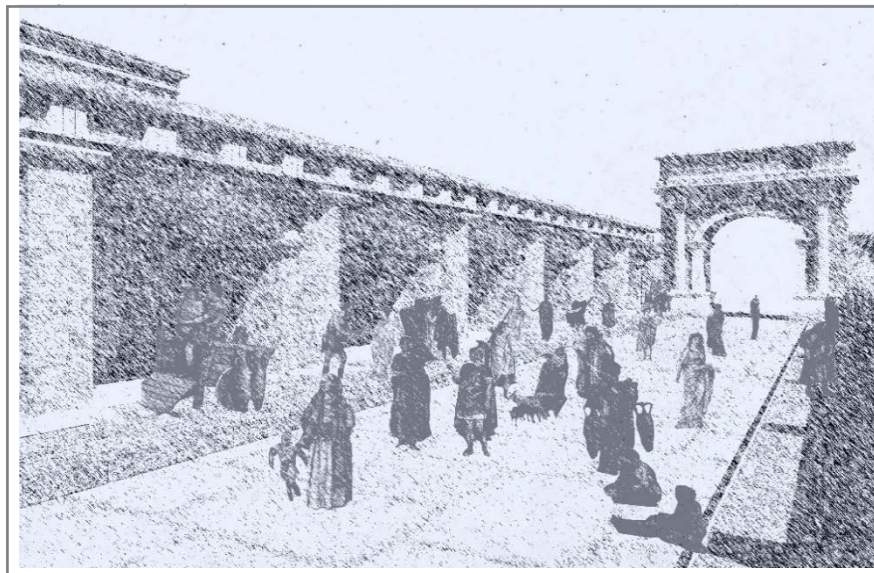
**Figure.8** Thematic Reanimation of Decumanus.
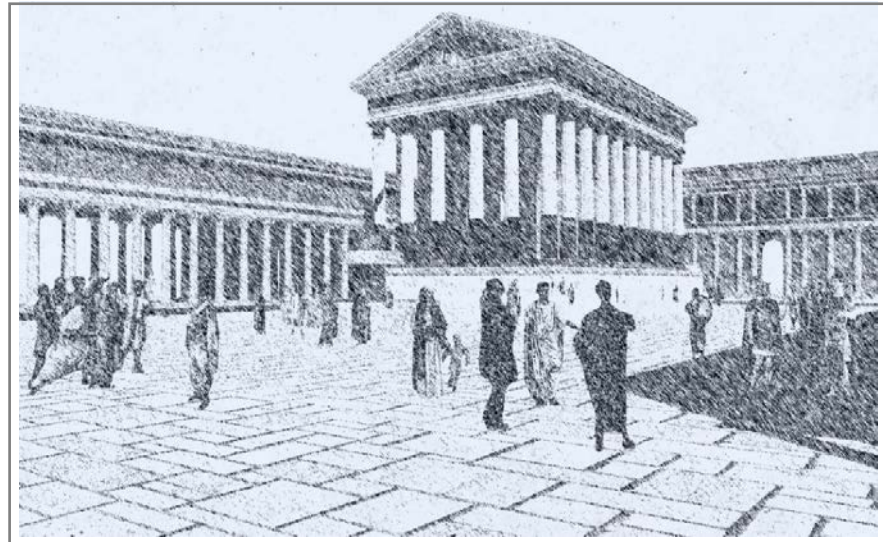
Figure.9 Thematic Reanimation of Podium Temple.

Odeion (S4), have had a potential to provide an experience from outside since first, it is monumental building, with architectural and aesthetic aspects, and second, it defines and contributes to the overall spatial and architectural experience of the forum. Furthermore, it is a means of providing a context, a background for the Podium Temple (Figure.9). Apart from its (external)formal contribution, its interior (spatial qualities) was of particular importance. As an intangible aspect we proposed adding the crowd, and an on stage performance of a musician from Lesbos who was commended for his exceptional accomplishment in a competition that take place in the building (Schwerteim, 2002).

For the sculpture hall (S2) and the Dodecagon building (S1), the dominant was the interior, rather than the exterior appearances of the buildings. For the first, we decided to place the found sculptures within the assigned space as an augmented layer. The Dodecagon building, having a unique, centroidal plan, was possibly related to some rituals concerning water, health and Eros cult. The space once have had a roof likely with an oculus (Schwertheim, 2018) carved architectural elements facing interior (now relocated somewhere else)(Figure.10), and possibly a water element located at the center, now all either stripped down or missing. We planned reintroducing the architectural elements and the roof that would add much to its missing aesthetic and spatial characteristics. We decided enriching the presentation further by adding an informational layer addressing the Eros Cult, and enriching the spatial experience by introducing water and sound of water echoing on the walls all contributing as intangible features.

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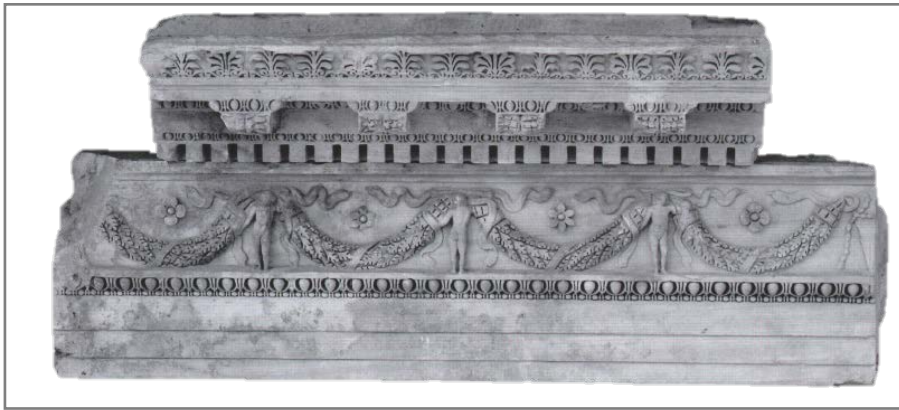
Figure.10 Frieze detail of dodecagon building (Eros figures) (Schwertheim, 2018).

The Case: Alexandria Troas Podium Temple

The focus of the forum was the early imperial Podium Temple (S5a) that dominates the visits and works as a binding element for all. We identified that it could (and actually it is) best be viewed from outside, as it was an isolated object, and wandering around to experience its monumental and sculpturesque characteristics was one of its dominant features once and then. This was conceived as a part of the Grand Scenario.

Starting with this dominant would be a logical choice, for the development of our AR experience "first, since it is already the visitors' main point of attraction, it is convenient to present it through AR and then test it. Second, it might be a departure point, a trial to learn from for a more comprehensive and inclusive study. Third, there is almost nothing left from it except the foundations to give a three-dimensional holistic idea about it, and there is nothing to do about this in conventional means."(Anay, Özten, Ünal, & Öztepe, 2022).

This decision is followed by a detailed documentation, expert interviews, and a literature study (Görkay, 2002). From the findings, we decide to develop our AR model upon three potential restitutions of the temple based on prostylos, peripteros, and pseudo-peripteros layouts (Figure.11), the temple being in Corinthian order. This multiple representation decision was also valuable to test and show AR's potential for providing holistic, informative and powerful alternating projections, yet being infinitesimally invasive. After preparing the digital 3D models, we developed our application for IOS (IPADS and IPHONES) using the ARKit library under Unity as our development environment.
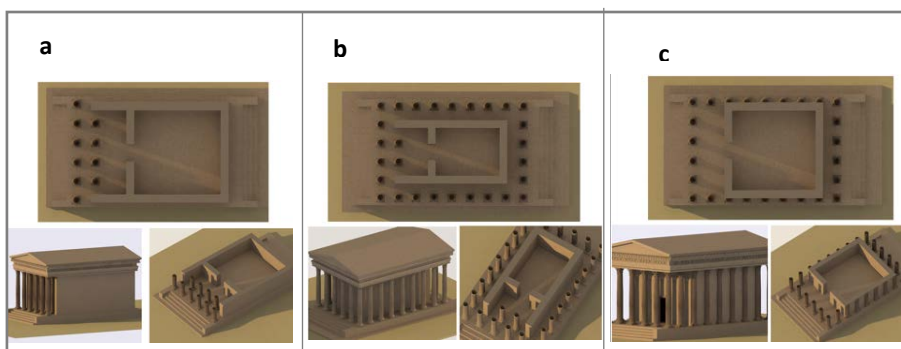
Figure.11 Potential restitutions of temple: a- Prostylos layout, section drawings and renders b- peripteros layout section drawings and renders c- pseudoperipteros layout, section drawings and renders.

FIELD STUDIES: METHODOLOGY & THE PROCESS

We employed a mixed-method approach in our research that yielded both qualitative and quantitative data.

First component was a semi-structured interview based on a framework of questions organized under the following titles: Basic information about the participant, Evaluation of the (AR)Application and the idea, Evaluation of the Experience provided, Informative/Educational Aspects, General Impression and Expectations, and Suggestions and Projections.

Second component was observations concerning participants' behaviour. While applying interviews we recorded visitors' behaviour such as general mood and approach, gestures, reflexes, exclamations, nature of the developed dialogue (active, passive, asking questions, sharing experience, positive, negative), and as well time passed during the visit, and the route taken.

In the process, after informing participants about the research, and after taking their consent, the interviews are conducted in the form of open-ended conversation. The researchers while keeping the conversation within the scope of initial question framework, let visitors to roam, talk and ask freely and comment, criticise and suggest. Therefore, it could be the case that they introduced new issues, questions, and interpretations, which in turn will add to the depth and comprehensiveness of the research. Each conversation is recorded digitally (as sound). As it was stated above, in parallel, we recorded participants' behaviour.

In total there were 215 participants, interviewed in 20 consequent days. 101 of them were women, 97 of them men, and 17 of them were children. As expected children were always accompanied by an adult. Thirteen of the participants were from the excavation staff, (archaeologists, architects, restoration experts, and students as well). Eleven of the participants were rather disinterested, but other visitors met our approach with great enthusiasm.

We used so-called general information, i.e. gender, age not as variables in evaluating data, but just for recording and seeing the distribution. Methodologically, we also did not intend to "select" the participants, but include all who wished to participate.

The process yielded sound recordings and notes concerning participants' behaviour, which this raw data were later, deciphered utilizing content analysis method. First, we processed data as a means of answering the initial set of questions. Second, we tried to identify unexpected and unprecedented patterns within the conversation. In parallel, we investigated recordings concerning participants' behaviour, if possible, in correlation with the interviews, or otherwise. This processed data is later structured and interpreted to draw the results.

The Findings and Evaluation

In general, most(183) of the participants evaluated the AR experience in positive terms, each addressing a different aspect of AR (Table1). AR as a technology itself was also viewed mostly(155) as having a great potential for the presentation of cultural heritage; even before asking, a number of visitors(26) evaluated it as impressive and suggested that it must be used for other cultural heritage sites. Even the issue of non-invasiveness came up as a rationale here. They also demanded the application should be self-sufficient and available publicly (as in "apple store.").

Table.1 Participants' tags (descriptions) of AR experiences.
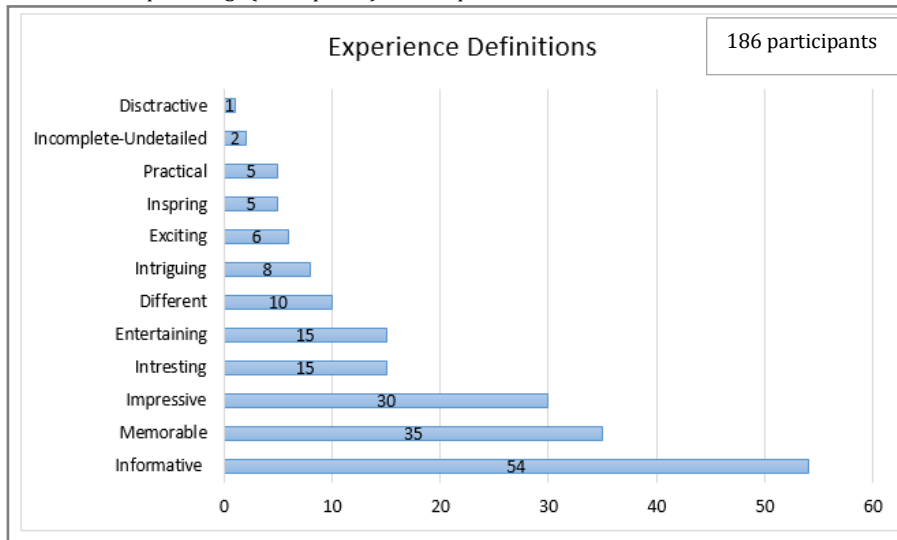
As a first impression and response, majority (177) stated that they did know/could not have imagined such a building (could have been) existed here before seeing it in the application. As such, the model was informative in many means such as the form, the scale, the type, the style, architectural elements, general arrangement, and so on so far. Participants(15) also raised issues concerning the details of the provided model. Especially those who have had a previous knowledge about architecture (i.e. archaeological excavation staff, architects, guides) identified the model as having insufficient detail and demanded more.

In congruence, participants(55) emphasized that what was visual, must be supported by informative augmentation (i.e. text, sound) as a means of introducing a complementary content that could not have been expressed with a visual representation alone. Many(63) visitors implied since the model did not have an informative layer, the experience would be always "less." The claim is that they only "see" the building, and how it was then, but without developing a deeper understanding about it, and raise an awareness about its cultural and historical meaning and importance. We particularly suggest that this should be one of the

important issues to address in developing AR applications, AR excels in introduction of information that could be digitized in any means.

• "Various information layers such as text, audio and video related to the structure should be added to the application."

• "If historical characters and various daily life activities are presented with some animations, it will provide a much better perception of the historical and cultural value of this place."

"Education" might seem not be the primary target for a developer, and the visitors, as compared to an entertaining, and recreational experience. However, obviously, there would always be at least an "implied" education, and transmission of information of some type would always be an indispensable part of the equation, which in turn would add much in "content" and might help in raising experience to a better, more satisfactory level. Information presented in context, transmitted through AR experience could be a very powerful device for education and the production of knowledge. This we suggest presents a great deal for an AR application.

Participants mostly(177) valued provided AR experience as memorable. Some of them even stated that there is no chance that they will forget this experience and the image of the building from then on. This was an indication of a success of the model on this vein, confirmed further. In parallel, participants also suggested that information received through such an experience would be more permanent.

• "The fact that we can see both the current state of the structure and the original state in the past, makes it more permanent in the mind."

• "Sometime after leaving the site, the original state of the structure experienced in application will remain in my mind, rather than its current state."

Generally, visitors found the provided AR model as being impressive(30), interesting(15), different(10), intriguing(8), inspiring(5), etc., all could be considered under a common theme. It was a common gesture, when first time visitors were handed the mobile device, they met it with exclamation ("Wow!") and enthusiastically tried to see "more." Obviously this is mostly by means of AR technology itself, providing an "unprecedented," experience, but it must be underlined that there might be a contribution of being an element of surprise, since for many (163) this was their first AR experience and they did not expect to see such a "thing" beforehand. From a certain point of view, a "shiny" AR experience and making advantage of element of surprise, is obviously "a low hanging fruit" that is hard to miss for an AR developer.

• "Looking at the current state of the building, I can't understand what kind of building it is and how it was used, but this makes me understand that it is a building with practical historical value."

• "I think this application greatly increases one's belonging here. "

We also observed from the gestures that just after they see the temple first time, participants immediately turned the device all around to see "more," especially seeking for a surrounding, and consequently being

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"let down" with the lack of a comprehensive context. In congruence, even without asking, considerable number of participants(38) indicated that a surrounding would have add much to the experience. This was one of the dominant critical themes resurfaced in many of the interviews. Visitors evaluated missing surrounding as a major problem to be addressed(157). In the suggestions category this theme also came up once more, being the general view as adding a physical context would have helped much to the experience and would re-establish the experience on a higher level and provide a better understanding of the building.

• "Seeing it as a temple allows us to connect with the past. Of course, it would be more beneficial if the whole environment was added."

• "If all the historical buildings and surroundings were added, I would feel like I was walking around in the past. It would be an enjoyable experience even for someone who is not interested in history. And so it would be more memorable."

Majority(176) emphasized recreational characteristic of the AR experience. The terms that came up was "fun" and "entertaining" as being two important components of the AR experience. Being "fun" and "entertaining," might be an end in themselves as far as a "touristic" activity was targeted, but these were often used as qualities or as adjectives associated with the experience, becoming more satisfactory, not boring or dull, much more elongated owing to these characteristics. Some also added the issue of passive or indirect learning while having fun, which was deemed as good, especially for children.

• "It will be a more fun and effective method in teaching cultural heritage, especially for children."

• "This application is much more enjoyable than seeing a pile of stones."

Curiously, many of the participants asked for a selfie or a photo in front of the building, possibly for recording the moment and for sharing it through social media. We "manually" provided them such material. Possibilities for "recording" a memory and making it socially available was not something that was initially planned to be incorporated in our model, but we thought that it might be a great opportunity for an AR application to promote historical heritage further, in a powerful and special way. Many(87) also stated that either before coming to see the site, or during their visits, they use some type of medium to get more information about it. Apparently, social media, rather than scholarly sources were one of such dominant sources providing a database for the visitors beforehand or during visits. Thinking that visitors' experience and activity contributes back to that pool, this we think presents a great opportunity a potential to take advantage of. These related issues are further supported by interviews. Participants(26) suggested that such a component in the application might help in promoting cultural heritage by this means. This might be done by incorporating social media capability within AR itself or incorporating AR within some type of social media.

• "I usually try to get information from the internet before visiting historical places. Such an application would be a more practical and enjoyable option. It would even be better if it is available from Appstore and playstore. Even without an application, a web page can be created and people can access it themselves with a QR code."

Figure.12 Photos of visitors with the podium temple.

We identified a number of user patterns from the onset, visitors, possibly being accustomed to (hand) gestures borrowed from their previous experiences with mobile devices and computer games, such as clicking certain parts of a building, and try to zoom into various parts, rotate, and pan, as a means of testing such abilities of the model. This, on the one hand, might be seen as a demand and an opportunity, to some degree should be explored and employed further in AR, on the other, it poses a number of issues those might be against the soil of AR itself. Same gestures, i.e. clicking certain parts of a model, trying to zoom into various parts, we believe are also related with abovementioned two issues of demanding the model having more detail and providing informative layers. Users were not only habitually using and testing the hand gestures, but also doing this for a reason, namely trying for getting more information about that certain part they've clicked and to see (more) detail of a part by zooming in.

CONCLUSION: WHAT WE HAVE LEARNED

General impression was that people generally receive AR with enthusiasm, expressed through wide spectrum of verbal, visual and auditory response, which we believe is an indicator of people becoming active part of the experience. They quickly became familiar with the idea and the application, internalizing it by various means, indicating existence of a sense of belonging and ingress, as if what was presented was a natural extension of corporeal and mental being and existence. There are five major categories under which could evaluate the research.

Technology

Apart from these general observations, first matter that is worth to revisit is the issues concerning the AR technology. These are limitations mostly, but there are also issues concerning the specificities of AR. From the interviews, we identified a very high level of expectancy, as far as the digital layers (representations, interactivity, environment, affects, etc.) are concerned. Possibly related with the level of digital technologies people are accustomed to in other fields such as cinema, gaming, and affined area of virtual reality, visitors seem to be set their standards and their biases to that state-of-the art levels. At its present state, it seems too hard to cope with the standards of other such disciplines, the excellence they have reached. Visitors, demanding more detail in models, a full physical context, and a full interactivity, all in one, may seem rightful, and just, but as far as the available technology is concerned, within the capabilities of existing AR-enabled mobile devices, accomplishing all these in a satisfactory level is quite hard to accomplish.

As it was introduced earlier, our approach was to develop a model that could be available to ordinary people, for daily and momentary use, and suitable for devices they could afford. This pointed to mobile devices, namely smartphones and tablets. Once this decision was made, you only have a handheld that is neither primarily designed for this purpose, nor having a specialized hardware to answer to the demands of heavy graphics and visual processing. One could either decrease the overall level, or sacrifice one or two of the essentials for the benefit of the others. In AR, (publicly) available technology, we strongly believe is the major constraint, working as a "bottleneck" for developing such high-level applications for ordinary people. In addition, much of the expectations of participants seemed to be "assuming" AR same as a computer game, a film full of digital effects, or more likely a VR application. A detailed discussion would be beyond the scope of the present paper, but we could claim that the product, technology and experience wise, there are essential differences between AR and the others.

Augmentation

Second matter that is worth to elaborate is the issues concerning "augmentation" in general. As one might guess, this concerns "core" issues of AR, and could only be discussed under multiple sub headings.
a) Form: What is obvious in developing an AR experience an archaeological site, or a building within it, seems to be about providing a virtual layer that completes what was missing formally. This could be interpreted as "augmentation," and proposition seems straightforward, however, the situation gets complicated since "missing," and the notion of "augmentation" might refer to a rich gamut of aspects rather than a mere form.

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b) The Context: This, we particularly find important, not only as a problem to address but also as a "must" general principle concerning AR presentation of architecture and built environment. Apparently, it seems that representing a sculpture or a coin without a context might not be a problem at all, while by nature, architecture demands such a background, an experience in context, without which the experience provided would always be evaluated as "less." Here we particularly point to physical context and the immediate surrounding. A piece of architecture, as a cultural product do not only have a physical context but also a cultural one. A cultural context might point to quite a number of things, all intangible, such as its history, its meaning, as well as, a narrative, a story, lifestyle, people, or an event.

c) The level of detail: Feedbacks concerning lack of desired detail in AR intrinsically brings up the issues of lack of information and availability of technology. First, restitutions have a level of reliability. Forcing those means a high-level speculation, even deceit and misinformation emitted to people as such. Perhaps an AR model would also need such a "reliability" layer or alternating proposals to make sure to stay on the safe side or not deceive people. We provided alternating restitutions but on a higher level. Second, as far as AR technologies are concerned, unfortunately, the question of the level of detail was (and possibly still is) highly constrained by the availability of sufficient hardware as it was discussed above.

d) Information Provided: A building and its context expressed in mere form might tell much. However, not all could be expressed and told through the building and its context itself. For example, one cannot identify the type and period of a building, its function, its importance, its history, when it was built, by whom, why, etc. without appealing to some other means. Tangible should be accompanied by intangible.

Interactivity

Third matter is the issue of interactivity. AR, since it demands a bodily existence and experience, by definition would always have a degree of interactivity. This being said, problems might raise here due to the specific nature of AR, i.e. for going somewhere, or for seeing something in detail, you have to really walk, rather than clicking to that position or move joystick to that direction as it was in computer games on in VR. This, we observed the visitors were not accustomed to. Interactivity, while being an essential component of AR, might be quite different from the types and norms of interactivity in real life and interactivity in VR and computers which people are much more used to. This is a major issue to be addressed by AR development. Developing hybrid applications that contain both AR and VR might be a solution too. Interactivity does not only concern visitors' intentional gestures on a mobile device or a mere natural bodily movement. It might involve a trigger that activates a response when someone approaches to a thing, enters a domain, does something, or behaves in a certain way, even

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spells a "magic word." The Response depends on the trigger and the correlated event that could be anything.

Due to the nature of process, an expert accompanied all visits. Naturally there was a continuous dialogue, special type of interaction which we believe added much to the experience. It was not passive such as a clicking a part of a building and getting information, or triggering and event, and passively listening to a story, or just walking around to see if something happens. It was a type of "intelligent augmentation." That mediates itself according to the situations that came up. However, this was a special occasion wince we were conducting a research. Assigning this task to a device would put us in the domain of machine learning and artificial intelligence. However, we strongly believe that such an understanding of interactivity would re-establish AR on a higher level.

Continuity, elongated experience and estrangement

Fourth matter is the issue of continuity, elongated experience and estrangement. We already introduced the power and importance of utilizing "an element of surprise" in the previous section. Yet from another point of view, this situation poses a serious question: what happens when the first impression becomes accustomed to, and initial enthusiasm vanes out? This, we particularly deemed as an important issue to be addressed by an AR application. This issue could be evaluated under an essential theme which actually is common to many design/artistic discipline such as film, and literature, involving experience that is based on time and diachrony, or a video game, even if it was open-world, still experienced in time. Keeping the visitor "estranged" (alert, curious) all the time during the process (the time dimension), while elongating the experience, keeping it intact and continuous, as much as possible must be a general principle to be sought for. Now we fall into the domain of art.

Social Media Integrity

As a fifth, since it was already introduced and discussed in the detail, we would like to just remind the matter of social media integrity, and social availability as an important issue to take in the consideration.

FINAL REMARKS

This study was established upon the proposition that "AR is tailored to fit to provide a compatible, accessible, and sustainable presentation of historical built environments and archaeological sites to public experience, while respecting much of the problem(atics) coming along with norms and privileges of historical heritage preservation and conservation." We believe that the research confirmed much of the assumptions deriving from this initial proposition, and AR showed a great potential towards this end as expected as it was discussed in detail above. However, we also believe, the major contribution of this study was not that it confirms the ultimate assumption but rather for it raised

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a number of issues and problems, as well as indicated a number of matters to address and possible ways to expand such research. Overall, the research yielded a number of valuable results and insights in addressing the departing problem situation, but it also posed new questions and research paths to follow for a new research.

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Resume

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