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CULTURAL HERITAGE COMMUNICATION AND DIGITAL RESOURCES: THREE EXAMPLES FROM MESSAPIAN ARCHAEOLOGY

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To Andrea Brogi to whom we owe so much for the realization and success of our projects.

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Abstract

Digital resources play a key role in the use of our cultural heritage. Awareness of their importance has grown considerably over the last two decades, but it is above all in the current world health emergency that they have proven to be fundamental. A number of multimedia products created since 2000 to present the Cultural Heritage are accessible on the CEIT portal of the University of the Salento. This paper illustrates three of these products, created in the years 2008-2010, with the aim of communicating to the public the results of scientific research conducted in southern Puglia on the archaeology of the Messapians in an effective way. These, the fruit of pioneering projects, have given rise to new horizons and challenges in digital technologies, and to new models of scientific communication and universal use of the cultural heritage, which today are more important than ever.

Keywords

Cultural Heritage communication, Messapian Archaeology, Zeus from Ugento, Black-figure krater from Cavallino, Hypogeum of the Caryatids at Vaste, Digital resources, Three-dimensional reconstruction, 3D models, 3D animation, Virtual representation

1. *Introduction*

The revolution brought about by digital technologies since the start of the new millennium concerning the study and use of Cultural Heritage has also had significant consequences for the promotion of the archaeological heritage (Volpe, 2019; Volpe, 2020a).

In this regard, a key role has been played by efforts to involve a broad and diverse section of the public, making use of advanced digital platforms for the presentation, not just of individual artefacts, groups of objects and museum collections, but also of archaeological contexts and landscapes (Dal Maso, 2018).

This is a true challenge, as part of which digital technologies are now successfully interacting with various types of language, verbal and otherwise, developing innovative and high-impact forms of communication.

In terms of language, the considerable ability to draw the public's attention by targeted and incisive selections of words, images and sounds is a familiar theme, powerfully exemplified by *Invisible Cities* (*Le città invisibili,* 1972) by Italo Calvino: the emperor Kublai Khan is indifferent to the opaque, interminable and, to him, incomprehensible reports presented by his functionaries on their return from the remote provinces of his immense dominions. Instead, the emperor listens with attentive curiosity to the stories skilfully told by Marco Polo using – in order to describe the cities he had visited and the men who had built them – imaginative forms of communication initially consisting of gestures, mime, sounds, the presentation of emblematic objects, and subsequently well-chosen words expressing the right meaning.

In Calvino's novel, however, the efficacy of communication is tempered by the deceit potentially inherent in the languages that were used and the subjective nature of their interpretation. Despite his fascination with Marco Polo's tales, for this reason, the Great Khan does not necessarily believe everything that he is told, suspecting that the description of the cities

corresponds not to their real appearance but rather to the image perceived by the Venetian merchant (Rizzarelli, 2002).

In the sphere of literary fiction, imaginative content and language used with the goal of drawing the attention of the public constitute a legitimate and effective creative act, scientific descriptions even when packaged in the form of compelling narratives, must in contrast seek to provide a correct and rigorous record of the data.

This is why, over the last two decades in the field of archaeological communication, the presentation of themes that are often impenetrable to laypersons using digital technologies that can ensure the involvement of the public has proceeded hand in hand with the need to develop a language that makes the results of scientific investigations – objectively and effectively while respecting the integrity of the content – accessible to all.

The key stages of the method that has gradually been developed to this end are set out in the recent monograph by Elisa Bonacini on museum presentation and digital products that enable the enjoyment of cultural heritage, especially digital storytelling, of which the author identifies various categories. These range from simple forms, both oral (audio guides and podcasts) and written (texts and hypertexts in digital format), to animated, interactive (with the direct involvement of the user in the construction of the narrative) and immersive storytelling, the latter enabling the public to virtually travel through time and space (Bonacini, 2020). The ultimate form of storytelling is participatory, in which the listener/user becomes the narrator.

Among the examples of animated and immersive digital storytelling, a number of multimedia products on the Cultural Heritage, edited by Virginia Valzano since 2000, are accessible on the CEIT[1] portal of the University of Salento.

This paper illustrates three of these products, created in the years 2008-2010, in the field of virtual archaeology under the scientific direction of Virginia Valzano and the collaboration of a team of classical archaeologists from the University of Salento.

Initially published on DVD-ROM by "Coordinamento SIBA"[2] of the same University and subsequently on the CEIT website, the three multimedia products were created with what were then highly innovative technologies (see below sections 3 and 4).

They present masterpieces of ancient art discovered in southern Puglia – the ancient Messapia – a historic and cultural area of great interest due to the large quantity of data produced by archaeological research conducted in the field and the scientific results obtained, in accordance with diverse multidisciplinary approaches, on a theoretical plane.

Digital communication with the wider public has also been an important theme in the archaeology of the Messapians in the last twenty years, and a key role in this sense has been played by multidisciplinary scientific laboratories providing support for cultural heritage.

An example is the LandLab Project[3] of the University of the Salento, which uses digital technologies and 3D and GIS methods to explore new ways of presenting to the public the results of scientific research and of transferring the knowledge acquired into the dynamics of social development of the regions involved (D'Andria, 2019; D'Andria, & Semeraro 2006; Semeraro, 2009).

The goal of clearly and effectively presenting to the public the results of recent scientific research in the field of Messapian archaeology is what prompted the creation of the three multimedia products illustrated in this study, the content of which is presented in the second section of this paper.

[1] CEIT: Centro Euromediterraneo di Innovazione Tecnologica per i Beni Culturali e Ambientali e la Biomedicina - Euromediterranean Center for Technological Innovation for Cultural and Environmental Heritage and Biomedicine, founded and directed by Virginia Valzano (http://www.ceit-otranto.it/).

[2] Coordinamento SIBA (Servizi Informatici Bibliotecari d'Ateneo), started by Virginia Valzano and directed by her from 1986 to 2010, coordinates the University Library IT services and the Telematic Information System for Research and Education at the University of Salento (see: http://www.ceit-otranto.it/images/valzano/siba-1986-2010.pdf).

[3] LAND-LAB project (Laboratorio multimediale di ricerca, formazione e comunicazione sui paesaggi archeologici - Multimedia Laboratory for research, formation and communication of archaeological landscapes), co-financed by the European Union (P.O.N. 2000-2006), and coordinated by Profs. Mauro Biliotti and Francesco D'andria, University Salento. (see: http://www.ceit-otranto.it/index.php/progetti/34/info-land-lab/82-progetto-land-lab).

2. *Three multimedia products illustrating Messapian Archaeology*

The testimonials of ancient art that form the focus of the three multimedia products presented in this paper are held in the "Sigismondo Castromediano" Museum in Lecce and the National Archaeological Museum in Taranto (MArTA). These items, which constitute archaeological evidence of considerable interest, were discovered in southern Puglia, an area inhabited in ancient times by indigenous peoples. The Greeks called this region "Messapia" because it lay between the Ionian and Adriatic seas.

The finds, discovered in the settlements of Cavallino, Ugento and Vaste from the 1860s to the 1950s, were selected by Virginia Valzano, head of the Coordinamento SIBA of the University of the Salento, with a dual purpose: to enable the public, by means of effective and immediate forms of communication based on the latest technology, to understand their historic and artistic value and to show the importance of these precious objects in Messapian settlements, where they were used in association with sacred practices (the Zeus of Ugento) and funerary contexts (the krater from Cavallino; the Chamber of the Caryatids in Vaste). They were then subjected to scanning, reconstruction and three-dimensional virtual representation.

For decades now, the study of contexts with a view to clarifying the function and meaning of artefacts discovered in Messapian settlements has been a strong point of the research into classical archaeology at the University of the Salento. This research has enabled a new reading of the data arising from fieldwork, which has been promoted since the 1960s by the university in collaboration with the local archaeological authority (Soprintendenza) and various foreign institutions. It is therefore today possible to discern the hierarchical organisation of the sites (which evolved over time from simple hut villages into increasingly complex forms of settlement), the characteristics of the cults practised in the sacred places and the layout of the areas containing the burials, both monumental and otherwise (D'Andria 1991).

The settlements that yielded the objects illustrated in the multimedia products are among the most important in Messapia, and in the case of Cavallino and Vaste, among the most extensively investigated (Fig. 1). Discovered in Ugento, the dominant settlement in southern Messapia, was the Zeus hurling thunderbolts, a masterpiece by the bronze-workers of Archaic Taranto (Degrassi 1981; D'Andria, 1983; D'Andria & Dell'Aglio, 2002). Placed by the settlement's aristocratic rulers on a column inside a sacred precinct on the acropolis, it recalled the punishment reserved for those who broke the rules by rebelling against the constituted divine and human order (section 2.2). From Vaste, a medium-sized settlement in southern Messapia, comes another superb example of the Greek sculpture of Taranto: the famous Caryatids which, together with the friezes decorated with chariots drawn by lions, framed the monumental Hellenistic chamber tomb of an aristocratic family (Lamboley, 1981; L'Arab, 1991; Lippolis, 1991; Mannino 2015) (section 2.3). Cavallino, the main Archaic settlement of central Messapia, yielded the Apulo-Etruscan krater of the classical period decorated with scenes inspired by Greek myths; the artefact served to enrich the burial of an aristocrat who was clearly highly educated and able to appreciate the immortal endeavours of the heroes of the saga of Troy (Arias, 1959; Mannino, 2005)(section 2.1).

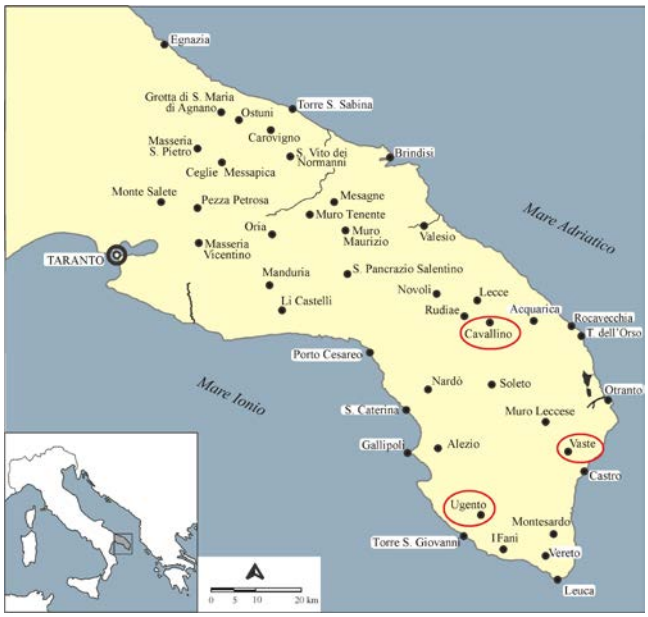


Fig. 1: Map of Messapia showing the location of the main archaeological sites.

2.1 The black-figure krater from Cavallino with the Embassy to Achilles

Having escaped the destruction of Troy, Aeneas and his companions cross the Mediterranean Sea and reach Italy. The hero's ship lands on the Apulian shores exactly where the

town of Castro lies today. Here, on a headland overlooking the Adriatic Sea, recent archaeological excavations carried out by the University of Salento have brought to light the ruins of a sacred building: the temple of Minerva, the goddess who protected the Trojans, recalled by Virgil in his *Aeneid*.

Besides Aeneas, the archaeological discoveries made in Southern Apulia call attention to other protagonists of the epic tales inspired by the Trojan war. Achaean and Trojan heroes are portrayed on many vases found on different sites of the region, most of which are on display in the "Sigismondo Castromediano" Provincial Museum in Lecce.

Of special interest is a black-figure krater from Cavallino, an archaeological site near Lecce, where research conducted by the University of Salento has uncovered an archaic native settlement. Extending over an area of 69 hectares, the settlement lies within imposing fortification walls with staggered entrance gates letting on to several road axes. The roads, lined with houses, converge at a wide central area, probably a square. The walls also enclose the remains of ancient burials, some of which were the tombs of aristocrats, as their wealthy grave offerings indicate. One of these tombs, excavated, near the North-Eastern Gate in 1956, contained the krater presented shortly.

The word krater means “mixing bowl”, as this kind of vase was used at symposia and banquets for mixing wine with water. It is a column-krater, 41 cm high, decorated with ornamental floral motifs on the rim and curvilinear patterns on the shoulder (Fig. 2). It can be compared stylistically to pottery manufactured between 480 and 450 BC in the southern Adriatic area, by Etruscan craftsmen coming from Campania.

Fig. 2: The black-figure krater from Cavallino - 3D Model.

The scene painted on the principal side draws inspiration from an episode of Homer's *Iliad*, the Embassy to Achilles (Fig. 3).

Fig. 3: The black-figure krater from Cavallino, the Embassy to Achilles - 3D Model.

The years-long siege of Troy by the Achaeans progresses, but Achilles, angry with Agamemnon, who has taken Briseis from his tent against his will, no longer wants to fight. In order to appease the wrath clouding the soul of the hero, Agamemnon sends an embassy to the camp of the Myrmidons on the seashore. Among the ambassadors is Odysseus, who brings "fabulous gifts" and uses "honey-sweet words".

The scene of the conversation between Odysseus and Achilles painted on the vase from Cavallino depicts the two heroes in such postures as to reveal their differing states of mind. Bearded and enveloped in a cloak, Odysseus accompanies his words with hand gestures, while Achilles, seated on a stool under a heavy cloak, his head bent, frowns as he listens. The famous weapons of Achilles, a pair of leg greaves and a long-crested helmet, appear in the background. A ship is moored to the right.

The outcome of the diplomatic mission depends on Odysseus, who is unrivalled in the art of speaking, enchanting whoever listens:

“Hail, Achilles, divine prince. Though your banquet is sumptuous, we have not come here for your food and drink. We are faced by great disaster, and we are afraid. If you do not take up your arms, it will be difficult to save the ships ... But if you want, there is still time to save the Achaeans, before it is too late for all of us, you included”.

But Achilles answers:

"Divine Odysseus, of sharp mind, it is best if you speak clearly ... there is no Achaean on the face of the earth who can convince me to abandon my anger ... Return to your tents and convey my message to the Achaean princes. Tell them to think about something else as I cannot help them to save their ships and their army. Tell them that I remain unyielding in my anger".

The reverse of the krater also shows a mythological scene. Though another dramatic situation, here the solution is sought by means of physical force, instead of speech (Fig. 4).

The scene takes place in Thessaly, a region of Greece. Heracles, wearing a lion skin, fights a duel with Cycnus, the giant son of the god Ares, who robs and kills pilgrims heading for Delphi. Cycnus is armed with a helmet, a breastplate and leg greaves, and defends himself with a spear and a shield. The contest is violent, but in the end Heracles overcomes the giant by cutting off his head with a blow of his spear.

Fig. 4: The black-figure krater from Cavallino, Heracles and Cycnus - 3D Model.

The scenes portrayed on the krater from Cavallino are linked by their reference to epic characters that embody different models of a hero: thus Achilles, who finds fulfilment in fighting for his honour, Odysseus, who is extremely clever and shrewd, and Heracles, who expresses himself through physical force, fighting against evil forces.

A vase with such refined decoration could only belong to an educated aristocrat who, if only in his imagination, wished to emulate the great deeds of divine heroes (Valzano, Mannino, Bandiera, & Brogi, 2009).

2.2 The Zeus of Ugento

Amongst the archaeological discoveries in southern Apulia, the Zeus of Ugento is of rather exceptional interest. It is a bronze statue of notable artistic quality that stands as an authentic masterpiece of the Archaic sculpture of Magna Graecia (Fig. 5).

Fig. 5: Zeus of Ugento.

The statue, housed in the National Archaeological Museum at Taranto, was found on Christmas Eve 1961 in the historic centre of Ugento, a town in the lower Salento, some 6 km from the harbour of Torre S. Giovanni. In antiquity, one of the chief and most extended settlements of the region between the Ionian and Adriatic seas that the Greeks called "Messapia" developed on the same site as modern Ugento.

The archaeological area of Ugento, which extends for 145 hectares within imposing Hellenistic fortification walls of almost 5 km in length, occupies both the southern extremity of a serra or limestone ridge, little over 100 metres above sea level, as well as part of the adjoining plain.

Archaeological evidence shows that the Messapian settlement witnessed a particularly florid period of occupation between the final decades of the 6th and the beginning of the 5th century B.C. The tomb in via Salentina was constructed during this time. It is a monumental built tomb, characterised by refined painted decoration, that was used for successive burials and which has yielded a rich assemblage of figural vases and metal objects.

The extraordinary late Archaic bronze statue of Zeus that has made Ugento celebrated in the history of archaeology, was casually discovered

almost half a century ago not far from the tomb of via Salentina, in the dominant part of the site. Deposited within a cavity in the rock and covered by a capital that originally supported it, the statue had been deliberately hidden, perhaps because of some imminent threat.

The sculpture represents Zeus, god of Olympus, absolute judge of cosmic energies and atmospheric phenomena. The nude Zeus advances, brandishing a lightening-bolt in his raised right hand and grasping the claws of an eagle, his sacred bird, within the fingers of his left hand (Fig. 6).

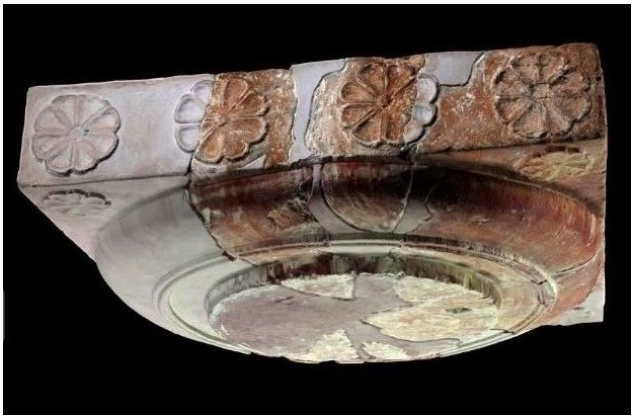


Fig. 6: Zeus of Ugento - capital: 3D Model.

The statue of Zeus sits on a rectangular base. This was inserted into a socket on the upper side of the Doric capital that was found with the bronze sculpture. The capital, carved out of a single block of local stone, has an abacus decorated on its four sides with rosettes in relief (Fig 7).

On the upper side of the abacus are holes for the insertion of wooden pegs that served to suspend garlands or votive ribbons. The underside of the abacus is decorated at its angles with rosettes of eight petals.

The architectural member also has an echinus with a collar of three rings and part of the fluted column that served to support the capital and the statue.

Like all medium and large bronze statues of antiquity, the Zeus of Ugento, some 74 centimetres high, appears to have been made by the lost wax process.

Fig. 7: Zeus of Ugento – 3D Model.

The presence of seams in correspondence with the feet, the wrists and the head attachment, shows that they were cast separately and later assembled through soldering.

The head of the god, which synthesises plastic sensibility and aesthetic taste, is characterised by a long pointed nose, a pronounced chin, a moustache and beard, rendered through meticulous work with burin and chisel, as well as elongated eyes originally provided with bulbs in bone and ivory and pupils in stone or glass paste.

The head is crowned with a double diadem composed of stylised laurel leaves and a rigid metal ribbon with rosettes in relief. Two rows of spiralled curls adorn the forehead. The hair is dressed in long coiled tresses; those that drop down to the shoulders are folded over and held together at the end by a ribbon (Fig. 8).

If the rendering of the details of head and face is analytical and meticulous, the treatment of the body, with the powerful muscular mass of the legs and the accentuated partitions of the abdomen, is essential. Fingers and toes are accurately portrayed down to the last detail.

Fig. 8: Zeus of Ugento - details of the head.

The comparison with votive coroplastic also shows that the statue is the work of an artist from Taranto who, between 530 and 510 B.C., elaborated formal indications of Corinthian, Corcyrian and Laconian artistic currents in an original way. The Doric capital, with its abacus decorated with rosettes, finds close parallels in other examples made in Messapia and discovered at Ugento itself, as well as at Cavallino and Vaste, and also dates to around 530 B.C.

The image of Zeus on a column must have been placed in a sacred precinct. There, where cult practises were performed and which served as bridgehead between the heavens and earth, the look of the Messapians of Ugento was lost in expectation of the prodigy of the divine apparition.

The sacred precinct was probably positioned in the highest part of the indigenous settlement, in an area where the divinity could be admired and solemnly entreated, even from a distance.

The invocation "Klaòhi Zis" ("listen oh Zeus"), incised on numerous Messapic inscriptions, must have resounded on the lips of the Messapians of Ugento in front of the bronze statue of the god (Valzano, Mannino, Bandiera, Beraldin, Maggiore, Brogi, & Negro, 2010).

2.3 The Hypogeum of the Caryatids at Vaste

The Hypogeum of the Caryatids is of exceptional importance in the archaeological record of the Salento. It is a Hellenistic chamber tomb discovered in the nineteenth century at Vaste, a centre in the hinterland of Otranto that developed over the remains of an important Messapian settlement.

The first reports of the monument are due to Luigi De Simone, member of the Commission of Antiquities and Fine Arts of Terra d'Otranto who, in 1869, whilst excavating in the property known as "fondo *Maura"*, found a "magnificent double hypogeum" previously sacked and partially destroyed by French soldiers (Fig. 9).

On the façade of the hypogeum was a sculpted decoration in local limestone composed of four female figures in high relief, the caryatids, standing to the sides of the two entrances to the funeral chambers. Two limestone bas-reliefs with erotes driving carts were found in the vestibule. According to De Simone they belonged to a frieze sited above the caryatids that crowned the façade of the hypogeum.

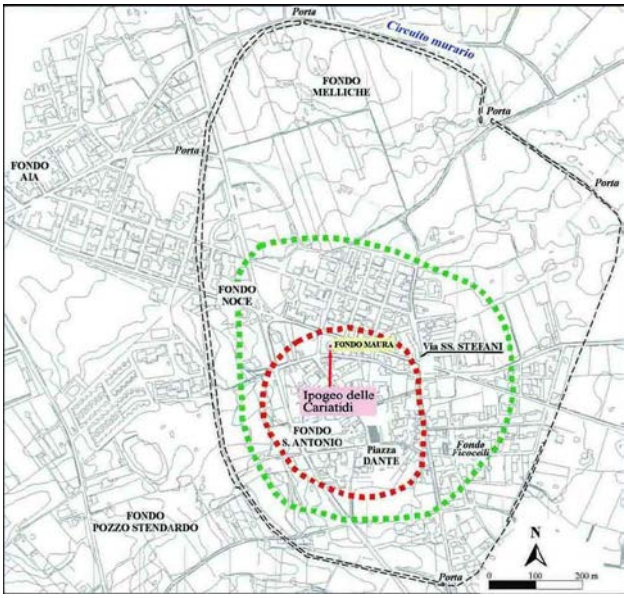


Fig. 9: Map of Vaste with location of the Hypogeum of the Caryatids.

At the end of the nineteenth century the Hypogeum of the Caryatids was already reduced to a mass of stones, so that today the sole remains are the sculptures that were recovered at various times. In the "Sigismondo Castromediano" Provincial Museum at Lecce are a caryatid and a bas-relief acquired between 1869 and 1873, whilst the other caryatids and the second bas-relief are in the National Archaeological Museum at Taranto, where they have been inserted in an exhibition inaugurated in 2007, alongside the reproduction of the sculptures held in Lecce.

The caryatids, whose function in the Hypogeum of Vaste was purely decorative, are carved in the doorjambs of the entrances to the funerary chambers. With slight variants, the four figures reproduce the same iconographic type; placed on a trapezoidal plinth, they stand frontally,

1.76 m high, with raised and bent arms, in the act of supporting the architrave with the palms of the hands.

The full oval face is framed by wavy hair, parted at the centre of the forehead and tied together at the back of the neck. The incised pupils emphasise the large eyes, whilst the mouth is only slightly open. Braces, buckled by a medallion in the form of a Gorgon's head, embrace the long dress and cross over the bust to leave the breast naked. The cloth of the dress, tightened around the waist by a belt, at times adheres to the body, and at times forms plastic undulations and ample folds that gently drop onto the shoed feet (Fig. 10).

Fig. 10: The Caryatids of the Hypogeum of Vaste - 3D Model.

On the bas-reliefs, delimited on one side by a fascia with incised vegetal motifs, is an erote, with his body bent by effort, holding reins and intent on driving a cart pulled by three felines that progress towards the right on the block at Taranto, and in the opposite direction on that of Lecce. Lions can be recognised on the Lecce relief by their thick manes with long flaming locks. Instead, lionesses, with manes of flattened undulating locks, can be seen on the block at Taranto. Without doubt colour was employed to help enliven the sculptures. The backdrop of the relief and the wheels of the cart are evidenced in yellow and red (Fig. 11: a-b).

Fig. 11a: The bas-reliefs of the Hypogeum of Vaste; Provincial Museum "S. Castromediano", Lecce.

Fig. 11b: The bas-reliefs of the Hypogeum of Vaste; National Archaeological Museum, Taranto.

The sculptures of the Hypogeum of Vaste find parallels in the artistic production of Taranto at the end of the 4th and the beginning of the 3rd century B.C., and in particular in the representations on painted ceramics and in the reliefs of the *naìskoi*, the funerary shrines that were mounted above the family tombs in anticipation of the Spartan colony. Even the patron of the Hypogeum of the Caryatids must have been a person of some substance; an important exponent of the Messapian aristocracy of Vaste. Indeed, the tomb was located in the central and highest part of the settlement, the so-called "acropolis". As the research of the Post-graduate School in Archaeology of the University of Salento has shown, in this part of Hellenistic Vaste, when the settlement was surrounded by imposing walls, various buildings were erected, including a cult centre dedicated to a fertility goddess, houses with complex plans that included public-ceremonial functions, and tombs and funerary precincts for the aristocratic families. The Hypogeum of the Caryatids, with its rich sculptural decoration, must have been one of the most representative monuments of the Messapian centre. As at Arpi, Canosa, Egnazia or Rudiae, the Hellenistic chamber tombs attested in the Apulian milieu generally bear painted decoration. Hypogea with sculptures are extremely rare and so would appear to be particularly prestigious. Indeed, apart from the Vaste example, only the perfectly preserved Palmieri Hypogeum in Lecce is known, with architecture and decoration of refined friezes with floral elements and scenes of fighting.

Comparison with the Palmieri Hypogeum by the archaeologists of the University of Salento has led to some interesting considerations regarding a new and original reconstruction of the Hypogeum of the Caryatids that the "Coordinamento SIBA", with the collaboration of the CASPUR of Rome and architect Andrea Brogi, has produced through the use of diverse techniques of acquisition and 3D elaboration (see below section 4.3 and Fig. 15-16).

The Hypogeum of Vaste was reached through the *dròmos*, a stepped corridor, about a metre and a half wide, cut into the bedrock and open to the sky. As may be seen from De Simone's plan, only a few steps of the *dròmos* were preserved when it was discovered. Up to now the bas-reliefs were always hypothetically referred to the façade of the hypogeum, but were probably originally placed in the *dròmos*. There the bas-reliefs most likely constituted the terminal elements of two freizes that, as in the Palmieri Hypogeum in Lecce, crowned the walls, running parallel and symmetrically to each other. If the hypothesis is correct, to the sides of the staircase were two series of carts driven by erotes, to the right pulled by lions, and to the left by lionesses, so symbolising the voyage to the after-life. The *dròmos* let onto the large vestibule, also open to the sky. From the vestibule it was possible to appreciate the façade of the hypogeum. The upper part of the façade, which was five metres wide and almost two and a half metres high, must have been characterised by a Doric trabeation with triglyphs and metopes, as in other Apulian hypogea. To the sides of the doors, both tapered towards the top and with a single leaf, were the caryatids, serene guardians of the hypogeum that watched over access to the funeral chambers. If in Archaic and Classical Greece female figures were guardians of the funeral monuments of the heroes, in Hellenistic times the Caryatids of Vaste safeguarded the sepulchre of the Messapian aristocrats, sign of a heroicisation now conceded even to mortals (Valzano, Mannino, Bandiera, Brogi, & Zannoni, 2010).

3. *Combining 3D technologies for cultural heritage interpretation and communication*

When presenting the history of a heritage site or an artifact using multimedia technology, the proper use of technology to acquire and represent spatial information is crucial in order to facilitate the understanding of that particular site and the relationship between the elements constituting that site. In many cases, one has to model complex environments that have a rich historical content. These are composed of several objects with various characteristics and it is essential to combine data from different sensors and information from different sources. There is no single approach that works for all types of environment and objects. A general approach combines information from historical material, multiple images, single images, laser scanner data, known shapes, CAD drawings, existing maps, survey data, and GPS data (Valzano, Bandiera, & Beraldin 2005).

This general approach was applied to the three projects mentioned above.

4. *Digital Resources: three-dimensional reconstruction and virtual representation*

The black-figure krater of Cavallino, the Zeus of Ugento and the Hypogeum of the Caryatids of Vaste were the subjects of digital acquisition, three-dimensional reconstruction and virtual representation by the SIBA Coordination of the University of Salento, directed by Virginia Valzano.

The three-dimensional reconstruction and virtual representation projects, initiated and coordinated in 2008-2010 by V. Valzano, as well as the three multimedia products created, required the use of specific methodologies and technologies, now mature and consolidated, and a number of highly specialized professionals and skills.

They were created thanks to the collaboration of CASPUR (Interuniversity Consortium for Supercomputing for University and Research) of Rome and the Canadian NRC (National Research Council Canada), and the advice of the archaeologists of the University of Salento, Francesco D'Andria and Katia Mannino, as well as the precious collaboration of the visual & interaction design architect Andrea Brogi, prematurely deceased a few days ago, to whom this article is dedicated.

This paragraph presents a summary of the 3D modeling work and virtual representation that was accomplished in preparing the multimedia products for cultural heritage interpretation and communication.

4.1 Divine Heroes. A krater from Cavallino and his tales

The first example presented concerns the modeling of the black-figure krater of Cavallino with refined depictions inspired by the exploits of heroes from Greek mythological tales (see above section 2.1 and Figs. 2, 3, 4).

The high resolution 3D acquisition was achieved by use of 3D laser scanner specifically designed for small and medium size objects.

A series of 2D images were captured in order to texture map the 3D model (Fig. 12).

a) b) c) d)

Fig. 12: The krater from Cavallino: a) Provincial Museum "S. Castromediano", Lecce – 3D acquisition; b) 3D Model wireframe; c) 3D Model flat rendering; d) 3D Model textured.

The animation of the model was created using computer vision and computer graphics techniques for visual communication.

The video documentary, intended for a wide audience, was made with mixed techniques of 3D visualization and video shooting.

The work, designed and coordinated by Virginia Valzano, was published in three languages, Italian, English and Greek, on the DVD Video "*Divini Eroi*: *un cratere da Cavallino e le sue storie. - Divine Heroes: a krater from Cavallino and his tales - Θεϊκοί ήρωες. ένας κρατήρας από το Καβαλλίνο και οι ιστορίες του*", created for the Province of Lecce as part of the Interreg project "Sul Cammino di Enea" (On Aeneas's track), and funded by the European Union (Valzano, Mannino, Bandiera, & Brogi, 2009).

The DVD video was ranked first at a national level in the "e-Culture and Heritage" category of the Italian eContent Award 2009, and represented Italy at an international level at the World Summit Award 2011.

The product was awarded the prize for the best cultural content in digital format, for scientific rigour, innovative methodology and technology applications (Alfredo Ronchi, eContent Award Italy, 2009)[4].

The three-dimensional reconstruction and virtual representation of the krater, in full colour, is available in stereoscopy, in real time and interactively, through the Virtual Theater 3D of CEIT.

The video-documentary is freely accessible online on the CEIT website, at the address http://www.ceit-otranto.it/index.php/progetti/33-divini-eroi, and to these addresses:
IT:https://vimeo.com/407174926;
EN: https://vimeo.com/407230486;
EL: https://vimeo.com/407299811.

The multimedia product, accessible to all, facilitates the study, enhancement and use, even from a distance, of the indigenous settlement of Cavallino and of the significant artifacts discovered on the site, thus contributing to a broader knowledge of the history and civilization of ancient Salento.

4.2 Lord of Sky and Thunder. The Zeus from Ugento

The second example presented concerns the modeling of a bronze sculpture known as the Zeus of Ugento.

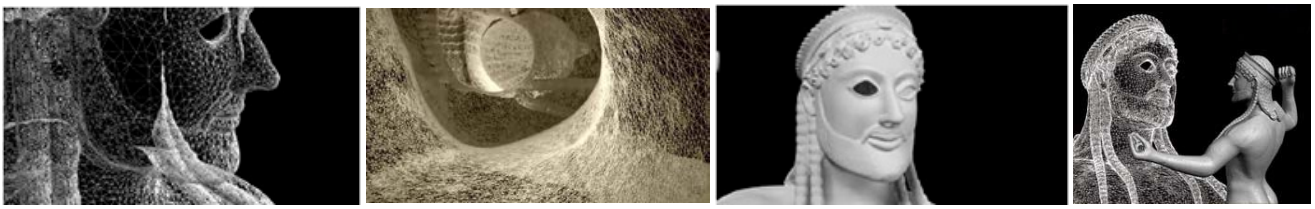
The project involved the creation of a high-resolution 3D model of the bronze statue. Bronze, which is used frequently for statues, poses a number of challenges to the 3D photographer. The material is fairly specular even if the statue is more than 2500 years old! The surface looks dark but when a light source is shone on it, both diffuse and specular components appear. A number of tests were conducted to determine the best system to measure the surface of this bronze statue.

After a number of tests, it was decided to use a specific 3D laser scanner for objects in material with a low coefficient of reflectivity, and up to one cubic metre in volume, to obtain the high-resolution 3D acquisition and elaboration of this

[4]Alfredo Ronchi is a professor at the Department of Architecture, Built Environment and Construction Engineering of the Politecnico of Milano (Itay). He is the General Secretary of the European Commission-MEDICI Framework (Multimedia for EDucation and employment through Integrated Cultural Initiatives) and the Secretary of the European Working Group on "EU Directives and Cultural Heritage". He is the President of eContent Award Italy and member of the World Summit Award Grand Jury.

a) b) c)

Fig. 13: Final 3D Model of Zeus of Ugento showed using synthetic shadings (colour information has been removed to reveal the surface details): a) photograph, Museum of Taranto, Italy; b) frontal view; c) back view;



d) 3D Mdel of Zeus – details.

masterpiece of Archaic art of Magna Graecia (Valzano, Bandiera, & Beraldin, 2005).

A mirror of high optical quality, able to reflect the light beams of the laser, was created so as to reproduce the internal details of the hands, which were not directly accessible by the scanner. The colour has not been acquired for this application. (Beraldin, Picard, El-Hakim, Godin, Valzano, & Bandiera, 2005) (Fig. 13).

The project, designed and coordinated by Virginia Valzano, was carried out as part of the LAND-LAB (Multimedia Laboratory for research, formation and communication of archaeological landscapes) project, co-financed by the European Union, P.O.N. 2000-2006, and was published, in Italian and in English, on the multimedia DVD-ROM "*Il Signore della folgore. Lo Zeus di Ugento - Lord of Sky and Thunder. The Zeus from Ugento*" (Valzano, Mannino, Bandiera, & Negro, 2010).

The DVD-ROM was ranked second nationally in the "e-Science and Technology" category of the Italian eContent Award 2010, and was awarded the prize for the best cultural content in digital format, for scientific rigour, innovative methodology and technologic applications.

The multimedia product, of very high cultural, scientific and technological value, contains the three-dimensional reconstruction and virtual representation of the Zeus of Ugento, interviews and a documentary video that pleasantly leads – through an original and enveloping background music by Gioacchino Palma – scholars and lovers of history and technology to a new level of knowledge of the archaeological heritage of the Salento area and of this masterpiece of Archaic art of Magna Graecia.

The documentary-video is freely accessible to all on the CEIT website, at the address http://www.ceit-otranto.it/index.php/progetti/32-zeus-di-ugento, and at these addresses:
IT: https://vimeo.com/406667390;
EN: https://vimeo.com/406683107.

4.3 The Hypogeum of the Caryatids at Vaste: reconstruction and virtual representation

The third example presented is about the modeling and virtual reconstruction of the Hypogeum of the Caryatids at Vaste.

As has already been said, at the end of the nineteenth century the Hypogeum of the Caryatids was already reduced to a pile of stones, so that today the only remains are the sculptures that were recovered at different times, and currently exhibited separately in two museums.

A caryatid and a bas-relief are kept in the "Sigismondo Castromediano" Provincial Museum at Lecce, whilst the other three caryatids and the second bas-relief are in the National Archaeological Museum at Taranto.

The "Coordinamento SIBA" of the University of Salento, with the collaboration of the CASPUR of Rome, subjected the four caryatids and the two bas-reliefs of the Hypogeum of Vaste to 3D reconstruction and virtual representation.

The high resolution 3D acquisition was achieved by use of 3D laser scanner specifically designed for statues and medium size objects.

A mirror of high optical quality was used so as to be to reproduce difficult undercut areas, not directly visible by the scanner (Fig. 14).

The 3D models of the Caryatids and of the frieze fragments were realized for the Province of Lecce in 2008, as part of the project "In the tracks of Aeneas" PIC Interreg III A Grecia-Italia financed by the European Union.

The three-dimensional reconstruction and virtual representation of the four Caryatids and the two bas-reliefs, kept separately in two museums, represent the reunification and virtual repatriation of these precious finds in the province of Lecce (Fig 15).

Their relocation in the archaeological contexts and in the specially reconstructed spaces, within the entrance portal to the Archaeological Park of Vaste, allows a wide and in-depth use by diversified users and constitutes an element of tourist-cultural promotion of the territory.

Where imagination fails, technology succeeds. Archaeological finds now speak in 3D. Only the intervention of the 3D scanner was able to bring them together and give an idea of the funerary cult of the Hellenistic age.

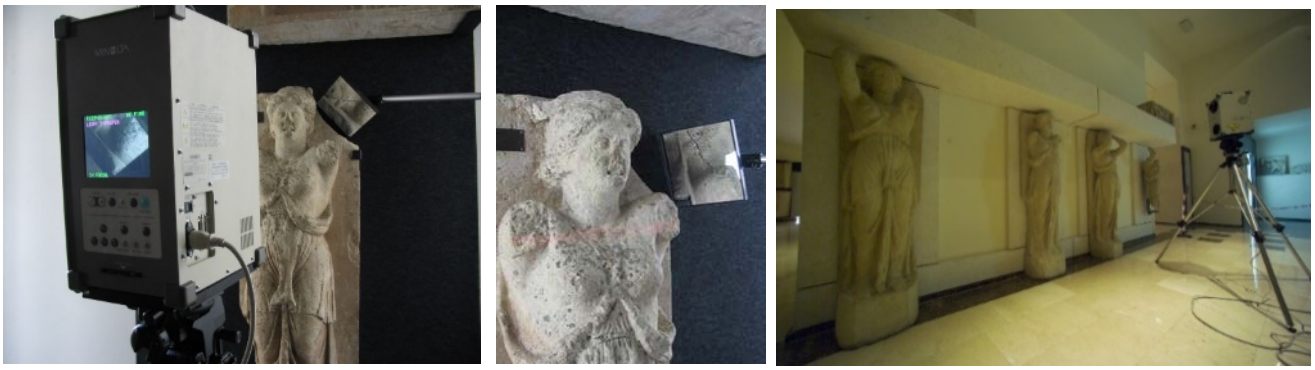


Fig. 14: Provincial Museum "S. Castromediano", Lecce; National Archaeological Museum, Taranto.

Fig. 15: 3D Models of the Caryatids.

The three-dimensional reconstruction and virtual representation of the entire Hypogeum of the Caryatids of Vaste were carried out later, in 2010, on the basis of the hypothesis of reconstruction of the same Hypogeum made by the archaeologists of the University of Salento, Francesco D'Andria and Katia Mannino, and through the use of different techniques of three-dimensional processing and virtual representation.

Fig. 16: Modeling and virtual reconstruction of Hypogeum of the Caryatids at Vaste.

As has already been said, it is a new and original reconstruction of the Hypogeum of the Caryatids, also resulting from the comparison made by the same archaeologists with the Palmieri Hypogeum of Lecce, a monumental tomb also from the Hellenistic period, located in a private property in via Palmieri, fully preserved and of extraordinary importance in the archaeological landscape of Salento.

The two bas-reliefs of the Hypogeum of the Caryatids, consisting of chariots driven by erotes and pulled by lions (symbol of the journey into the afterlife), always hypothetically referred to the facade of the Hypogeum in the past, are now on the sides of the steps leading to the funerary rooms, as in the Palmieri Hypogeum (Fig. 16).

The stereoscopic and interactive visualization of the 3D models of the Caryatids, of the bas-reliefs and of the entire Hypogeum is accessible through the 3D virtual theater of the CEIT of the University of Salento, which allows the immersive exploration of objects, environments and architectural structures, arousing the emotions and sensations of a live visit. Through the 3D virtual theater the past and history come to life in their real splendor.

The results of the project, designed and coordinated by Virginia Valzano, were published, in Italian and in English, in the multimedia DVD-ROM "*L'Ipogeo delle Cariatidi di Vaste - The Hypogeum of the Caryatids at Vaste*" (Valzano, Mannino, Bandiera, Brogi, & Zannoni, 2010).

The DVD-ROM was awarded among the best contents in digital format in the categories "eScience and Technology" and "eCulture and Heritage" of the Italian eContent Award 2010.

The multimedia product, of a very high cultural, scientific and technological value, contains the three-dimensional reconstruction and virtual representation of the Caryatids and the Hypogeum, 3d models and animations, interviews and a video-documentary.

This pleasantly leads scholars and lovers of history and technology to a new level of knowledge of the archaeological heritage of the Salento area, accompanied by an original and fascinating musical background composed by Gioacchino Palma.

The video-documentary is freely accessible on the CEIT website, at the address http://www.ceit-otranto.it/index.php/progetti/32-zeus-di-ugento and at these addresses:
IT: https://vimeo.com/407020593;
EN: https://vimeo.com/407121650.

Through various media (3D virtual theater and CD / DVD, the Internet), scholars and passionate tourists have, therefore, the opportunity to know more deeply and admire, even from a distance, the beauties of the archaeological heritage of the Salento area and to appreciate the results of scientific research carried out in southern Puglia on the archeology of the Messapians.

The methodology and technologies used for the three projects presented can be easily replicated for the three-dimensional reconstruction and virtual representation of environments, architectural structures and objects for which interventions are planned both for study and restoration and in order to spread their knowledge for cultural and tourist purposes.(Valzano, Negro, & Foschi, 2017; Valzano, Negro, & Lucarella, 2019).

5. Final considerations

Today, thanks to the new technologies, a high degree of realism can be achieved, and the context in which the artifacts were discovered or used can be recreated.

Real-world acquisition and modeling are now possible. Technological advances are such that the difficulties are more logistical than technological in themselves. Models of large objects, structures and environments are possible, even if they require the combination of a number of techniques and of specific skills and professional competencies.

The new technologies used in various disciplines have fostered new forms of communication and and fruition, as in the case of virtual technologies applied in the cultural heritage sector that allow the democratization of culture.

The fruition of cultural heritage, after being left aside for a long time, has assumed a fundamental role in recent years, so much so in the current phase of world health emergency.

Despite its tragic nature, this pandemic has offered Italian museums a great opportunity to progress in the development of digital technology both at the level of online sites and at the level of social networks.

During the lockdown period, videos showing images of the most beautiful Italian art cities completely deserted became viral, so that a number of digital initiatives, virtual tours, video schedules on YouTube were promoted by the Ministry for Cultural Heritage and Activities and Tourism, as well as a new social campaign, "*L'Arte ti somiglia*" (Art looks like you), which plays on the similarity between people and portraits in the works of art kept in Italian museums, to remind us of how important it is not to lose contact with the Italian cultural heritage.

Digital communication and multimedia have shown their generosity and creativity, but the not always positive and low-quality overproduction has highlighted the delays in our country.

It is necessary to invest in the production of high-quality digital content, in the necessary professional competencies and skills, in the correct and professional use of new technologies, so as to achieve effective communication and a deeper knowledge of cultural heritage.

The three multimedia products presented in this article are the result of pioneering projects that, 10-15 years ago, pushed 3D technology to higher levels, gave rise to new horizons and challenges in digital technologies, as well as to new models of scientific communication and universal use of cultural heritage, which today are more important than ever.

They ensure free and open fruition and knowledge of the Salentine cultural contents and archaeological heritage, in full compliance with the Italian Constitution and the principles of Open Science, a topic of remarkable importance, currently debated at national and international

level, which challenges today's scientific communication and research evaluation (Valzano, 2020).

To address this issue, CEIT-University of Salento held the national Workshop "Open Science: new models of scientific communication and research evaluation" in January 2019 (Lucarela, 2020), and the international open access Journal SCIRES-IT dedicated the special issue of 2020 to the same topic (Valzano, Cigola, & Gargiulo).

The above illustrated products and the advances in digital technologies, therefore, facilitate communication and foster the process of democratization of cultural heritage, understood as a common and universal good. Moreover, they enable the fruition and sharing by anyone and anywhere; promote the strengthening of the collective dimension and the practices of safeguarding and enhancing cultural heritages shared by communities, as envisaged by the "Council of Europe Framework Convention on the Value of Cultural Heritage for Society", approved in 2005 in Faro (Portugal) and ratified by Italy on 23 September 2020, after 15 years.

Among its main objectives, the Convention, known as "The Faro Convention", aims, on one hand, at actively involving citizens not only in the fruition of cultural heritage, but also in its protection and management; on the other, it serves as a reminder that Cultural Heritage is an instrument of dialogue and peace among people of other cultures. The Faro Convention was born, in fact, as an instrument of peace, dialogue and sharing of knowledge among citizens and to allow a wider and more participatory fruition of cultural heritage (Volpe, 2020b).

The direct relationship with the works of art and places can never be replaced by virtual means but undoubtedly they allow for a more detailed analysis of the context of the work, as well as the reconstruction of the lives of the objects before they are kept in museums. Digital applications and virtual fruition can bring together distant historical moments in a single context so that places that actually cannot be accessed or that no longer exist, such as the Hypogeum of Vaste, are made accessible thanks to these tools.[5]

[5] Katia Mannino: Paragraphs 1-2, 2.1, 2.2, 2.3; Virginia Valzano: Paragraphs 3-4, 4.1, 4.2, 4.3; Katia Mannino and Virginia Valzano: Paragraph 5.

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