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Virtual Reconstruction of the Temple of Olympian Zeus in Syracuse: A Journey in the Metaverse between History and Technology

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***Abstract* – This paper presents the results of a research that led to the virtual reconstruction of the Temple of Olympian Zeus of Syracuse within the metaverse. Through the integration of traditional archaeological methodologies and advanced digital technologies, the project offers an immersive experience that allows to explore one of the most significant monuments of Magna Graecia. The paper illustrates the methodological process adopted, the technical challenges faced and the educational and dissemination potential of this approach in the context of the valorization of historical-cultural heritage. Also, through Virtual Reality it is possible to visit the implemented metaverse, using Meta Quest VR headset.**

I. INTRODUCTION

The Temple of Olympian Zeus (Olympieion) [1], located in Syracuse, is one of the most important monuments of Doric architecture in Greek Sicily, built in the 6th century B.C. This architectural structure stands as a religious devotion to ancient Syracuse, representing the political and cultural power of one of the largest Greek colonies in the Mediterranean.

Nowadays, the Temple is reduced to a few archaeological remains that make it difficult for tourists and scholars to understand its original majesty. The state of physical degradation represents a significant challenge in understanding not only the architectural grandeur of the Temple, but also its deep religious significance and role in the city environment.

Through the potentialities of the 3D modeling and metaverse [2, 3, 4, 5, 6, 7], it is possible to reconstruct the temple in its entirety, bringing it back to its former splendor, thanks to the development of a complete digital space in which history is revived. This project it is not just a virtual reconstruction of the temple as architectural monument, but it reproduces a whole ecosystem through which the user can interact with the historical-cultural context in a dynamic and immersive way.

Fig. 1. Olympieion Today.

II. HISTORICAL CONTEXT

The Temple of Olympian Zeus was built during the period of the tyranny of the Dinomenids, under the reign of Hieron I. The temple served both as a memorial to the decisive victory over the Carthaginians at the Battle of Himera in 480 B.C., as a powerful symbol of the emerging Syracuse domain in the western Mediterranean.

The victory at the Battle of Himera not only secured Greek territorial control, but also provided the economic resources and political stability needed for ambitious architectural projects. The decision to dedicate this monumental temple to Olympian Zeus was deeply symbolic, connecting Syracuse to the wider Hellenic world, while affirming its particular status as a major power capable of rivaling the great sanctuaries of continental Greece.

The structure of the temple consists of 6 columns on the front and 17 on the long sides, following the canonical proportions of the Doric templar architecture adapting to local conditions and preferences.

From archaeological excavations and historical sources, it was discovered that the temple was never completed in its intended form. This incomplete state reflects the

complex political and economic circumstances of 5th century B.C. Syracuse, where building projects often exceeded the resources and stability of their rulers. Despite its incomplete state, the temple remained a sacred and political landmark for centuries, serving as a focal point for religious ceremonies and political gatherings.

Today only two monolithic columns and various fragments of the temple base remain, along with architectural elements that provide an understanding of the original structure (Figure 1). These remains offer valuable insights into the construction techniques, materials and proportional systems used by ancient builders.

III. METHODOLOGY

The reconstruction of the *Olympieion* of Syracuse [1] in the metaverse, represents an important example of connection between historical-cultural heritage and technological advancement. Through metaverse technologies, which serve as a tool to preserve the archaeological site, it is possible to relive the ancient magnificence of the temple through an engaging experience with virtual reality. The primary objective was to reconstruct not only the architectural structure, but also the cultural and religious context that characterized the site. The first fundamental step in the reconstruction process was to deepen the work of historical-archaeological research. This research phase required a careful analysis of the historical texts, that provides valuable information on the political and religious context surrounding the construction of the temple.

Thanks to the collaboration of the archaeological park of Syracuse, a survey was carried out at the archaeological site, to collect data from the place. This field work was carried out in order to collect data on the detailed measurement of the two columns and the construction material used. Subsequently, further extensive research was carried out based on data collected by expert archaeologists and historians of ancient art, maintaining a philologically rigorous approach throughout the process, to compare Syracuse *Olympieion*, with other temples of the same period and architectural tradition, including the Temple of Apollo at Syracuse and other important Doric temples in Sicily and southern Italy. This comparison made it possible to identify the likely architectural characteristics and proportional relationships that would have characterized the original structure (Figure 2).

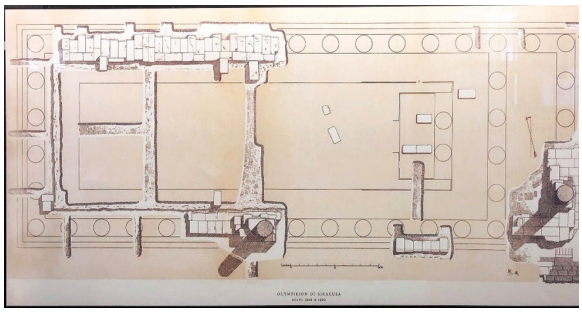

Fig. 2. Olympieion floor plan.

The second step of the reconstruction, has provided for the processing of data collected and the reconstruction of the Temple, using the open-source software Blender (Figure 3), which allowed its development and export in the format fbx, required by the environment Meta, accessible using Meta Quest VR headset [8]. This technical requirement required careful model optimization to ensure compatibility while maintaining visual fidelity and historical accuracy. The modelling process started with the creation of the temple plan, based on the data collected. Later, the inner walls, acroters and a hypothetical statue of Zeus placed on *Naos* were modelled. Finally, the number of vertices of the temple was quantified, so as not to exceed the maximum limit imposed by the metaverse, and the file was exported in fbx format.

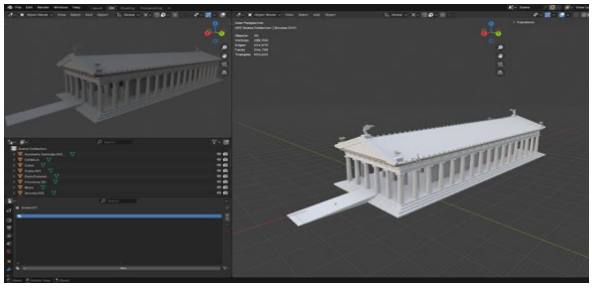

Fig. 3. 3D model reconstruction Olympieion.

The third and final step was to create, using the software Meta Horizon Worlds, the environment in which to import the model of the *Olympieion* (Figure 4 & Figure 5). This phase represented the most innovative aspect of the project, transforming the static archaeological reconstruction into an interactive and shared digital environment. The creation of the metaverse environment required careful consideration of user experience design principles, ensuring that visitors could navigate the virtual space while acquiring information about the historical and cultural significance of the temple.

Within each area of the Temple have been strategically placed NPC (Non-Playable Characters) in order to provide historical information and guide visitors through the virtual tour.

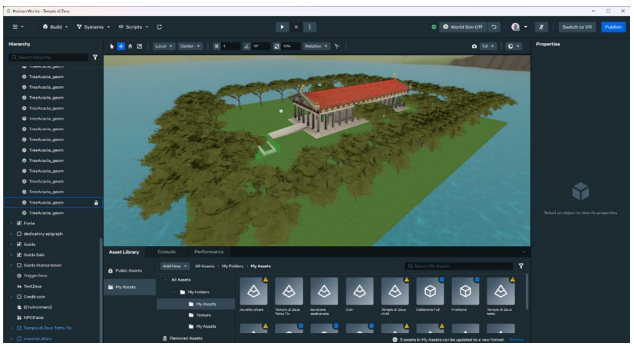

Fig.4. Reconstruction of the virtual environment of Olympieion

Fig.5. Test with Horizon Worlds

IV. RESULTS AND EDUCATIONAL AND CULTURAL IMPACT

The virtual reconstruction of the *Olympieion* in the metaverse has produced important results that demonstrate the potential of digital technologies in the conservation and dissemination of cultural-historical heritage:

A. Accessibility of cultural heritage to a global audience:
The implementation in the metaverse makes the archaeological site accessible to a global public, transcending the geographical, economic and physical barriers that restrict access to archaeological sites. Through the use of the viewer, a global audience can experience the magnificence of the temple, opening new possibilities for international cultural exchange;

B. Digital preservation of a monument at risk of further degradation:
The project created a detailed digital archive of the monument, providing protection against further physical degradation of the archaeological remains. This digital preservation extends beyond simple documentation, creating an interactive repository that captures not only the physical characteristics of the temple but also its historical and cultural context;

C. Creating an innovative teaching tool for schools and universities:
The project can also be used as an innovative teaching tool for schools and universities, offering students and educators an unprecedented opportunity to explore ancient architecture and history through hands-on virtual experience. The immersive nature within the metaverse allows for a new approach to learning, based on experience, that traditional educational methods cannot provide;

D. Stimulating reflection on the relationship between archaeology and new technologies:
The project has stimulated important reflections on the growing relationship between archaeology and new technologies, contributing to the ongoing discussions on the role of digital tools inpotential for virtual environments as a tool to improve without replacing traditional archaeological methods.

E. Validation through Comparative Analysis:
To ensure the accuracy of our virtual reconstruction, a validation process was implemented through a comparative analysis with archaeological evidence and reconstructions of similar temples. The reconstructed model was compared with the physical remains of the Olympieion, achieving a margin of deviation of less than 2% from the measured dimensions of the surviving structures. The architectural proportions were validated against contemporary Doric temples, specifically the Temple of Apollo (located in Syracuse) and the Temple of Concordia (located in Agrigento), confirming their alignment with 6th-century BC architectural norms. The model was subsequently subjected to revisions by Professor Elvia Giudice of the University of Catania (Professor of Classical Art History) and the Archaeological Park of Syracuse, who validated both its historical accuracy and the plausibility of the hypothetical elements. The methodology used was also compared with established digital reconstruction projects of Greek temples, confirming its adherence to current standards in digital archaeological reconstruction. Given the limited remains of the Temple of Olympian Zeus, most of the reconstruction represents historically plausible interpretations based on comparative analysis with Doric temples [9] still in good condition, while maintaining strict adherence to archaeological evidence for documented structural elements.

Fig.6. Immersive experience with Meta Quest 3s

The immersive experience through Meta Quest VR headset (Figure 6), allows virtual visitors to understand not only the physical aspect of the temple, but also its cultural and religious significance in ancient Syracuse, offering a contextual understanding that is impossible to obtain from archaeological remains.

Fig.7. Final Result

V. CONCLUSION

The reconstruction of the temple of Zeus Olympian in Syracuse in metaverse (Figure 7), has made it possible to make available, a cultural historical find and has highlighted how the digitization of archaeological assets can transform and enhance, starting from remains and historical documents, the cultural heritage, making us relive history in a complete immersive experience. This implementation in the metaverse represented the most innovative challenge, transforming the static reconstruction of the site into an interactive and shared environment. The feedback collected from tests carried out with different users, confirm the effectiveness of this approach that allows you to know first and foremost the history of the Sicilian archaeological heritage. In the future, this type of project may be extended to other archaeological sites throughout Sicily, with the aim of bringing a growing number of users both to understand and appreciate the historical-cultural heritage of these historically significant places, because the methodology developed for the reconstruction of the *Olympieion* provides a replicable framework that can be adapted to other archaeological contexts, each with its own specific challenges and opportunities. The success of this project opens up the possibility of creating new, interconnected virtual environments that allow users to explore related archaeological sites that could lead to the creation of virtual museums and educational platforms that render the entire heritage of Magna Grecia accessible to a global audience. In an age where archaeological assets are threatened by environmental factors, reconstruction in virtual environments can be not only a substitute, but a valuable means of preserving its value and passing it on to future generations.

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