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A PHILOLOGICAL APPROACH FOR THE 3D RECONSTRUCTION OF THE MESSAPIAN WALLS OF MANDURIA IN AN AUGMENTED REALITY PROJECT

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Abstract

This article concerns some theoretical discussions about storytelling and persuasive narration as a premise for the philological reconstructive study of an archaeological area. The forms of communication discussed here create emotions by interacting with human feelings, sharing stories that convey knowledge in a simple yet effective manner. The use of passive media and interactive technologies with minimal usability requirements encourages broad user engagement, pro-moting cross-disciplinary paths and unexpected connections. For this reason, this mode of cultural transmission represents the most effective way to engage a broader audience. In the second part of this discussion, some results from a recent project at the archaeological site of Manduria (TA) are presented, where, alongside the use of new digital languages to support storytelling, the methods of philological reconstruction and emotional storytelling are highlighted.

Keywords

Manduria, Virtual Reconstruction, Philological reconstruction, Messapian walls

1. *Empowerment and storytelling*

It is challenging to pinpoint a singular, decisive definition of empowerment. One of the earliest attempts was made by Julian Rappaport (Rappaport, 1981), who described empowerment as a process enabling individuals, groups, and communities to enhance their capacity to actively control their lives. Rappaport identifies empowerment as both a process of individual or collective enhancement and the result of this process. It encompasses the ability to comprehend one's surroundings and exercise control over events, to assume an active, conscious, and responsible role in decision-making processes, to develop strategies aimed at achieving objectives, and to expand opportunities for success in various domains. Scholarly consensus highlights the operational and relational modalities for initiating and realising empowerment processes, with recurring terms including participation, facilitation, trust, delegation, emancipation, sharing, encouragement, collaboration, optimism, and tolerance (Francescato & Burattini, 1997). Rappaport defines empowerment as a multidimensional social process enabling individuals to attain greater control over their lives by actively participating in their social and professional contexts. Etymologically, the term empowerment originates from "to empower". meaning to endow with power. For the beneficiary of such a process, it signifies "full awareness," inclusion, and comprehension. It is within this precise connotation that the entire process of storytelling can be anchored. The ability to participate meaningfully in knowledge transfer processes, especially those concerning cultural heritage, art, archaeology, and history, is crucial for diverse audiences who have different interests and may lack the foundational cultural framework required for comprehension. Without empowerment, users are likely to become distracted, disinterested, or bored, leading to limited emotional involvement (engagement). This article therefore explores the potential implications related to the concept of "full comprehension" of the subject matter conveyed during a narrative (storytelling), alongside the concepts of awareness, persuasiveness, and pervasiveness, all situated within a comprehensive framework of scientific rigor supported by philological approach applied to the representation of data. The theoretical aspects

related to the tools and codes of narration are fully realised in a recent case study, which is presented in paragraph 3 of this article. The reconstruction of the archaeological site of Manduria has proven to be the most suitable context for the application of these theoretical principles. The project's commissioners required content that was universally accessible, easy to use, emotionally engaging, and capable of providing visitors with a lasting educational experience, delivered through modern communication technologies. In addition to the technological solutions employed to enhance the accessibility of the Manduria project, all paradigms of emotionally engaging storytelling (Fig. 1) and compositional strategies were incorporated to capture the attention of visitors, regardless of their cultural background or level of interest (Gabellone & Chiffi, 2024).

1.1 The transmission of cultural messages whith emotional engagement

The countless forms of digital output and processing, facilitated by contemporary information technologies, offer new perspectives on the transmission of cultural messages. The rapid emergence of innovative forms of representing ancient contexts has established new standards in visualization, significantly shifting cultural offerings towards digital languages that require active public engagement (Lindsey, 2017). This development does not merely replace traditional communication paradigms based on images and text but introduces a more intricate cultural mediation framework that profoundly engages the audience's senses, attention, and comprehension. Immersive mediation systems, such as virtual reality, differ fundamentally from traditional methods like reading a book because they engage multiple levels of consciousness during the message transmission. A defining feature of virtual reality experiences is the strong engagement they produce, as the perceptive environment and interaction with characters can be shared with other individuals. Immersive experiences and active methodologies enable users to independently navigate knowledge pathways yet often intersect unpredictably with the experiences of others. These technologies, characterized by their interactive, participatory, and immersive nature, are frequently augmented by non-interactive, passive tools that still elicit emotional engagement in users. Storytelling certainly stands out among technologies that enhance cognitive functions as the most representative and effective form; it transforms narration into a tool through which we interpret the complexity of reality (Lindsey, 2017). Storytelling is frequently defined as a cognitive instrument (Gabellone, 2021), capable of constructing, transforming, and transporting us into distant environments, generating cognitive artefacts that facilitate the comprehension of complex messages. Nowadays, storytelling is aimed at a variety of multimedia and literary works, capable of conveying 'stories' constructed from scientific data, reality, both past and present, or pure invention. Roland Barthes (Barthes, 1966) observed that narrative is akin to life: "it exists in itself, it is international, trans-historical, trans-cultural." Humanity entered the civilization we know when it learned the art of storytelling. "Stories exist in all times, in all places, in all societies. The narrative begins with the very history of humanity itself.

Fig. 1: A dramatic frame with the dead of Archidamus III. In evidence his shield, with *dókana*, symbol of the Dioscuri.

There has never been, nor will there ever be, a people without stories. We recount our past through storytelling, just as we shape the present through ongoing, and often conflicting, narratives. In much the same way, we envision the future. Storytelling is far from being a mere sequence of events; rather, it represents a persuasive art form aimed at drawing attention to visual elements, connotations, and allusions designed to elicit an emotionally engaging outcome. Narratives enable us to explore the infinite possible meanings of actions through the variable connections that can be established between antecedents, coincidences, consequences, and implications. Walter Benjamin (Benjamin, 1936) warned against conflating narration with information, asserting that "if the art of storytelling has become increasingly rare,

the proliferation of information has played a decisive role in this." From this perspective, narration (Fig. 2) differs from information in one crucial aspect: it does not offer a singular explanation but remains open to multiple interpretations. Enhancing interest in specific topics through various forms of communication and storytelling, leads to a greater awareness among the audience.

A significant example in this context is provided by the use of immersive technologies such as AR, VR, and XR, combined with persuasive storytelling.

Fig. 2: The various scenes that make up the narrative show many of the protagonists of the battle between Taranto and Manduria. The polemarch is representing here.

These two approaches, though seemingly distinct—the former being active, the latter typically passive—are united by their ability to engage audiences. Active immersion, achieved through AR, VR, and XR headsets, creates a strong sense of presence within the virtual environment (Debailleux, Hismans & Duroisin, 2018). The realism of the representation and the near-physical interaction with three-dimensional elements enable a natural and direct understanding of architectural features, figurative components, and spatial organisation of ancient contexts. Conversely, in "persuasive" films, the passivity of viewing is counterbalanced by an emotional approach that engages the viewer in an informational journey where, despite the inactivity of consumption, they remain actively involved through emotional connection. This type of viewing does not require technical expertise and seamlessly integrates with various media, including traditional ones, within a "light," yet effective, learning framework. In this sense, the multimodal approach offers benefits even for those with limited familiarity with digital tools and the internet. Consequently, the diversification of media and the use of simplified language allow for broader comprehension of the communicated message, while also catering to the diverse preferences of visitors. This reflection should not lead to the conclusion that active technologies are overly complex or difficult to use. On the contrary, it highlights the evolving role of museums and archaeological parks as multifaceted communication hubs and centres for cultural production and promotion. Their role is certainly not limited to the mere conservation and display of objects, but extends to their ability to establish an effective dialogue with the social and cultural context, positioning them as primary cultural tourist attractions. The evolution of communication methods in the museum context is a result of broader shifts in the languages used in social communication (Russo, De Fino, et al., 2024). Persuasive forms of communication, rather than purely informative and explanatory ones, seem to align more closely with the principles of an engaging, convincing, and emotional presentation.

These forms of communication create emotions by interacting with human feelings, sharing stories that convey knowledge and experience in a simple yet effective manner. The persuasiveness and communicative effectiveness of these solutions have been confirmed by renowned learning theorists. These studies reveal that adults remember 10% of what they see, 20% of what they hear, 50% of what they see and hear, and 80% of what they see, hear, and do, namely, things with which they have an empathetic or interactive relationship (Caon, 2016). Through communication forms that employ audio and video, we can draw attention to key narrative elements and activate pre-existing mental frameworks (Shaw & Robertson, 1997).

2. *The Boundaries of Scientific Storytelling in Virtual Archaeology*

Archaeological reconstruction refers to the process of study that, based on a heterogeneous dataset, culminates in the definition of a tangible proposal for the morphological, stylistic, or functional aspects of an ancient context. In this process, the rigor of preliminary study methods constitutes the fundamental prerequisite for achieving a plausible and reliable solution. However, this alone does not ensure a definitive result immune to exceptions.

The virtualization process reproduces the physiognomy of studied monuments through

deductions that prioritize a specific "point of view" which here will be identified with the term interpretation. Consequently, the resulting representations may vary significantly, sometimes to the extent of making the different reconstructions of the same object unrecognizable. Interpretation is, as we know, the logical outcome of a critical evaluation of a substantial body of data to assign meaning to phenomena or expressions that are not explicit, relying on partially evident informational elements.

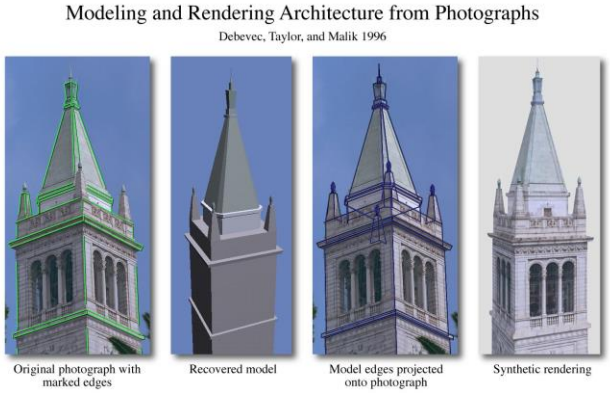

Fig. 3: The Campanile project introduced a key innovation in the field of photogrammetric reconstruction

This process, as already mentioned, evolves with advancements in knowledge but also in relation to more complex dynamics that shape methodological orientations within a discipline, primarily influenced by experience. Furthermore, an additional factor makes the reconstruction process even more precarious, confronting it with two opposing tendencies. Very often there is a cautious and hyper-philological approach (Gabellone, 2019) advocating the exclusive use of incontrovertible data, favoring a neutral language for representing sections with no surviving archaeological evidence. On the other hand, one sometimes witnesses the opposite temptation, that is, to embrace approximation and analogy method too easily. This inclination is perhaps fueled by a desire to showcase results using the powerful tools of new technologies, presenting the public with 'something more' than a simple drawing. Regardless of the approach, reconstruction processes inherently involve a degree of uncertainty, as one of their core objectives is to propose plausible solutions. For a virtual reconstruction to be scientifically accurate, it is necessary to consider a process analogous to philological methods in which the interpretation is a logical consequence of the collected data, critically highlighting additions and assigning qualitative values to various proposals, akin to a philologist's use of ellipses or bracketed interpolations.

This approach remains rare today, and such standards were frequently absent in the past. For example, archaeological reconstructions in the 18th and 19th centuries were often highly speculative and guided more by romanticism than rationality. In more recent times, reconstructions have taken on increasingly technical contours, evolving into hyper-realistic, immersive, emotional, and persuasive forms. In this emerging discipline, now called virtual archaeology, the final level of reliability must always occupy the central focus of every reconstruction process, ensuring rigorous scientific formalization of interpretative solutions. Virtual archaeology, a relatively recent discipline, owes much of its development to the rapid advancements in information technologies. It has been heavily influenced by the ongoing transformation of archaeological research, where purely descriptive approaches have been supplemented by interpretative hypotheses. These, in turn, with the contribution of different knowledge, have been progressively enriched through interdisciplinary visions and broadened toward more expansive reconstructive hypotheses (Gabellone, 2021).

The unintended consequence of this evolution has been the flattering influence of the informatics environment, which has inevitably led to the proliferation of dazzling digital renderings and 3D images now populating the web. The undeniable allure of this new discipline has attracted a wide array of neophytes who have produced a significant number of often fanciful reconstructions, but often ignoring the theoretical reflections developed over the years.

Among the most impactful and significant experiences that have literally changed the paradigms of 3D scene production and rendering, both in terms of virtual reconstructions and representations of real-world contexts, we must mention the advent of HDRI technologies and unbiased rendering algorithms, as applied in projects such as *"The Campanile Movie"* (Debevec, 1996) and *"The Parthenon Project"* (Stumpfel 2003) (Fig. 3). These studies have effectively set new technological standards in the rendering of 3D scenes applied to Digital Heritage, shifting

Fig. 4: The entire archaeological area of Manduria messapian site

content from cold, technicist environments to cinematic-level simulations. Despite these advancements and the renewed appeal of 3D-based reconstructions, there has been a proliferation of reconstructions lacking scientific oversight, where the technological component at times overshadows the very purpose of virtual archaeology, which must always remain grounded in scientifically rigorous communication. Unbridled reconstructive imagination frequently results in incongruous and poorly conceived representations, with the addition of scenic elements that evoke theme park recreations, "The archaeological Disneylands".

Consequently, digital reconstructions are often dismissed outright, indiscriminately equated with such fantastical theme park-like productions. Representations which are far from rigorous scientific production. Paradoxically, despite the undeniable risks of encountering speculative or fantastical solutions, this might represent the most intriguing and novel aspect of virtual archaeology. The potential lies in proposing plausible solutions that return reconstruction to a purely didactic domain (Valzano & Mannino, 2020). Here, the focus shifts toward facilitating the semantic interpretation of ancient structures, employing media capable of reaching everyone.

This requires an approach that seeks to deduce the information gaps by deriving data from stylistic and compositional comparisons with contemporaneous elements, seeking affinities among documented features to propose a coherent framework consistent with the architectural and stylistic language of the studied object.

3. *From Theory to Practice: the reconstruction of Manduria in Messapian age*

An emblematic case that demonstrates how theoretical principles can be applied to fieldwork in order to achieve constructive results was recently completed at the Archaeological Park of Manduria. All the results presented here were achieved in the project "MESSAPI IN RETE, Miglioramento della Fruizione dell'Area Archeologica di Manduria, PON Cultura e Sviluppo FESR 2014-2020", under the patronage of Soprintendenza Nazionale per il Patrimonio Culturale Subacqueo and under scientific direction of Government Archaeologist Laura Masiello. The city of Manduria, in the province of Taranto, is notable for its three defensive circuits and an extensive settlement dating to the Messapian period (Fig. 4).

The intricate reconstructive activities have largely been incorporated into two main informational tools: the WebApp for visiting the Archaeological Museum of Manduria and the WebApp for on-site

visits to the archaeological area through Augmented Reality (AR) technologies. The primary mode of visiting the Museum is facilitated by a web-based application that links necessary information about the exhibited objects and the distinctive features of the discoveries to multiple stopping points. The proposed solution for the WebApp is based on the development of in-depth content organized around thematic clusters: the world of women, warriors, and children, with individual sections that open “windows” into the current urban fabric where significant archaeological contexts have been found. The display cases are connected to textual insights, videos, sign language (LIS), surveys and 3D reconstructions, all of which can be managed in real-time on any device (Fig. 5).

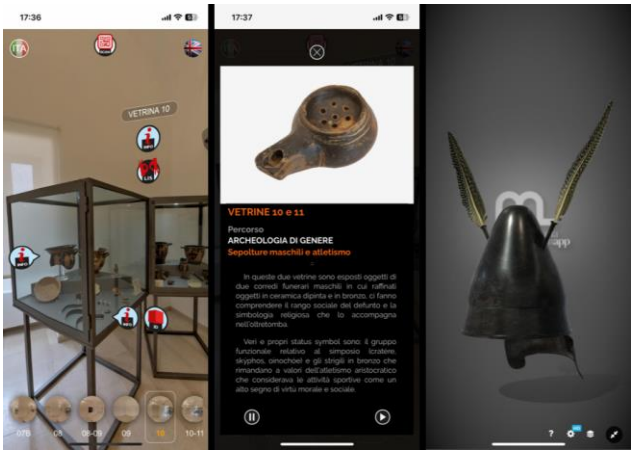

Fig. 5: The WebApp for the museum visit offers in-depth information on the objects, 3D exploration of the objects, and LIS videos for the deaf.

The visit is enhanced by additional features, including immersive stereoscopic viewing on compatible devices (primarily VR headsets) and a live tour guided by a remote operator, a particularly intriguing mode of visit that allows participants to share real-time environments in full resolution across the devices they are using during the tour. For the visit to the archaeological area, a second WebApp has been developed, which combines ultra-realistic 3D reconstructions with live viewing obtained from next-generation smart glasses (Epson Moverio BT40s) (Fig. 6). Special attention is given to scene lighting and the creation of a setup that replicates the exact lighting conditions present in the actual photographic capture, ensuring a seamless integration between the reconstructed elements and the real site. This approach allows for the visualization of various reconstructed monuments within their original context, with the visit being fully guided by the application, which leads the user step by step towards an exhaustive understanding of the archaeological findings. The Augmented Reality (AR) mode designed for the archaeological site of Manduria provides a non-obtrusive experience, offering an overlay between the real world and virtual informational elements (multimedia content, geolocated data, analytical data, etc.). This environment allows for the addition and visualization of multimedia elements that "augment" real-world information, which can be accessed and displayed through mobile devices such as the latest smartphones and immersive headsets (Fig. 7).

Fig. 6: The AR tour uses state-of-the-art smart glasses, which accompany the visitor throughout the entire tour. This allows for a completely self-guided tour.

But what methods have been employed to enable the user to engage with scientifically rigorous content? What techniques have been used to ensure a depiction that is seamlessly aligned with reality, and what sources have been drawn upon to convey a moment from the past through a single image? As with any virtual archaeology project, the fundamental informational basis for reconstruction is derived from surveys. This may seem like an unnecessary clarification, given that no one would undertake an archaeological reconstruction without a fundamental understanding of the metrics involved. However, in this case, this phase is essential because it achieves two significant outcomes: first, the metric consistency of the reconstruction, and second, the spatial consistency of viewpoints and Field-of-view associated with the AR WebApp. Without a three-dimensional survey base, it would not be possible to correctly align the current state with

the reconstruction, nor could the position, viewpoint, and virtual camera's field of view be recreated within the chosen environment. The survey thus covered all areas subject to reconstruction (Figg. 7-8). A drone-based acquisition system (Parrot Anafi with a 21 Mp camera) was employed, with automation of the photogrammetric survey process managed by the Pix4D Application and processed within Metashape (Fig. 9).

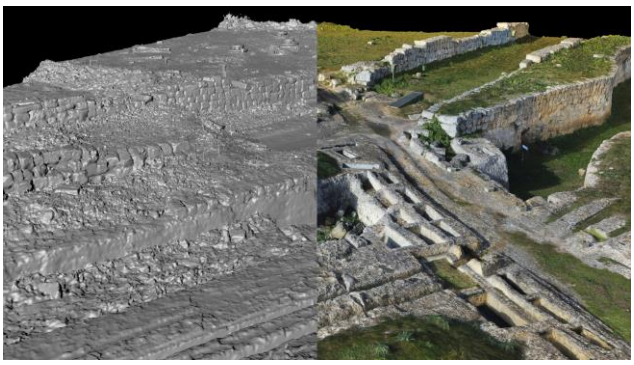

Fig. 7: Photogrammetric survey performed by drone, fundamental support for the knowledge and for the correct positioning of the points of view.

Fig. 8: Photogrammetric survey of Fonte Pliniano. The 3D approach guarantees great freedom in video shooting and the correct positioning of viewpoints in AR.

The flight, conducted at a height of approximately 10 meters, allowed for a mesh resolution of around one centimetre. To be more precise, the smallest triangle of the acquired mesh measures approximately one centimetre along its longest side. The survey also facilitated the study of masonry and the correct arrangement of blocks, seemingly random, yet adhering to a very precise logic, with alternating courses of head and cut blocks. The three-dimensional survey, also photogrammetric in nature, was conducted for all objects appearing in the animations, some of which were virtually restored to present them in their original form (Fig. 10). This simple yet effective measure enables the availability of "virtual actors," speaking objects that, within the communication systems described earlier, allow for a far richer and more accessible understanding than a mere description would provide. The reconstructive process therefore involved the architectural heritage of the Archaeological Park, which, while vast and significant, is of fragmented technical-functional intelligibility.

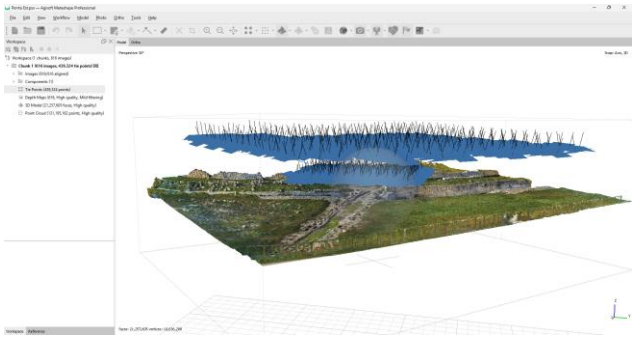

Fig. 9: The drone survey (used for the photogrammetry) of the east gate required two flight passes at different altitudes. This allowed for an increased level of detail in the areas of greatest interest.

Each reconstructed element was integrated within the ancient landscape (Fig. 11), as well as military architecture and war scenarios, ancient rituals, clothing and equipment of the characters depicted, it was based on the meticulous analysis of different types of ancient sources (par. 4 onwards). It is crucial to highlight how the discovery of new and relevant archaeological structures emerging from recent excavation campaigns has necessitated a reworking of some fundamental functional and chronological hypotheses regarding the contexts to be reconstructed. A useful and real-time update of already-known scientific data, focused on the so-called "Heroes' path" with a new necropolis sector aligned along it; the anchoring systems for the wooden door hinges in the inner east gate, and the uncovering of large sections of the wall built in the 4th century B.C. using the refined technique of *anathyrosis*, within the ditch of the oldest circuit. The challenge was to break down and reassemble into comprehensible diachronic and functional sequences the many visible clues, but unfortunately placed on a single perceptual level that is difficult to "read" and interpret for a non-specialist audience.
All of this demonstrates how scientific rigor and emotionally engaging narration can productively attain the same dignity as a scientific publication.

Fig. 10: In this frame, the reconstruction of the Messapian bronze belt ("cicada" hook type) can be seen, an object of great historical and archaeological interest, almost overlooked by the visitors of the museum. In the reconstruction video, the object is described and represented in 3D, an approach that is useful for the understanding and enhancement of the artifact.

This, in fact, encapsulates the ultimate purpose of this discussion: to shield narrated content from the often-hasty judgments of critics who dismiss these expressions as being of lesser value than a written book. The criterion employed here is largely philological, but the reconstruction of the archaeological evidence present in the Archaeological Park of the Messapic Walls of Manduria encompasses a very diverse range of findings, in some cases, characterized by limited information that does not always allow the adoption of the most rigorous criteria as previously outlined. Setting aside the rejection of reconstruction that would undermine the enhancement and understanding afforded by emotionally engaging narratives, the project employed a philological method for certain elements and an analogical approach (based on comparison) for contexts where reconstruction relied on knowledge derived from established literature.

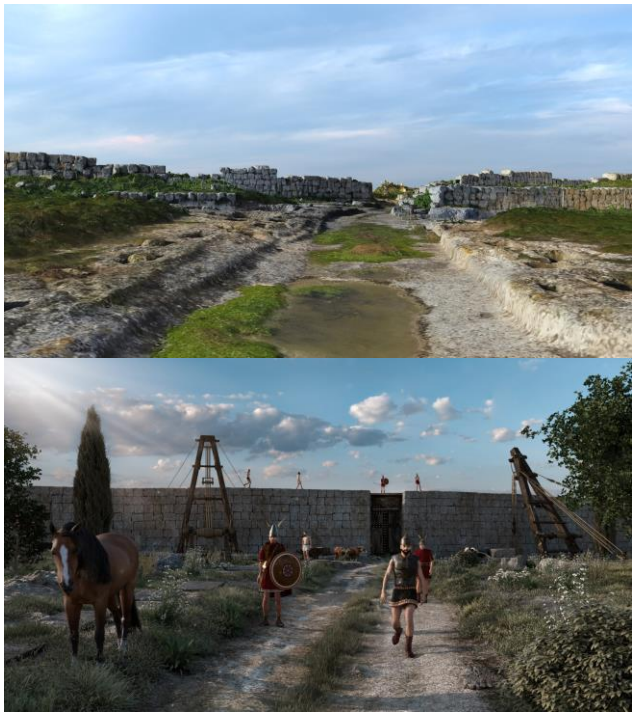

Fig. 11: An example of the method based on a fully 3D approach. Above, a view of the current state of the east gate. Below, a virtual reconstruction from the same point of view. This approach allows the reconstructed structures to be precisely superimposed onto the real-world context.

The 'typological' reconstruction criterion was only rarely employed due to its lower reliability, as it involves proposing solutions based on generic references to 'building types,' namely architectural complexes where only the canonical constitutive elements can be reconstructed and into which the discovered fragments will be integrated. The ultimate goal in all cases is to provide information in visual form that is easily accessible to non-specialists, illustrating how a functional element or broader context might have appeared in antiquity (Fig. 12). The reconstructions depict these points of interest, presenting them in a "narrated" form, not only from historical and archaeological perspectives but also from social and cultural viewpoints, Each area under study has been analyzed to provide a plausible interpretation that highlights detailed aspects while underscoring the significant heterogeneity of information uncovered through archaeological

and historical research, elements contributing to a comprehensive understanding of the spatial and temporal contexts of the findings.
Virtual archaeology plays a pivotal role in facilitating the distribution and representation of information, not only through the faithful representation of locations but also by incorporating evocative elements that revive ancient rituals, relationships between past and present, and suggestions evoking the *genius loci* of a millennial-old history.

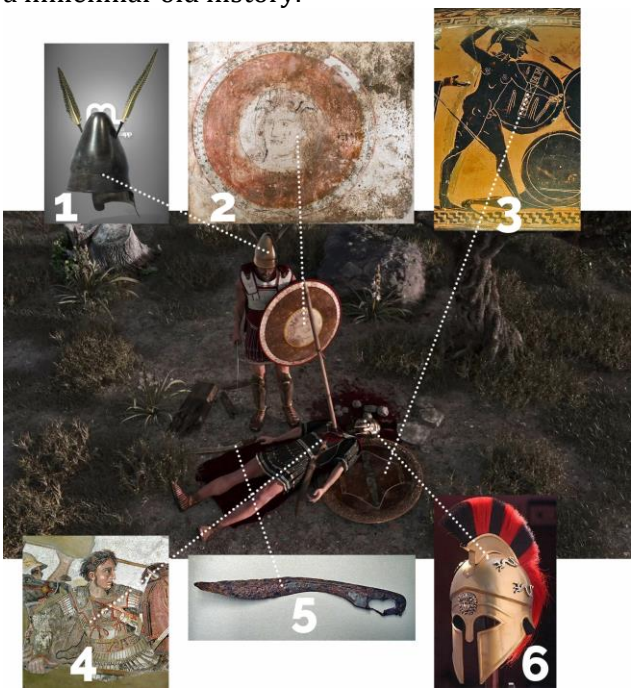

Fig. 12: An example of the philological approach to reconstruction. 1. The messapian helmet exposed into the Manduria Museum (integrated). 2. Emblem with gorgon on Messapian shield, from paintings in tomb 12 Egnazia (MANN), 3rd century BC. 3. Detail of the inside of the shield from an Attic black-figure vase. Cleimachus Painter, 560-550 BC, Louvre Museum. 4. *Linothorax* of Alexander the Great, detail of mosaic of Issos battle found in Pompei, today in MANN Museum. 5. Iron *kópis* (MET SF2001346, Metropolitan Museum of Art, New York). 6. Late Corinthian bronze helmet (reconstruction).

Our journey brings to life objects displayed at the Archaeological Museum of Manduria and archaeologically significant remains such as the *Via degli Eroi*, the double-gate area, necropolises and funerary rituals, the Fonte Pliniano, and, most notably, the different phases of the monumental walls. Interdisciplinary contributions have allowed the integration of specialist knowledge on rituals, construction details, and animated scene components with the capabilities of 3D technologies, offering a possible interpretation that remains firmly grounded in scientific rigor.

The reconstruction process revolves around the acquisition of archaeological data and the availability of detailed surveys, all conducted using digital photogrammetry. This method has been applied not only to the extensive areas of the park but also to artefacts housed in the museum, which were fully reconstructed in 3D and made accessible for public use through a web application, WebApp, requiring no downloads of additional resources. Through the use of the latest generation augmented reality headsets, visitors can observe the original appearance of the walls, transparently and directly on-site and watch animated stories while interacting with three-dimensional scenes. This is a "transparent" technology that does not disrupt the environment but rather enhances its features, history, and uniqueness. It serves as a significant tool for the dissemination of scientific knowledge, education, outreach, and the valorization of cultural heritage, conceived to promote knowledge and contribute to the sustainable growth of the territory.

All these aspects, as already mentioned, in order to be acceptable and valid from a didactic and entertainment point of view, must be supported by an extreme scientific rigor, based largely on the philological criteria. These aspects are described in detail in the following chapters. [F.G.]

4. Storytelling with scientific rigor

There is no sequence of the reconstructed scenes that does not conceal dozens of specialized studies that the archaeologist is called upon to master and decode into instructions useful to content creators so that the final product faithfully reproduces technical specificities and diachronic differences of objects, characters and historical-archaeological situations. And this by filling the inevitable gaps in his investigations through concrete comparisons and multi-faceted analyses, where respect for what is attested and the diachronic placement of events and phenomena lead to solutions that are not univocal but plausible within a scientifically founded and reasoned range. Results that above all are highly understandable to a public that is mostly unfamiliar with scientific content and language. A significant effort of synthesis and communication that archaeological consulting has carried out in detail towards a highly educational product, without sacrificing the scientific accuracy of the reconstructed situations.

The reconstruction process has involved the architectural heritage of the Archaeological Park, imposing but of fragmentary technical-functional intelligibility, as well as the ancient landscape within which the scenes are immersed, both from a geomorphological perspective and a vegetational one that can be hypothesized for the despicted period. For military architecture in particular, comparative studies of the many fortified centers present throughout the Mediterranean were employed, and for environmental contexts, specific paleobotanical studies were referenced. For the clothing of the characters and the equipment of the soldiers, extensive reference was made to the vase representations and wall paintings from Italic (Pontrandolfo & Rouveret, 1992), Spartan army (Cartledge, 1977) as well as to apulian archaeological finds of weapons and elements of the panoplies (Mannino, 2004).

Fig. 13: The Plinian's well into the AR narration

In all cases, a detailed analysis of ancient sources- both historical and literary, as well as treatises- was undertaken to formulate the most credible historical and technical hypotheses, analytically employed in the fine-tuning of reconstructions of architectural (walls, ditches, gates, tombs, waterworks) and situational (funeral rites, battle, building site scenes) details, as well as in dozens of actual reconstruction restorations of archaeological finds kept in the museum. Some of these contents, adapted for educational purposes, was also used in the writing of the storytelling, narrated by a voice-over. The virtual paths thus constructed between augmented reality, explanatory schematizations, and historical-archaeological information unfold at points of observation (the P.O.I.) of particular monumental concentration (Desantis, 2023).

5. Detailed discussion about philological approach

5.1 Plinian's Well

The first and most representative monument of the city of Manduria is undoubtedly the so-called Fonte Pliniano (Fig. 13), whose external structure associated with an almond tree (which seems to have had cultic values in the Messapian age), represents the heraldic effigy of the city.

The aspect that more than any other needed to be made explicit to the visitor is the hydraulic functioning of the phenomenon described by Pliny the Elder (*N.H.*, II 103, 226), which has an almost underground development and therefore not visible. Many scholars tried to give a scientific explanation to this phenomenon, considered prodigious, but only the cartographer Giuseppe Pacelli (Pacelli, 1810) and the naturalist Oronzo Gabriele Costa (Costa, 1884) managed to give the most convincing interpretation. The handmade drawings (plans, sections) and the arguments and empirical experiments of these two scholars were used to support their theories, not without taking into due account more recent hydrogeological studies.

5.2 The East Gates

This is one of the districts of the Archaeological Park that is richest in visible clues, but whose diachronic and functional reconstruction presents itself on a single plane represented by the remains of walls, necropolises, and tombs that are difficult to understand for a non-specialist audience.

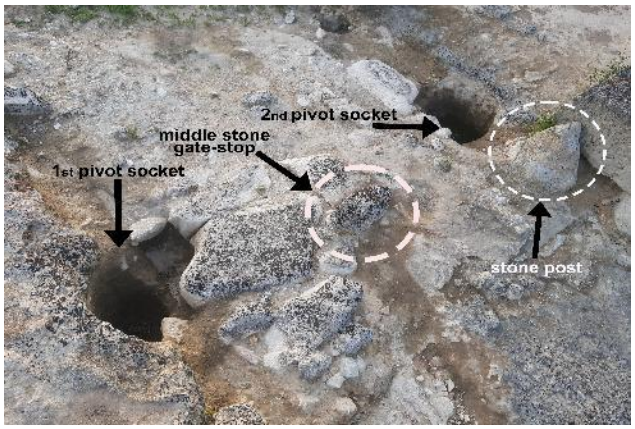

Fig. 14: Wooden door anchoring system east gate internal walls

It should be emphasized that the uncovering of new and significant archaeological contexts and structures that emerged from recent excavation investigations (particularly in the area of the east gates and in the far western part of the park) has

necessitated the reformulation of some fundamental functional and chronological hypotheses (dating back to previous acquisitions from the excavations of N. Degrassi in the last century, Degrassi 1961) of the contexts to be reconstructed, and this is ongoing. The particular concentration and complexity of the selected contexts, as well as the peculiar characteristics of the defensive structures of Manduria, have thus led to an update of the already known scientific data, with a fruitful real-time impact on the reconstructions carried out. The rediscovering of two deep hole as pivot sockets with a middle gate-stop between two stone-post in the eastern opening of the inner circle (Fig. 14), has allowed for a precise placement of the wooden door, set back from the profile of the walls and positioned inside an oblique funnel corridor, to strategically reduce the impact force of enemy armies during a siege.

Fig. 15: Internal locking system of a wooden gate door

Here (as well as in the Double Gate), a focus of in-depth study has been inserted on the structure of the imposing double-leaf doors and their internal locking systems (Fig. 15), for which the reconstruction was able to rely on descriptions from written sources and iconographic references from pottery. The greater vulnerability that the doors presented to external attacks led to the development of mechanisms and technical expedients to counteract the danger. In addition to lateral turreted bastions (as in the case of the outer circle gates), the wooden elements of the door were covered with metal plates to prevent them from being sawed or set on fire. Complex internal locks were devised, such as one that used metal pins (*bálanoi*), inserted into sockets (*balanodóke*) that passed through both the crossbar (*mochlós*) and the door itself, which could only be extracted by a special metal key (*balanágra*). Regarding the internal closing solutions for the wooden gates of the walls, reference has also been made to Hellenistic treatises (*Aen. Tact.* XVIII), while for anchoring systems both to the ground and on the door lintel, specific studies have been referenced (Haddad, 2016) and those studies known in similar functional structures within domestic contexts, observable on stone thresholds, such as in Megara Hyblaea, where moreover, along the southern side of the Hellenistic walls, the central gate shows surviving traces of a complex hinge-roller and stop-posts system very similar to that of the inner east gate of Manduria (Scalisi, 2010).

Fig. 16: Reconstruction of the internal space between the two eastern gates along the "Heroes' Path"

A perfect example of oral transmission of technical knowledge, as formulated in the famous theory of the "tribal encyclopedia" (Havelock, 1963), is in Book XII of the *Iliad* (vv. 453-462), where the description of Hector's superhuman assault on a gate of the Achaean fortifications provides us with a detailed manual of the structural components, both wooden and metal, as well as those related to the frame's anchoring, allowing us a valuable functional differentiation of technical terms often used elsewhere as generic synonyms. In particular, the so-called "*thairói*" (*strophéus* in classical age as sokets/pivots/axis, Dieu 2024) draw our attention. These were the pivots that rotated within cavities carved into the threshold and the intrados of the lintel: they served the same purpose as hinges, keeping the door in position and allowing it to rotate.

5.3 The "Way of the Heroes"

Near the dense district of the eastern gates, the uncovering of tombs aligned with the ditch of the inner circle, along a majestic roadway, reveals a desire for monumentalization of this sector of the necropolis, which has been given the evocative name of "Way of the Heroes" (Fig. 16). This communicative expedient is based on the

hypothesis that those tombs (for multiple burials) may have been conceived to honor those who distinguished themselves in the victorious conflict against the Spartan army during the battle of 338 BC . If confirmed by the excavation data of the tombs (found intact), this hypothesis would provide a contex of strongly symbolic architectural and "urban" solutions, resulting from a significant identity maturation of the Messapic Manduria in the 4th century BC. And it is precisely in one of these tombs that the sequence of deposition on a wooden *klíne* has been set, during the burial phase. Just as it has been rebuilt right here in augmented reality, a suggestive observation point between the two walls and the two eastern gates, in a nocturnal setting populated by sentries guarding both the gates and the sacred area. The latter was located along an intramural ring-road that connected important structures, also from symbolic and religious points of view, such as the Double Gate and the Plinian's Well.

Fig. 17a-17b: War aulet surrounded by hoplites. Above, the Chigi Olpe (640 BC) which inspired the scene.

5.4 War aulete

We know of the Spartans' preference for the use of the double *aulos* as an instrument used in wartime. The aulete wore the *phorbéia* (Latin *capistrum*), a strap-like harness, generally made of leather, with holes at the level of the lips where the mouthpieces of the instrument were inserted, which helped maintain constant air pressure in the musician's cheeks, and which was usually worn by professional auletes. Just as from the precious vase representations (for example, the Olpe Chigi) (Figg. 17a-17b). In the noise of the battlefield, their role was crucial for signaling strategic movements such as advances, attacks, or retreats. They were young, often little more than adolescents, mixed in with the infantry and marched in rhythm between platoon and platoon. At the right moment, they would raise the reeds of the aulos to produce a broader and more intense sound. They were considered specialists of high social rank (D'Acunto, 2013). For the sound, a few intense seconds of harmony by Max Brumberg, a builder of historical flutes and harmonic musician, were used. A true dirge of death, harsh and merciless. For the Spartans, it was a technical signal of order in battle (Tuch., V 70), but it was also meant to instill courage and valor. For the enemies, this sound seemed to come directly from the underworld, a full-blown prophecy of death, "...*a performance at the same time solemn and dreadful*..." Plutarch defines it (*Lyc.* 22,5).

Fig. 18: Panathenaic black-figure amphora (detail), 525 BC (British Museum). Javelin throwing position, with two fingers inserted into the strap eyelets.

5.5 Peltasts

Archidamus III arrives in Taranto in 344 BC, commander in-chief of an army made up mainly of mercenaries (Diod.63, 1; Theop. FGrHist. 115, 232). And among them essential was a large contingent of light infantry made up of the "Peltasts", so called by the "*péltai*" their particular shield in the shape of a crescent moon, covered in leather or wicker. In the sequence of the battle they were therefore armed with javelins ("*akóntion*"), of which the accurate dynamics of grip ("*ankýle*") and throwing have been recreated, well known from written (Plutarch, *Phil.* 6,9) and iconographic sources (Fig. 18) (Murray et al., 2011).

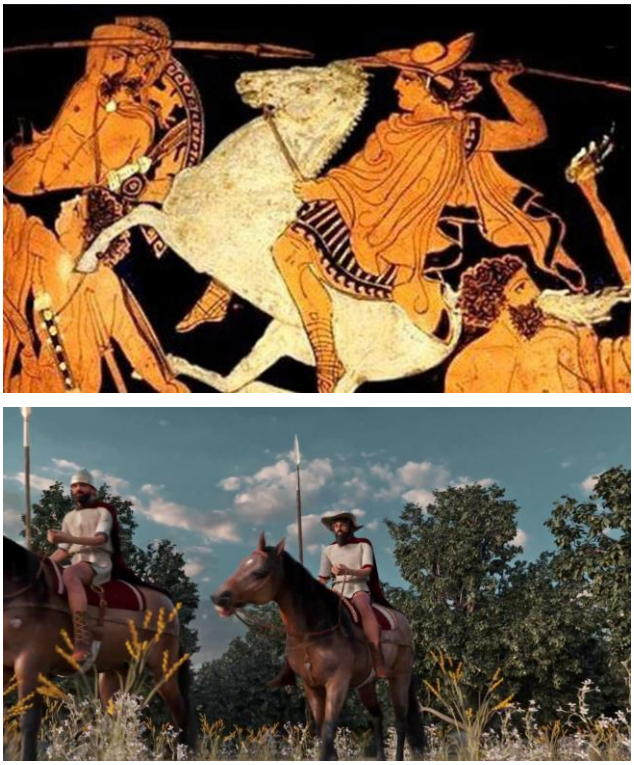

Fig. 19b-19a: Taranto's knight with a *pétasos* hat. Above a vascular image based on the reconstruction (Athenian red-figure amphora c. 4th BC., Suessula Painter, Louvre Museum)

5.6 Tarentine Cavalry

A contingent from Taranto certainly took part in Archidamus III's expedition, including his hoplites and mercenaries . Two cavalrymen from Taranto were chosen due to the great prestige that this special corps ("*hippómachoi*") enjoyed in ancient times. The two Tarentine cavalrymen are depicted here wearing a "*pilos*" headgear and a hat called "*pétasos*" the latter typical of travelers and hunters, but also of cavalrymen all over the Grece (Fig. 19b). The references are the monetary series and Tarentine friezes, as well as vase representations that sometimes depict the Dioscuri equipped with *pétasos* (Fig. 19a) (Lippolis, 2009).

5.7 Archidamus III

The figure of Archidamus III has been constructed with particular attention as it is the focal point of the narrative progression, where the Spartan king is indeed a historical leading figure of the recalled battle of 338 BC (Fig. 20), but also a subject through which multifaceted symbolic aspects should be concentrated, which in extreme figurative synthesis refer to a sort of iconographic enviroment that the visitor-user can also find in artifacts present in the Archaeological Museum.

Fig. 20: Archidamus III leads the Spartan army in the face of imminent attack.

Two key themes of dense significance are considered: the peculiar devotion of Spartans and Tarentines towards the Dioscuri (particularly in their role as protectors of the Spartan kings in war) and the belonging of the "foreign" leader to the noble dynasty of the Eurypontids, direct descendants of the hero Heracles. Specific emphasis has therefore been placed on the emblem depicted on the shield of Archidamus III (Fig. 21c), the so-called "*dókana*" (Guarducci, 1984; Lippolis, 2009) an ancient and complex wooden cult instrument (Fig. 21b) that is a symbolic and aniconic representation of a precise ritual code intended for the Tyndarid twins, whose effigies the Spartan kings carried with them into battle since ancient times (Hdt, 5, 75). The *dókana* seem to schematize a door intended for the performance of rites of passage aimed at a chthonic dimension of the underworld, to which the two snakes engraved on the vertical axes refer, axes that symbolize the dual significance of both the Dioscuri and the reigning Spartan kings. This scheme was later reinterpreted as the backrest of a throne even in the Tarentine environment, where the cult of the twins, elevated to "*Ànakes*" ("Lords"), was transplanted by the Laconians as early as the time of the foundation at the end of the 8th century BC. Plutarch (*Moralia*, "*Perì philadelphía*", 34,478A) informs us that the Spartans considered the *dókana* as symbolic simulacra, whose two vertical woods would represent the stylization of the Dioscuri themselves, and the two crossbars that connect them the bonds of brotherhood between the two Twins. Their propitious role in the military context (which is of greater interest to us here) is well

represented by the legendary (and providential) theophany of Castor and Pollux who, sent by Sparta in place of the requested military contingent, in the battle of the Sagra (560-550 BC) allowed the Locrians to prevail against the Crotonians despite the latter's clear numerical superiority (Moscati Castelnuovo, 1995).

The cult of the Dioscuri and Heracles received particular boost precisely during Archidamus III's stay in Italy (344/338 BC), cults of which Taranto had always been the main radiating center throughout Magna Graecia (Nafissi, 2004). Significant evidence of the widespread permeation of the cult of Heracles even among indigenous peoples such as the Messapians, not only in tomb contexts of strongly Hellenized élite figures but also in more common contexts, is indicated by two particular artifacts present in the Archaeological Museum, which are the subject of specific in-depth sheets that users of the developed WebApp can consult. The aim is to create a cognitive background in which, within an ecosystem of integrated and interrelated references and meanings, the user can independently move from the reconstructed (a symbol on a shield as the focal point of a highly dynamic and dramatized animated sequence) to the tangible (two related objects in the museum).

On the head of one (I.G. 69819) of the many characteristic truncated pyramid-shaped terracotta loom weights found in a cistern in Via Ausonia (Alessio, 1996), there is an impressed figure of a standing Heracles with the *leonté* on his left arm. Heracles in the Italic context was venerated as a herdsman along the transhumance routes, protector of livestock and related pastoral and woolen textile activities (Meo, 2012). From a rich funerary equipment of a female figure of prominent social standing, in tumb 515 found in 1958 in Contrada Scegno, was a little coin (I.G. 113146).

It is a silver diobol (minted in Taranto/Heraklea but maybe of local imitation), dating from 335-302 BC (D'Andrea, Miglioli, Tafuri and Vonghia, 2022), of the head of Athena with an Attic crested helmet and a *hippocampus* (or *Skylla*); and on the reverse, Heracles standing, with his left knee bent, strangling the Nemean lion. What is noteworthy in the context of a funerary setting is the repurposing of the coin, which has been pierced to become a pendant-amulet with the image of Heracles (Stevens, 1991; De Callatay, 2016).

Fig. 21: a. *Guilloché* rim of a bronze shield (Athens, Agora Museum); **b.** Votive stele with emblem (*dókana*) of the Discuri. From Sparta, 5th century B.C.: **c.** reconstruction of the shield of Archidamus III with the *dókana* effigy.

5.8 Armor and shields

In reconstructing the sequence of the advance of the Spartan hoplites, particular care was taken with their attire and the treatment of the shields. We have taken into due account the reform of the panoply attributed to the Athenian strategist Iphicrates (Diod., XV, 44.4), following which the equipment of the hoplites was considerably lightened, especially of metal components, so that the infantry in particular would be more agile in battle (Xen., *Mem.*, III, 5, 25-28). Thus, for example, since bronze armor was abandoned by the Spartan army in the 4th century (uncomfortable for infantry and impossible to wear on horseback), the so-called "*linothórax*" was chosen, a breastplate equipped with epaulettes, baldric (as clearly visible on Archidamus III's herm at MANN, Fig. 22), as well as *ptéruges* (Xen., *Hip.*, 12.4), as on Alexander the Great's mosaic at MANN (Fig. 12.4). Made of multiple layers of overlapping linen that provided greater resistance to arrow penetration than bronze foil.

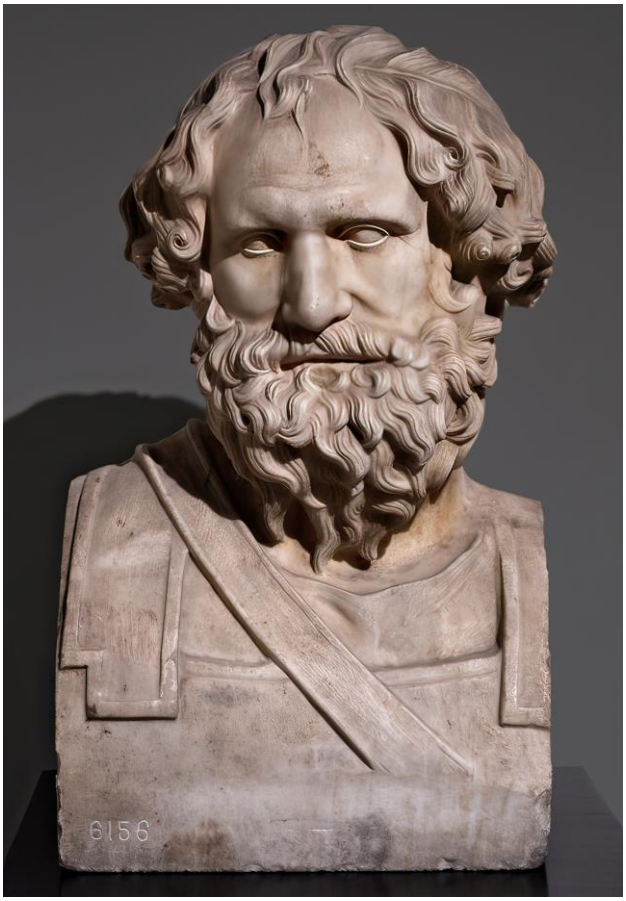

Fig. 22: Herm of Archidamus III, MANN

Not only the *epísema* of the shield of Archidamus III, but also the external and internal finishes have been designed with the meticulous detail that archaeological finds and vase representations offer us. The *óplon* thus had a concave structure, consisting originally of a core made of poplar wood and covered externally with a thin sheet of bronze, with finely worked flat rims and arabesque decorative motifs in the "*guilloché*" technique (Fig. 21a) , creating a visual effect similar to a weave. Internally (Fig. 12.3), it had a grip made of leather or rope (*antilabé*), and a ring in the shape of a metal bracelet (*pórpax*) wrapped around the forearm of the bearer to ensure a more secure grip, while a rope weave along the inner edge allowed the shield to be attached to the shoulder, on the back of the baldric, when not in use.

5.9 The double gate

At an opening along the path of the inner circle correspond two road axes that fork in the east and northeast directions and which, in turn, cross two opposing gates in the outer city wall. A double interruption of the ditch (with big staircases carved into the rock), the construction of two gates with a trapezoidal central bastion, at such a short distance, involved a significant expenditure of material and design resources (Fig. 23). This effort can be explained by the intention to create a monumental gate of high symbolic value. A junction, therefore, densely emblematic that connected external rural areas with the internal road network of the city (Desantis, 2008), through road axes that skirted necropolis areas, along which we must imagine "preferential lanes" for religious processions related to the cult of the dead and to internal sacred areas (a destination that likely included the nearby cave of the Plinian Well in Messapic times, with ritual practices dedicated to water and fertility deities).

Fig. 23: The Doble Gate, from above (Virtual reconstruction)

Fig. 24: The ritual procession in the way that comes out of the Double Gate.

The double gate must also have served a defensive function. Here, indeed, the fronts of assault doubled, weakening the striking force of the attacking army. The potential overcoming of this double access would have forced the besiegers into a funnel maneuver upon impact with the subsequent corresponding gate in the internal circuit. These two aspects, religious and military, were chosen to recreate the structure of the gate

Fig. 25: A 3D model scene without textures. This image shows the complexity of the elements used to ultimately obtain simple outputs, such as animated sequences for storytelling and pre-alculated Augmented Reality scenes

and the setting of a "procession" (Fig. 24) that, continuing northeast, passed by the burial of the "foreign bride" whose deposition and equipment have been recreated, also inspired by Greek funeral rites (Laneri 2011). [V. D.]

6. Conclusions

This article stets out the methodological premises that highlight how virtual archaeology benefits from easy understanderstandable narrative languages and "user friendly" technologies that can be used by the general pubblic, but also aims to describe the main interpretative choices, the analogies with other contemporary contexts and the historical-archaeological sources used in the reconstructive study. The results of this work also focus on the communicative effectiveness of storytelling in the field of scientific communication and especially in the field of virtual archaeology. In addition to the technological solutions employed to improve the accessibility of the Manduria project, all the narrative paradigms and emotionally engaging compositional strategies to capture the attention of visitors were described, regardless of their cultural background or level of interest. In taking the necessary dialogue of knowledge as a methodological work basis, it was highlighted how the achievement of the objectives of transmitting knowledge and the possible repercussions in the field of personal empowerment are intimately linked to various factors.

First of all, it is emphasized that archaeological reconstruction not supported by a rigorous scientific approach leads to the opposite result of the required one, i.e. to an incorrect transmission of information and the consequent failure of enhancement actions. From these considerations derive the knowledge transmission strategies used for the Manduria site: easy-to-use applications (Fig. 25), extensive use of passive media and simplified AR technologies for direct viewing of the reconstructionson-the-site. All these premises are supported by an entirely 3D approach that has made it possible to work on georeferenced photogrammetric surveys, perfectly linked to virtual reconstructions. The scientific validity of the entire operation is however closely linked to the philological approach used to reconstruct every detail that appears in the narratives and environmental reconstructions, in this treatment limited only to the most interesting examples.

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