Digital Technologies for the Fruition of Archaeological Heritage. The Visualisation of the Temple C Metopes Polychrome in Selinunte

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Abstract. Through the tools of the representation this paper investigates a hypothetical virtual re-presentation of the metopes original polychromies. The reconstructive interpretative process was carried out through a critical reading of historical and iconographic sources. Starting from the reading of drawings made by Angell and Harris at the time of the archaeological finds, of Hittorff's studies and watercolors, and of some coloured fragments still observable in the original metopes, the graphic elaborations that simulate the original polychromes have been prepared.

The purpose of this study and of the analysis here described is the experimentation of an interactive visualisation application (augmented reality) designed for the "Antonino Salinas" Regional Archaeological Museum of Palermo. The study is part of the repertoire of virtual reconstructions, through the use of light, of lost colour configurations. The project aims to propose a new modality for the use of archaeological finds, thanks to an inedited teaching and immersive experience of the metopes and to the experimentation of a new visual environment that overlaps the real one leading to rethink the relationship between reality and its representation.

Keywords: Augmented reality · SfM survey · 3D model · Video mapping

1 Introduction

In March 1823, William Harris and Samuel Angell, architects of the Royal Academy of Arts in London, during an excavation campaign in Selinunte, found in very small fragments, three metopes that were part of the oriental frieze of the temple C, located in the Acropolis, made probably after the middle of the sixth century BC and dedicated to Heracles or Apollo. Immediately restored by Pietro Pisani, an officer of the Ministry for International Affairs in Palermo, the metopes were exhibited at the University of Palermo Museum, today the "Antonino Salinas" Regional Archaeological Museum.

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They represent Apollo on a chariot flanked by Leto and Artemis, Herakles and the Kerkopes, Perseus beheading Medusa in the presence of Athena and the birth of Pegasos[1].

Angell and Harris found the eastern frieze complete with metopes interspersed with strongly protruding triglyphs, where they fell. Therefore the direct testimonies of the two architects provide information on the location of the metopes in the temple and on the traces of color that were still visible[2]. Drawings and surveys of Angell and Harris were published in 1826 by Angell and Evans[3] (Fig. 1).

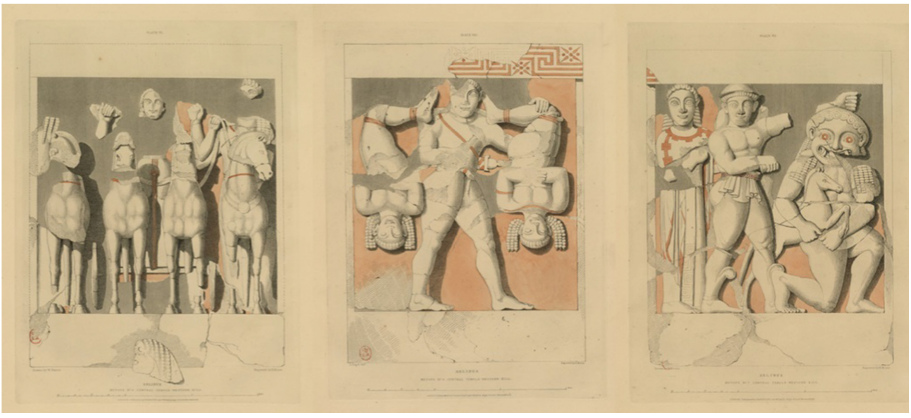

Fig. 1. The metopes represented by Angell and Evans (1826)

In 1823 Jakob Ignaz Hittorff[4], Royal architect in Paris, arrived in Sicily together with the architect and pupil Karl Ludwig Wilhelm Zanth to "survey the ancient monuments of Sicily in all their details, (…) give a faithful image of their current state, and an idea as complete as possible of their original state"[5]. And indeed, their drawings "are so precisely finished that they are often correct down to the millimeter. As such, these drawings offer clear documentation of the actual state of the buildings, and serve as an accurate base for their reconstructions"[6].

Immediately became aware of the discovery of the metopes, Hittorff went to visit the museum of the University to meet Angell and to see and draw the reliefs from life.

[1] For a complete description of the metopes see Angell and Evans (1826), 44–54 and Marconi (2007), 234–239.

[2] The quadriga occupied the central part of the frieze. It is a relief that testifies the expertise and the level of knowledge of the perspective of that time.

[3] Evans replaced Harris died in Selinunte of malaria where he remained to study the topography of the site. Marconi (2007), 133. Angell and Evans (1826).

[4] J.I. Hittorff trained at the Paris school of architecture and was a pupil of Léon Dufourny and Quatremère de Quincy.

[5] Hittorff (1870), XX.

[6] Kiene et al. (2016), 25.

However, his drawings differ by the engravings of Angell and Harris because Hittorff and Zanth "were able to see the metopes only in the museum in the presence of guards. Additionally, they were not allowed to draw in front of the originals, because Angell and Harris had been granted the exclusive right to reproduce them for one year. Hittorff and his team thus drew from memory"[7].

The drawings of Hittorff and Zanth received many appreciations compared to those made by Pisani, who were judged by Thiersch "of lesser quality and do not reveal the style of these metopes"[8] (Fig. 2).

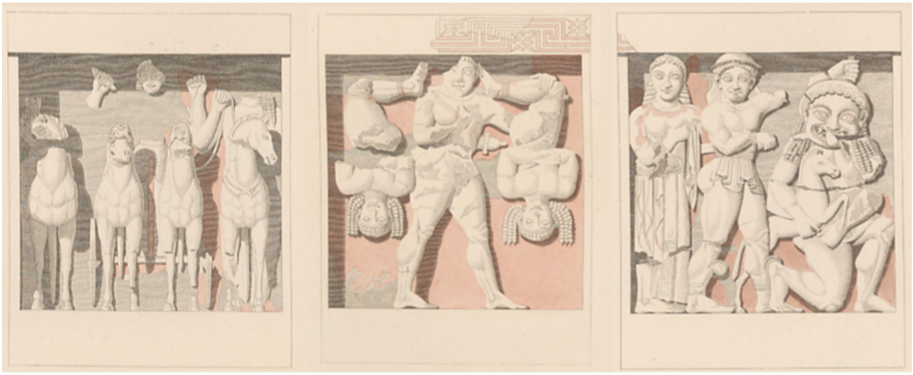

Fig. 2. The metopes represented by Hittorff and Zanth

The corpus of drawings by Hittorff includes minutes, finished drawings (generally drawn with graphite and black ink), engravings and watercolors used for exhibitions and scientific discussions. Sometimes the sketches and published illustrations show significant differences, as in the case of the fragments breaks' representation forming the metope of Perseus and Medusa (Fig. 3).

Fig. 3. The metopes. Sketches by Hittorff (pen and graphite)

[7] Kiene et al. (2016), 75.

[8] Kiene et al. (2016), 43.

Drawings and studies of Hittorff became well known soon, so much that the Duke of Serradifalco, in his *Antichità della Sicilia* (Serradifalco 1834) used "the model for the measuring and drawing of the monuments of ancient architecture[9]" of *Architecture antique de la Sicile* receiving an accusation of plagiarism by Hittorff (Fig. 4).

Fig. 4. The metopes reproduced by Serradifalco (1834-1842)

2 Hittorff and the Classical Polychrome

The metopes of Temple C have been of great importance in the archaeological field and for studies on classical polychrome. Hittorff was the first to study the coloured traces on the sculptural and architectural fragments found in Selinunte. Starting from the drawings of Agrigento by Hittorff, "which will follow those of Selinunte a few days later, the plots of the most intense nineteenth-century architectural debate will develop, the one on the polychrome, whose theoretical foundations were already thrown into countless essays, but whose architectural evidence had to wait for the fascinating plates and watercolors of Hittorff and Zanth because a new and original vision of Greekness evolved from the neoclassical imaginary"[10].

Before reaching Selinunte, Hittorff visited Agrigento and, among the findings during the excavations, he also found architectural and sculptural fragments with traces of coloured stuccos, from which he elaborated his theory on the classical polychrome that was destined to undermine the convictions of Winckelmann.

His studies were published, together with a collection of plates and watercolors, made together with his pupil, Karl Ludwig Zanth, in *Architecture antique de la Sicile* and became the basis for subsequent hypotheses[11].

[9] Kiene et al. (2016), 21.

[10] Cometa (1993), 22–23.

[11] The work was published in its first edition in 1827 (Hittorff 1827) and was later expanded and published after Hittorff's death by his son Charles in 1870 (Hittorff 1870).

In a letter to Schorn, Hittorff reported that he had seen that parts of temples of Selinunte were still covered in red, blue, yellow, and green stucco[12] (Fig. 5). Therefore, he also extended to the architecture of the temples the intuitions of Quatrèmere de Quincy on the polychrome of the sculpture of the Greeks[13]. From book 4 of *De Architectura* by Vitruvius he drew that, in the early buildings, the wooden triglyphs were covered in blue wax[14]. On the occasion of an essay presented at the Académies des Inscritions et Belles-Lettres et des Beaux-Arts de Paris, Hittorff noted that the slight traces of blue and yellow on the background of the metopes and the red, green and blue on the architrave of the Temple of Empedocles in Selinunte, suggested that the pediment was originally entirely coloured[15]. This thesis would also be supported by the similarity of the pottery's coloured ornaments to the elements of the Doric frieze. From Alexis Paccard's studies on the Parthenon, he derived the use of blue tones for triglyphs and mutules, of red for guttae and for the backgrounds of metopes[16]. Encouraged by the discovery of other coloured fragments in Athens, Syracuse, Agrigento, he

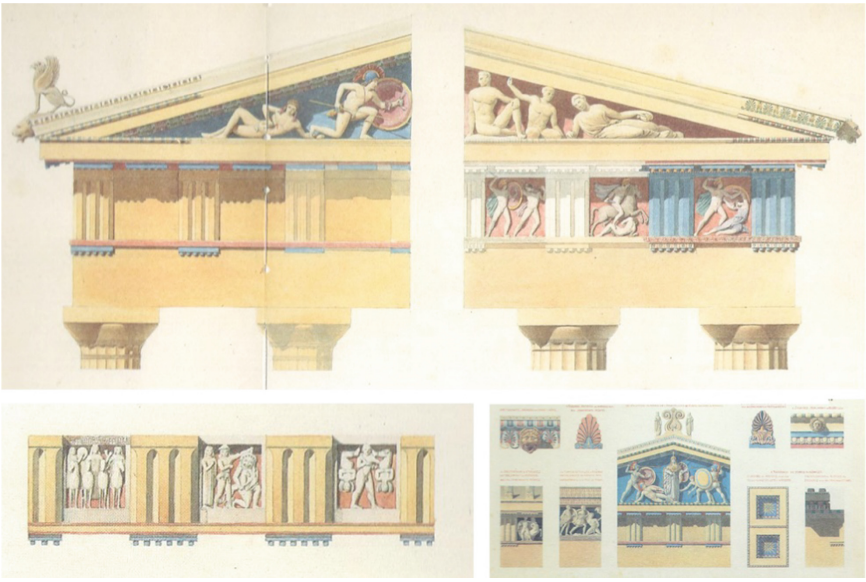

Fig. 5. Polycrome details by Hittorff

[12] Cometa (1993), 68.

[13] See Quatrèmere de Quincy (1815) *Le Jupiter olympien, ou l'Art de la sculpture antique considéré sous un nouveau point de vue, ouvrage qui comprend un essai sur le goût de la sculpture polychrome, l'analyse explicative de la toreutique et l'histoire de la statuaire en or et en ivoire, chez les Grecs et les Romains.* De Bure frères.

[14] Hittorff (1851), 13, 444.

[15] Hittorff (1993), 76.

[16] Hittorff (1851), 420.

hypothesized the restoration of the colours of the Temple of Empedocles (Temple B) in Selinunte[17]. Observing the drawings of Hittorff and Zanth on the temples of Selinunte, it is clear that the red colour was used mainly for the backgrounds, the meanders, the belts, yellow for weapons and accessories, blue for the triglyphs, the guttae and the cornice. In the hypothesis of reconstruction of Temple B (Temple of Empedocles), Hittorff also assigned the yellow colour to the columns, the façade, and the stylobate.

3 The Analysis of the Metopes

Through the tools of representation the paper investigates a hypothetical virtual representation of the original polychromies of the metopes (Fig. 6). The reconstructive interpretative process was carried out through a critical reading of historical and iconographic sources. Starting from the reading of drawings made by Angell and Harris at the time of the archaeological finds, of Hittorff's studies, and watercolors and of some coloured fragments still observable in the original metopes, the graphic elaborations that simulate the original polychromes have been prepared.

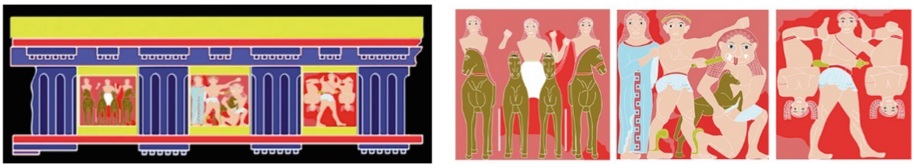

Fig. 6. Hypothesis of colour reconstruction for the processing of video mapping (Giorgia Biancorosso)

The quadriga has red traces that have been found on background, breast straps, draft pole and dress of Apollo and right figure[18].

The metope with Perseus and Medusa has red traces on background, eyes of Medusa, meander and low neckline on the dress of Athena, cap and belt of Perseus. Eyes and eyebrows have a dark color, as the interior decoration of the belt of Perseus[19]. A red meander band, of which remains a small fragment, decorated the metope at the top.

The metope with Herakles and the Kerkopes has red traces on background, details of dresses of the three figures, cross belt and scabbards of Herakles, ropes of Kerkopes. This metope is crowned at the top by a red meander and stars band, too[20].

[17] Hittorff (1851), 446.
[18] Marconi (2007), 234.
[19] Marconi (2007), 237.
[20] Marconi (2007), 238.

4 Experimentation for the Visualisation of Polychromies

The purpose of this study and of the analyses described above is the experimentation of an interactive visualisation application (augmented reality) designed for the "Antonino Salinas" Regional Archaeological Museum of Palermo (Biancorosso 2016). The study is part of the repertoire of virtual reconstructions, through the use of light, of lost colour configurations[21] (Fig. 7). Augmented reality allows adding to an object, an architecture, a real context, information, elaborated and conveyed through digital tools, which otherwise would not be perceptible Bertuglia et al. (1999), 42–47.

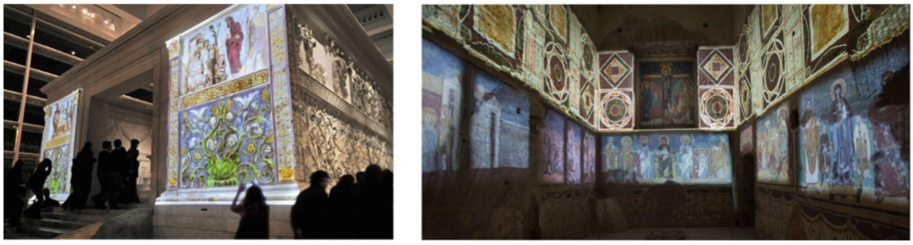

Fig. 7. a. "I colori dell'Ara Pacis" video mapping. b. "Santa Maria Antiqua" video mapping

The ability to simulate reality, through the use of video projections (video mapping), allows to visualize the imagined missing original chromatic aspects on the real element and to evaluate the impact as if it were a digital restoration operation. Video mapping is a projection technology that turns any surface into a dynamic screen on which to project images through one or more video projectors[22].

Given the complexity of the metopes, characterised by the presence of shaded areas, the first phase of the experimentation required the elaboration of an accurate digital three-dimensional model of the same. This model was developed thanks to a photogrammetric survey, carried out with SfM (Structure from Motion) techniques, which produced a three-dimensional point cloud (Fig. 8). The geometry of the object was generated virtually by converting the point cloud into a polygon mesh from which the 3D model was then processed. This virtual model formed the basis for digitally replicating the exact shapes and dimensions of the metopes and ensuring perfect overlapping of the digital projections to the real artifact.

Several steps were necessary for the creation of the video. Using a vector graphics software, the metopes have been redrawn, subdividing the elements of the drawing into different levels, prepared and ordered for the following animations (Fig. 9a). The vector organised drawing was imported into a graphics animation and compositing software that allowed the realisation of all animations - animated drawing of metopes, geometric

[21] Effective experiments were conducted, among others, at the Rocca di Vignola, and in Rome at the Ara Pacis, at the Domus Aurea and at Santa Maria Antiqua.

[22] In the Anglo-Saxon world, video mapping is also often called *spatial augmented reality.*

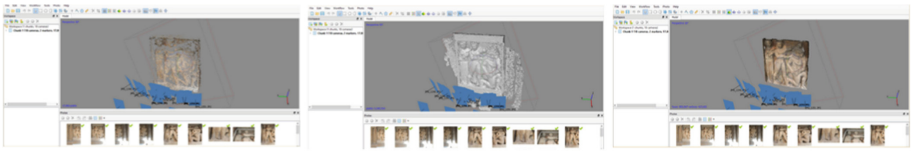

Fig. 8. Phases of the SfM survey (Giorgia Biancorosso)

constructions, and insertion of colour (Fig. 9b). The last phase achieved with the use of video editing software, allowed to carry out the editing aimed at the final export, also synchronizing the video with the narration's audio track that explains in detail the histories represented in the metopes and the colour virtual reconstruction (Fig. 9c).

Fig. 9. The video phases; a. the vector drawing; b. the realisation of all animations; c. the final editing (Giorgia Biancorosso)

The image to be projected was calibrated and adjusted through the use of digital masks to coincide with the shape of the target object. In order to control, in the design phase, the correctly superimposition of the final elaboration to the metope's real complex surfaces, it was decided to make a 1:5 scale model, by 3D printing, as simulation support and verification of the final projection (Figs. 10 and 11).

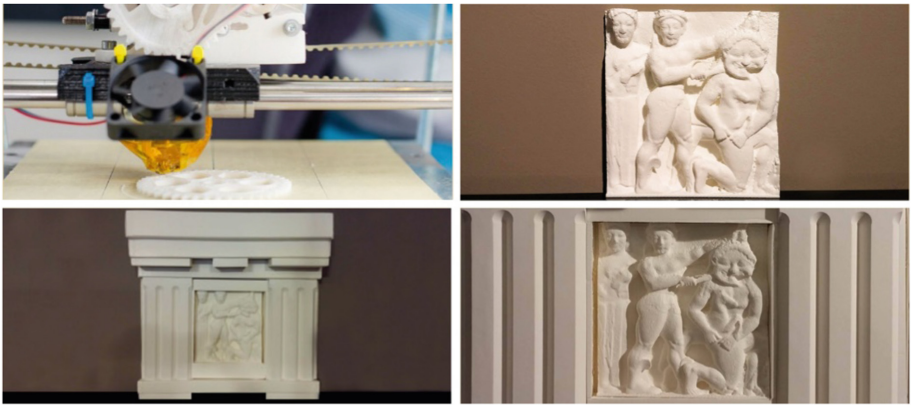

Fig. 10. 3D printing of the 1:5 scale model (Giorgia Biancorosso)

Fig. 11. The calibration of the image and the verification of the final projection (Giorgia Biancorosso)

In the final elaboration, still to experiment, the real surfaces of the metopes will become the support on which to project the previously elaborated images. If on the one hand video technology will be introduced into the real environment, on the other hand, it will take possession of it virtually including it within the video itself.

5 Conclusions

For a few years now, in the context of communication, use, and enhancement of cultural heritage, more and more importance is given to the emotional involvement of the user who is often called upon to live "immersive", multisensory and interactive experiences. The user is guided towards new levels of knowledge through multimedia performance.

Digital technology has assumed a fundamental role in the management, understanding, enhancement, and dissemination of cultural heritage. The video projections here presented are configured as virtual copies of lost elements, on-site real-scale reproductions, which show all their communicative potential. The project aims to propose a new modality for the use of archaeological finds, thanks to an inedited teaching and immersive experience of the metopes and to the experimentation of a new visual environment that overlaps the real one leading to rethink the relationship between reality and its representation.

Through the real-time projection of the 3D model on the same area of the real site, it will be possible to view different aspects of the surfaces without intervening directly on the artefact. The real elements will be transformed through virtual animations, providing an original and unusual sensorial experience.

Acknowledgements. Survey and video mapping experiment presented in this essay are part of the graduation thesis *L'immagine del Passato. Progetto di Video Mapping per le Metope del Tempio C di Selinunte*, Supervisor Prof. Vincenza Garofalo, graduation student Giorgia Biancorosso, University of Palermo, Academic Year 2015–2016. (NB this specification is very important and for a mistake it was not introduced in the paper). The author wishes to thank Dr. Francesca Spatafora, Director of the Salinas Museum, for having given permission to survey the metopes.

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