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SCULPTURAL FRAGMENTS FROM THE CHURCH OF SAN GENNARO EXTRA MOENIA IN NAPLES: DIGITAL TWINS FOR HERITAGE KNOWLEDGE, ANALYSIS AND FRUITION

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Abstract

This paper examines the role that new technologies and digital representation strategies can play in the conservation and enhancement of the medieval sculptural heritage, often difficult to understand due to its fragmented and lacunar state. The case study presented is the apparatus of sculptural fragments belonged to the Church of San Gennaro Extra Moenia in Naples and today preserved in the Palatine Chapel of the Castel Nuovo Museum. The creation of a library of digital twins becomes a useful tool for academics, enabling them both to enrich their knowledge of sculptural fragments and to advance hypotheses and reconstructive analyses in a digital environment. The design of a virtual reality experience through the use of QR codes and Google Cardboard also allows the creation of new ways of fruition of medieval heritage, especially for non-expert audiences who do not always appreciate traditional methods of cultural meaning transmission.

Keywords

Medieval sculpture, digital twins, virtual reality, virtual reconstruction, digital representation

1. *Introduction*

Over the last two decades, the new information and communication technologies and the digital tools have assumed an increasingly dominant role in our society, spreading into every aspect and sphere of daily life. This domain has led to a radical paradigm shift in the way in which humans, digital artefacts and the outside world communicate and interact (Simondon, 2017), also involving the world of art and cultural heritage. We have experienced the construction of a true digital culture (Damiani, 2020) and the codification of new communication systems and strategies for the fruition of the historical and artistic heritage. The main purpose of these new practices is to enable new and wider publics to understand the expressive meanings of cultural heritage, especially in those fragmented, incomplete and lacunar cultural goods that risk remaining mute without subjects able to perceive and interpret them (Toscano & Gremigni, 2008). Although the digitalisation of cultural heritage is now a collectively accepted practise that is recognised as a fundamental step for the preservation and enhancement of collective memory and identity (Scuderi & Salvetti, 2019), it is evident that the heterogeneity and complexity of cultural heritage leads to the consideration of different interpretative methodologies and intervention strategies for each case. In this specific case, this contribution focuses on the still little researched and promoted medieval Italian sculptural heritage, a central topic of the more general research project 'MemId. Memory and Identity. Reuse, reworking and repurposing of medieval sculpture in the Modern Age". The MemId project, conducted by three research units (University of Trento, University of Naples Federico II, University of Genoa), aims to undertake an innovative programme of in-depth study on the topic of medieval sculpture through an FISR research grant financed by the Ministry of University and Research. Medieval sculptural apparatuses have often been subject to decorative, functional or location modifications over the centuries (Cavazzini, Di Fabio, & Vitolo, 2021), due to their high historical and artistic value, their ease of adaptation to new contexts and their representative and symbolic value. This has inevitably impacted the preservation and knowledge of these sculptural artefacts, which have often come down to us fragmented and incomplete, both in their material aspect and in

terms of their original meaning and value. We wondered, therefore, how new technologies and advanced representation strategies could intervene to preserve and enhance the invisible information that every historical-artistic artefact contains within itself and that goes beyond the material dimension (Ott & Pozzi, 2008). In-depth knowledge of the artefact becomes, in fact, a fundamental prerequisite for its understanding and preservation over time; the correct and appropriate use of new technologies can enable digital interventions on the sculptural apparatus, guaranteeing their full protection and conservation. The research also investigates how this knowledge can be used in the valorisation of this medieval heritage, looking at the correct use of technological tools and digital techniques to ensure the understanding and fruition of its historical memory and identity by both experts and the wider community.

2. *The case study*

The case study here described is the medieval sculptural apparatus now preserved in the Castel Nuovo Museum in Naples. The apparatus consists of twelve sculptural pieces from the Church of San Gennaro extra moenia, an ancient Neapolitan example of an early Christian three-nave basilica probably built between the late 4th and early 6th century (Cautela, Di Mauro, & Ruotolo, 2013). In 1987, these sculptural fragments were removed for safety reasons from the Church of St. Gennaro (Ebanista, 2018), where they were walled up in the semicircular apse - an important testimony of the original early Christian architecture - and were reassembled on a metal support frame in the Palatine Chapel of Castelnuovo (Fig. 1). The figurative pieces, identified by Gemma Cautela (1989), represent: at the top, the Virgin and Child with Saints Stephen and Benedict; below the Blessing Redeemer, two bishop saints, almost certainly Gennaro and Agrippino with benefactors; at the sides, the Announcing Angel and the Announced Madonna. Completing the sculptural apparatus are four architectural elements, consisting of two capitals and two pinnacles. The history of these fragments is troubled and, in some ways, still unclear; this is largely due to the continuous transformations that affected the Basilica of San Gennaro from the 9th century onwards. Over the centuries, the church was subjected to numerous changes, both

Fig. 1: Sculptural fragments from the Church of San Gennaro extra moenia preserved in the Palatine Chapel of the Castel Nuovo Museum in Naples (photo by the author)

functional, first becoming a hospital then a poorhouse, and structural, such as the replacement of the vaulting with a trussed ceiling in 1892 and the removal of superfetations in the early decades of the 20th century (Ebanista, 2018). These transformations also interested the decorative apparatus, especially the mediaeval one, which underwent phenomena of reuse, repurposing or rework. There is no information about when these sculptural fragments were walled up in the apse of the church, nor is their specific original location known. Written sources believe that these pieces must have belonged to the ciborium that adorned the apse in the 14th century (Cautela, 1989). No trace remains of such religious micro-architecture, but its presence in the basilica is certainly testified by the epigraphic slab of Prior Athanasius, who died in 1356, in which it is mentioned that he commissioned *"ciburium sup(ra) altare et arcu(m) marmoreu(m) i(n)t(roi)-t(us) chori"* (Cautela, 1989, p. 396). The relationship between these sculptural pieces and the ciborium is attested by a number of written sources, whose chronological history is reconstructed in detail by Carlo Ebanista (2018). The first to attest to the presence of the ciborium in the basilica was Alessio Aurelio Pelliccia (1785) identifying a medieval altar with the figures of Saints Benedict, Gennaro and Severinus. Christian Friedrich Bellermann (1839) recognised among the sculptures the Virgin and Child, some bishops, other figures and a blessing Christ. An important testimony linking the sculptural remains to the ciborium is that of Scipione Volpicella (1847) who recognised the remains of *"[...] un'importante commissione di mezzorilievo in marmo [...] dovevano ornare l'antico altare maggiore, del*

Fig. 2: The sculptural fragments surveyed for the construction of the digital twins catalogue. The pieces are shown in the double orthogonal projection method (author's image)

quale si riconosce ancora la struttura, e che venne abbandonato quando fu alzato il moderno davanti l'abside"[1] (Volpicella, 1847, p. 668). Volpicella identified the Madonna and Child and Saints Agrippino and Agnello in the upper walled area, the Eternal Father in the lower centre and Saints Gennaro and Severo in the area below, with two kneeling Benedictine monks, as well as the Virgin announced by the Angel. The remains were located in the apse in 1872 as described by Gennaro Aspreno Galante (1872) who reported the presence of "[...] *un'antica cattedra, episcopale o abadiale che sia* [...]"[2] (Galante, 1872, p. 451), to be identified with the remains of the fourteenth-century ciborium (Ebanista, 2018).

3. *Digital twins for heritage knowledge*

To meet the purpose of knowledge and valorisation of the medieval sculptural heritage inevitably means starting with a process of documentation, as this constitutes the prerequisite for any intervention on the existent. The main result that the MemId project aims to achieve is, in fact, the construction of an online database available to both researchers and the general public through which they can access the information sheets of each sculptural case examined during the research. New technologies can also make a contribution in this regard; in recent years, in fact, there has been considerable progress in digitalisation and cataloguing systems for cultural assets through the use of digital survey and three-dimensional data visualisation platforms (Cotter, 2004). The three-dimensional survey not only makes it possible to preserve those material, chromatic and geometric aspects that would risk being lost with surveys conducted using traditional methods, but also to create interpretative models of reality through which to identify compositional rules, define geometric laws and capture details of the cultural good (Gabellone, 2022). This means, therefore, constituting an imposing database through which to both conduct historical-philological hypotheses on the uses, functions and scenarios relating to the artefact in the past and predict its future conditions and evolutions. Starting from these considerations, we decided to build a library of digital copies of the sculptural fragments now preserved in the Palatine Chapel in the Castel Nuovo Museum (Fig. 2). The choice of the most appropriate surveying tools and techniques was defined following a preliminary inspection of the Palatine Chapel. The sculptural fragments belonging to the church of San Gennaro extra moenia are now preserved on the closing wall of the chapel's only rectangular nave. They are anchored to a metal frame fixed to the wall for the purpose of ensuring their state of preservation and maximum safety, due to the fragility of the sculptural pieces. Digital photogrammetry becomes, in this regard, the most appropriate method for acquiring the relief of fragments, allowing to acquire the necessary data without direct contact with the objects (Egels & Kasser, 2002). Moreover, it does not require prior recognition of position data in space or the cameras' orientation, differently from the stereo-photogrammetric method, thus simplifying and speeding up work operations in a museum environment open to the public. Another interesting aspect is the possibility of using low-cost digital cameras. In fact, the photographs were taken with a Nikon D5200 SLR camera,

[1] Translation of the author: "[...] an important commission of marble half-reliefs [...] they were to decorate the ancient high altar, the structure of which is still recognisable, and which was abandoned when the modern one was raised in front of the apse".
[2] Translation of the author: "[...] an ancient cathedra, whether episcopal or abadial [...]".

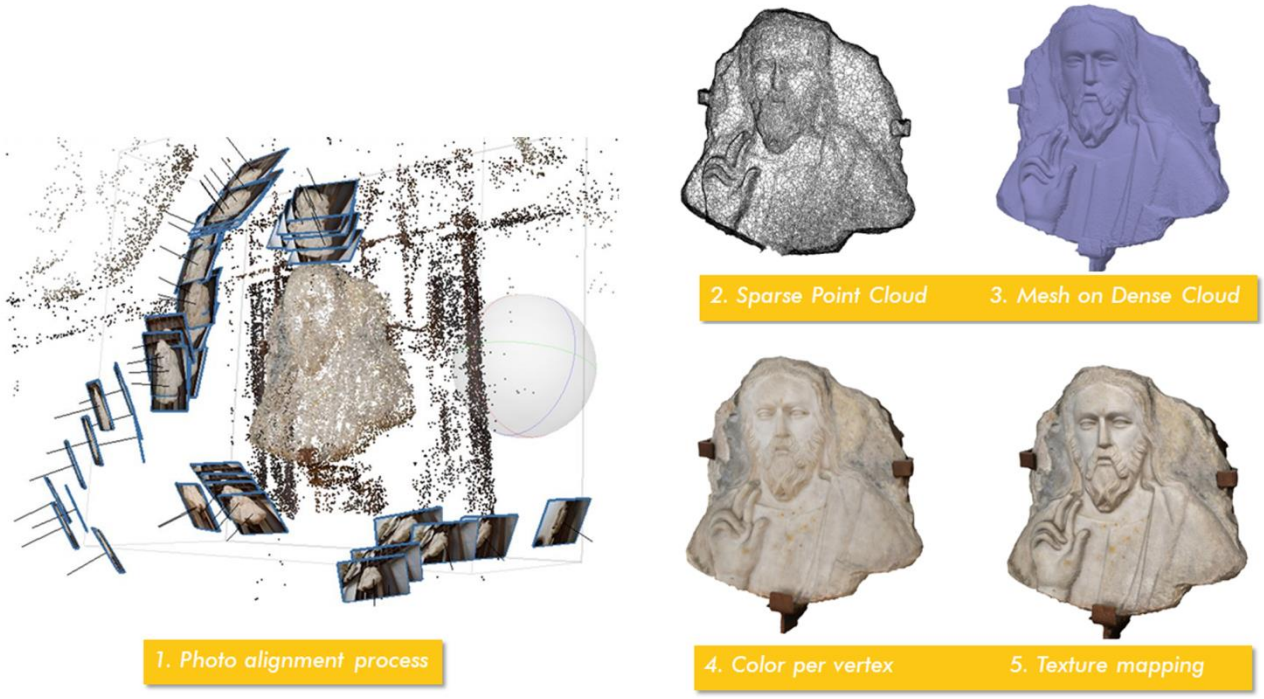

Fig. 3: Phases of the photogrammetric process applied to the case study of medieval sculptural pieces. The example of the Blessing Christ (author's image)

setting up an AF-P DX NIKKOR 18-55mm VR zoom lens and an AF-S DX NIKKOR 35mm fixed focal length lens, both suitable for close-range photogrammetry. The successful use of this surveying technique, however, depends on equally good planning of the shooting session, in which some necessary aspects were taken into account, such as the overlapping of at least 60 per cent of the photos taken, the capture of each individual point of the sculpture with photos taken from different heights and different viewpoints, and the maintenance of adequate and similar lighting conditions in all images. The images were captured using a converging axis camera system and, therefore, by constructing a circular photographic path around each sculpture. The impossibility of moving the sculptural pieces fixed to the frame made it impossible to capture the posterior parts of the fragments, which were later constructed in the digital environment. During the phase of image acquisition, great attention was paid to the lighting conditions of the environment and the effects on the relief of the colorimetric data; in fact, while the shape measurement in the digital survey is absolute, recording the position of each point of the sculptures, the colour measurement does not register the actual colour of the surfaces, but their chromatic appearance at the time of the capture. Each sculptural fragment was surveyed individually and without the use of flash, so as to avoid partial obstruction or the production of unpleasant shadows. In addition, illuminators and diffusers were positioned appropriately to make the surfaces homogeneously covered without losing the chiaroscuro shadows of each individual piece. The acquired data were imported into Metashape, a point cloud processing software; this was chosen because it uses the calculation technique known as Structure from Motion, which allows to obtain a digital model of the object through the automated collimation of the photographic points (Pereira Uzal, 2016). The data restitution phase followed the consolidated practices of digital photogrammetry (Fig. 3). The key points were then triangulated to derive the spatial co-ordinates, materialised in a sparse point cloud, subsequently densified to reconstruct the continuous triangulated surface (the mesh) at high quality, realised through complex modelling, filtering, data refinement and smoothing procedures. The surface model thus obtained was subsequently enriched by the chromatic and chiaroscuro aspect through texture mapping obtained by mosaicing the images of the photographic survey. Only the photo images with a value greater than 0.5 units were used to generate a high-quality texture; the software

automates the calculation of this value according to the level of sharpness of the most focused part of each photograph. The 3D model obtained with the SfM technique and Computer Vision enhances the possibilities of representation and communication of medieval pieces and allows to obtain a more complete and homogeneous semantic framework, in comparison to a heterogeneous and lacking corpus of documentation and information, typical of fragmented and lacunar sculptural apparatuses.

4. Digital twins for heritage analysis

The new digital surveying technologies allow to obtain flexible three-dimensional models, able to be adapted to different cognitive and communicative purposes depending on the visualisation mode. The 3D model of each medieval fragment, represented with realistic textures and authentic chiaroscuro effects (Fig. 4, Fig. 5), certainly becomes a knowledge resource for experts and academic researchers. The incompleteness of the piece itself demonstrates, in fact, the complexity of the case study and also becomes a field of investigation in relation to the original forms and geometries that can be analysed to the smallest detail (Hutson & Olsen, 2021). Mesh surfaces obtained with Metashape can be exported in OBJ format to most three-dimensional solid modelling software, allowing sculptural pieces to be interrogated, navigated and manipulated. In the present case study, polygonal meshes are exported into Rhinoceros software, together with the corresponding high-definition textures. The 3D virtual space allows not only to analyse, measure and scale the sculptural fragments, but also to carry out configurational tests, hypothesising the architectural context to which these fragments should belong (Hutson & Olsen, 2021). The written sources that have come down to us all agree on a link between the sculptural apparatus preserved in the Palatine Chapel of Castel Nuovo and that *"ciburium sup(ra) altare"* (Cautela, 1989) of the Church of San Gennaro fuori le mura reported in the tomb slab's epitaph of Prior Athanasius. The ciborium, in fact, does not exist to date and textual or illustrative descriptions of it are completely lacking; this constitutes the greatest limitation of the investigation of this medieval microarchitecture. Working in a virtual

Fig. 4: The 3D modelling results. From top to bottom: Virgin and Child, Saint Agrippino with a benefactor, Announced Madonna on capital. (author's image)

environment, however, does not preclude hypotheses on the original context to which the sculptural fragments belonged, also considering the possibility of examining the typological nature of the ciborium and constructing a reference scheme to express the essential properties of the artefact. As Giulio Carlo Argan states, in fact, "*il tipo è la risultante di un processo di interpretazione critica che tende ad evidenziare gli elementi comuni e ricorrenti riscontrabili in opere diverse; tende, cioè, a ridurre la molteplicità delle soluzioni formali ad uno schema morfologico comune*"[3] (Argan, 1936, p. 39). The variety of materials used in the construction of a ciborium corresponds to a substantially constant structural scheme: the plan is generally squared on four vertical columns, connected by elements such as horizontal architraves or arches, the latter being solid, pointed or lobed. The roofing of the ciboriums, flat or vaulted, also takes different forms according to the symbolic value covered, and is often adorned with elements such as spires or pinnacles. It was therefore decided to reconstruct a hypothetical ciborium (Fig. 6) based on the typological and dimensional features of the architectural structure, deduced by comparison with existing ciboriums from the same historical period. The aim of the reconstruction is to transcend the spectacularisation of historical and artistic memory; the objective is not, therefore, to create a virtual clone, but a critical-interpretive - and therefore provisional and refutable - model that replaces the physical absence of the architecture. It must be remembered, in fact, that medieval sculptural apparatuses, as well as the architectural structures to which they belonged, have been the subject of phenomena of reuse, rework and repurposing since the Modern Age because of their features of symbolicity and ease of adaptation. This condition especially affected churches and liturgical furnishings, which underwent sometimes radical reorganizations of buildings and decorative arrangements due to changing religious practices and with renovation of styles. The medieval sculptures and microarchitectures involved in these processes were partly preserved, sometimes adapted to new uses, and in the worst cases demolished. This phenomenon also affected ciboriums, whose original function was to cover simple and modest altars, giving them dignity and prominence, both architectural and symbolic. Over the centuries, the altars assumed greater majesty and size and began not only to contain reliquaries but also to be placed further back within the sanctuaries.

Fig. 5: The 3D modelling results. From top to bottom: Pinnacle, Saint Gennaro with a benefactor, Saint Benedetto. (author's image)

[3] Translation by the author: "type is the result of a process of critical interpretation that tends to highlight the common and recurring elements found in different works; i.e. it tends to reduce the multiplicity of formal solutions to a common morphological pattern".

This contributed to the gradual disappearance of the ciboriums and the reuse of their parts; for example, the four columns were often reused as riddel posts on or near the four corners of the high altar. These considerations are fundamental to understand the logic of the reconstruction of the ciborium of San Gennaro Extra Moenia. Most of the medieval ciboriums on the Campania territory, in fact, no longer exist, as in the case of the marble ciborium in the Church of San Giorgio Maggiore ai Mannesi, or there are only fragments remaining, as in the case of the ciborium in Ravello Cathedral. Major permanences of original ciboriums can be found in Rome, such as that of San Lorenzo fuori le mura, San Clemente, San Paolo fuori le mura, San Giorgio in Velabro, San Giovanni in Laterano, and Santa Maria in Cosmedin. Although it is clear that regional and stylistic variations could have existed, these examples represent the closest comparative element to the ciborium studied and, therefore, become the main cases in the comparative analysis. We added to them other related cases from Lombard workshops, such as the ciborium of Sant'Ambrogio in Milan and the ciborium of the Church of San Pietro al Monte in Civate, selected for the presence of high-reliefs and sculptural decoration in the tympanum. In fact, reference dimensional ranges of this microarchitecture have been identified (Severini, 2015), such as the height of the columns (1.40 - 2.30 m), the height of the archivolts (0.70 - 1.00 m), their width (1.40 - 3.30 m) and thickness (8.00 - 12.00 cm). They are then related to the morphological and dimensional features of the figured sculptural fragments. The typological analysis of the ciborium, the properties of the individual fragments surveyed and the current conservation scheme of the sculptural apparatus allowed the identification of marbles that correspond to a plausible configuration of the spatial organisation and assembly of the ciborium. The pinnacles, for example, were arranged according to their architectural function, as were the capitals, which also influenced the positioning of the Announcing Angel and the Virgin Annunciate to which they are anchored. The figurative pieces, such as the Blessing Jesus and the Virgin and Child between Saints Stephen and Benedict, were relocated on the arch, respecting the positioning in the current conservation scheme. The bas-relief of the two holy bishops St. Gennaro and St. Agrippino, on the other hand, was not included in the

Fig. 6: 3D model of the ciborium. The reconstruction does not claim to represent the original 14th-century ciborium, but to create an analysis model to investigate shapes, proportions and positioning of the sculptural fragments in an artefact that no longer exists. (model by the author)

reconstruction, because it was not supported by the amount of data necessary to define its role and location in the ciborium. The considerations carried out are also compatible with the features of the reference presbytery in which the ciborium was supposedly placed. The reconstruction does not pretend to represent the ciborium in its original features, but to create a semantic model through which to solicit reasoning on the forms and proportions of an artefact that no longer exists. The modelled ciborium has medium dimensional values in relation to the above-mentioned reference ranges, also in consideration of the measurements of the existing capitals. In this model, the fragments inserted in the upper part appear slightly oversized. It is possible, therefore, either that the ciborium was larger - and thus the capitals with the annunciation did not belong there - or that the fragments on the arch had another decorative function. The announcing angel on the lower left, in fact, seems to show various references to the Virtue holding up the Tomb of Mary of Valois in St. Clare, while the Madonna and Child is comparable in type to a fragment of the Sarcophagus of Giovanni da Capua depicting the same subject. It cannot

therefore be excluded that some sculptural fragments may have belonged to a funerary monument and not to the ciborium. From a communicative point of view, great attention is paid to the visualisation aspects of reconstruction. With the idea that "*il Disegno dell'Architettura definisce ed esalta somiglianze, analogie, regole e deroghe, proponendosi come mezzo per 'rendere evidente un'assenza' (il progetto), o per documentare il costruito (il rilievo)*"[4] (Panza, 2010, p. 336), we decided to keep the sculptural pieces textured and realistic, as they exist and are actually surveyed. The architectural parts, on the other hand, not existing and being hypothetical, are reproduced with a light and transparent material, devoid of details. This communicates the not built and the not certain but, at the same time, becomes volumetric, geometric and formal expression of the artefact obtained through typological investigation and comparison with similar micro-architectures.

5. Digital twins for heritage fruition

In today's society, in which the concept of information culture is parallel to that of visual culture (Manovich, 2005), new technologies have certainly influenced our perception of cultural heritage (Arizpe, 2000), with effects on the way we know and experience the world. New strategies of fruition become a valuable tool for non-expert audiences, especially in understanding medieval sculptural pieces. These, in fact, especially when they have undergone transformation phenomena, are often marked by time, fragmented and lacunar, or extracted from their original context; technologies can contribute, therefore, to bridging that gap between what is perceived and the underlying meanings (Albisinni & Ippoliti, 2016). It is obvious, however, that the use of ICTs should follow a coherent and critical approach, generating narratives that privilege quality, readability of data and the transmission of organised and measurable knowledge of the good, rather than producing phantasmagorical and hyper-realistic images that distract attention from the very meaning of cultural heritage. The risk is not only to fall into processes of rapid obsolescence and "digital disruption" (Page, 2019), but also into phenomena of trivialisation and exaltation of the ephemeral which new technologies can potentially entail (Cerquetti, 2015). For this reason, we decided to include the three-dimensional models of the sculptural fragments in digital narrative strategies, as this mode of fruition follows the interactive and experiential communicative models to which the public is continuously exposed through today's media and technologies. A QR code has therefore been designed for each sculptural fragment, constituting a unique marker of association with the 3D model uploaded onto the Sketchfab platform (Fig. 7). The user only needs to frame the QR code with their mobile device - smartphone or tablet - to open the link to which the model is connected. Inside the Palatine Chapel, therefore, the visitor will be able to activate the display of the 3D model, navigate it and perform the basic operations of movement and zoom. In order to obtain responsive content, it was necessary to intervene on the models by reducing the number of polygonal faces. The reduction was done with acceptable values that would allow for less complex three-dimensional models, and thus faster loading, but without excessive loss of visual information. The visualisation of the sculptural fragments is also set to be enjoyed in virtual reality through Google – Cardboards (Fig. 8). These are inexpensive and affordable visors, compatible in size with most smartphone models on the current market. The price of the box-visors varies depending on the quality of the material and the aspherical PMMA lenses (polymethyl methacrylate), but is undoubtedly more affordable than the Oculus Rift, as it uses the mobile phone display as screen. Once the eyesight splitting on Sketchfab is activated, the visitor inserts the smartphone into the Google Cardboard, enjoying a virtual and immersive experience without loss of quality. Although the experience can also be lived remotely, due to the fact that the three-dimensional model is uploaded on a public platform, it was decided to insert the reference QRcodes only inside the museum, for the purpose of realising a more appreciable and emotionally evocative experience that is in no way intended to replace the real-life experience. The strategy of perceptive immersion, in fact, is designed

[4] Translation by the author: ""the Drawing of Architecture defines and exalts similarities, analogies, rules and exceptions, proposing itself as a tool to 'make evident an absence' (the project), or to document the construction (the survey)".

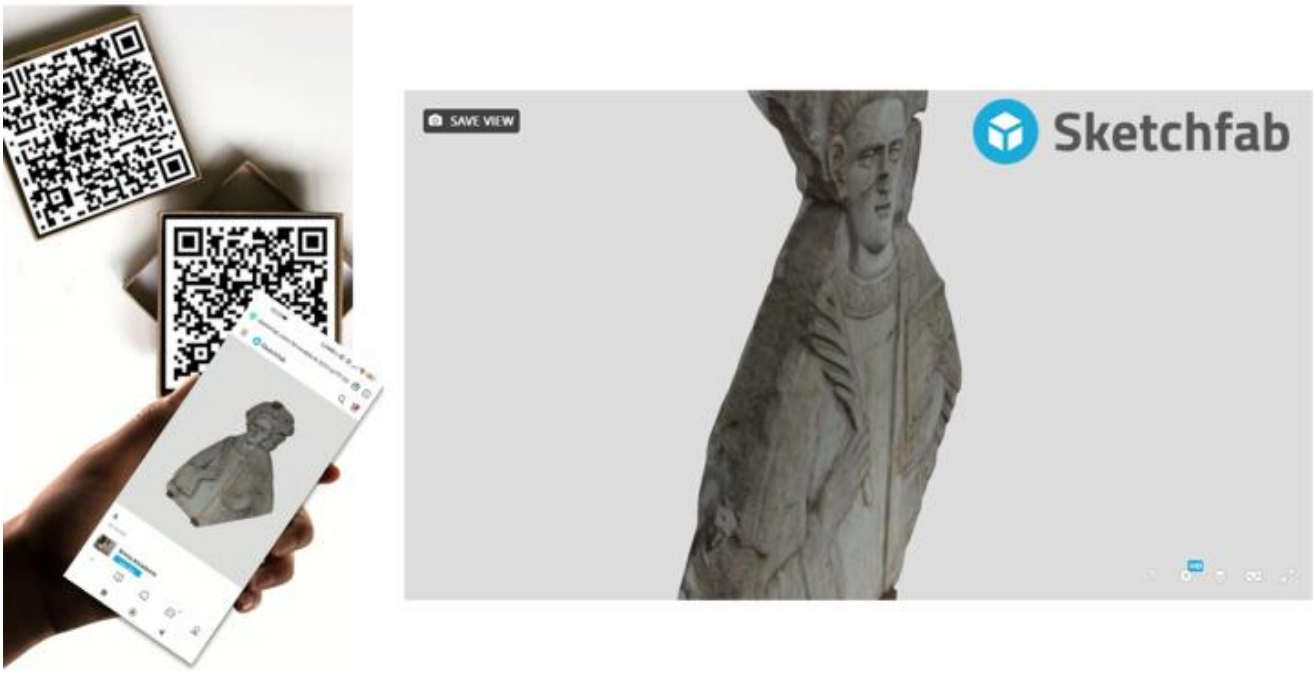

Fig. 7: Digital fruition through Sketchfab of 3D models, each one linked to a unique QR code (author's image)

especially for those new audiences, generally young people and children, who do not recognise themselves in traditional and linear methodologies of cultural transmission.

6. Conclusions

This paper is part of the wider MemId project, a research project in which the integration of interdisciplinary knowledge is aimed at the knowledge and valorisation of the medieval sculptural heritage, which is still little investigated. In particular, this contribution shows, through a case study of the project, how the use of new technologies and advanced techniques of digital representation can be a valid tool to support both scientific research and the dissemination of medieval art. Historical-artistic knowledge, in fact, is integrated and supported by surveying and digital representation techniques, enabling the analysis and drawing of the existing, the extraction and representation of new knowledge, as well as the production of new strategies for the communication and enjoyment of cultural heritage. The construction of a digital database of virtual copies for the medieval sculptural fragments of San Gennaro extra moenia becomes the first indispensable tool for enriching the existing documentation of this case study, which is necessary for all scientific experts and researchers. The construction of a free access portal to high-definition three-dimensional models also allows the development of considerations and plausible reconstructive hypotheses concerning the 14th-century ciborium of the church. The model becomes a tool for investigating and interpreting the formal and typological relationships between architecture and sculpture, between what still exists and what is only hypothesised. In particular, the different approach between the surveyed parts, shown in a realistic key, and the hypothesised parts, modelled in transparency and without details, becomes a communicative language aimed at showing the value of those existing artistic traces, without falling into examples of exaggerated realism or extreme veracity. At the same time, the relocation of the sculptural pieces in the ciborium and the attention paid to materials, textures and light, contributes to enriching the emotional and sensorial impact of the observer, ensuring a deeper and more aware understanding of the medieval sculptural apparatus. The use of new technologies, moreover, is experimented as a means of communication with a non-expert public; the use of virtual reality, in fact, can contribute to the construction of the meanings underlying medieval sculptural pieces, which are

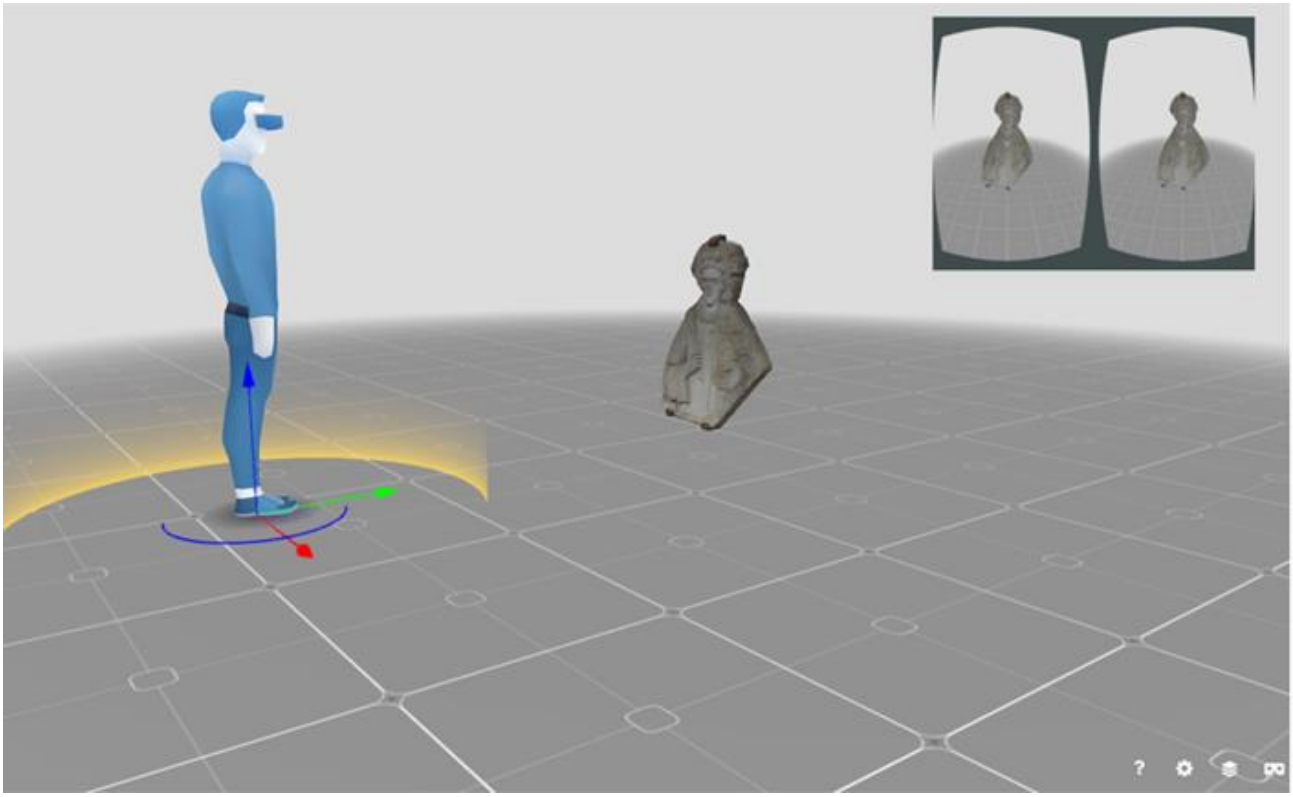

Fig. 8: Activating binocular vision with Sketchfab enables virtual reality fruition of 3D models through the use of Google Cardboard (author's image)

often misunderstood as lacunar and fragmentary. The research, therefore, intends to reflect on the ways in which the new technologies can contribute to the construction of a path of knowledge and valorisation of the medieval heritage, balancing the indispensable scientific assumptions of the field of representation with the communicative outcomes of the results through new forms of digital and virtual fruition.

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REFERENCES

Albisinni, P., & Ippoliti, E. (2016). Musei virtuali. Comunicare e/è rappresentare. *DISEGNARECON, 9*(17), 1-9.

Argan, G. C. (1936). *L'architettura protocristiana, preromanica e romanica.* Firenze: Nemi.

Arizpe, L. (2000). Cultural Heritage and Globalization. In E. C. Avrami, R. Mason, & M. De la Torre (Eds.), *Values and Heritage Conservation. Research Report The Getty Conservation Institute* (pp. 32-37). Los Angeles, CA: Getty Conservation Institute.

Bellermann, C. F. (1839). *Über die ältesten christlichen Begräbnisstätten und besonders die Katakomben zu Neapel mit ihren Wandgemälden. Ein Betrag zur christlichen Altertumskunde.* Hamburg: Forgotten Books.

Cautela, G. (1989). Il restauro del ciborio trecentesco della basilica di S. Gennaro extra moenia. *Campania Sacra, 20*, 391-400.

Cautela, G., Di Mauro, L., & Ruotolo, R. (2013). *Napoli sacra: guida alle chiese della città.* Napoli: Elio De Rosa.

Cavazzini, L., Di Fabio, C., & Vitolo, P. (2021). Introduzione. *MEFRM: Mélanges de l'École française de Rome: Moyen Âge, 133*(1), 1-4.

Cerquetti, M. (2015). The Importance of Being Earnest. Nuove sfide per le ICT in ambito museale. In F. Forlani, & T. Pencarelli (Eds.), *The Experience Logic as a New Perspective for Marketing Management* (pp. 1-5). Heldelberg: Springer.

Cotter, G. A. (2004). The digitization of museum specimens: Much is at stake as museums worldwide work to put their collections and data online. *Scientist, 18*, 8-9.

Damiani, S. (2020). *Arte e cultura digitale.* Roma: Aracne.

Ebanista, C. (2018). Nuovi dati sulla Basilica di San Gennaro Extra Moenia a Napoli tra Medioevo ed Età contemporanea. In P. De Vingo (Ed.), *Le archeologie di Marilli. Miscellanea di studi in ricordo di Maria Maddalena Negro Ponzi Mancini* (pp. 305-337). Alessandria: Edizioni dell'Orso.

Egels, Y., & Kasser, M. (2002). *Digital Photogrammetry.* London: Taylor & Francis Inc.

Gabellone, F. (2022). Digital Twin: a new perspective for cultural heritage management and fruition. *Acta Imeko, 11*(1), 1-7.

Galante, G. A. (1872). *Guida sacra della città di Napoli.* Napoli: Stamperia del Fibreno.

Hutson, J., & Olsen, T. (2021). Digital Humanities and Virtual Reality: A Review of Theories and Best Practices for Art History. *International Journal of Technology in Education IJTE, 4*(3), 491-500.

Manovich, L. (2005). *Il linguaggio dei nuovi media.* Milano: Edizioni Olivares.

Ott, M., & Pozzi, F. (2008). ICT and Cultural Heritage Education: Which Added Value? In M. Lytras, J. Carroll, E. Damiani, & R. Tennyson (Eds.), *Emerging Technologies and Information Systems for the Knowledge Society. WSKS 2008. Lecture Notes in Computer Science* (pp. 131-138). Berlin - Heidelberg: Springer.

Page, K. (2019). *The Edge of Disruption: Ride the Wave of Digital Transformation.* London: Kogan Page Ltd.

Panza, M. O. (2010). Stanze che hanno per tetto il cielo: dagli ipogei alla “camera urbana". In E. Mandelli, & G. Lavoratti (Eds.), *Disegnare il tempo e l’armonia: il disegno di architettura osservatorio 1* (pp. 330-337). Firenze: Alinea Editrice.

Pelliccia, A. A. (1785). *De christianae ecclesiae primae, mediae et novissimae aetatis politia IV.* Vercelli: Ex Patrio Typographeo.

Pereira Uzal, J. (2016). 3D modelling in cultural heritage using structure from motion techniques. *Ph investigacion, 6*, 49-59.

Scuderi, A., & Salvetti, F. (2019). *Digitalization and cultural heritage in Italy: innovative and cutting-edge practices.* Milano: Franco Angeli.

Severini, G. (2015). Il ciborio di Santa Maria antiqua: analisi comparativa e rilievo 3D per un'ipotesi di ricostruzione. *Temporis Signa. Archeologia della tarda antichità e del medioevo, X*, 140-160.

Simondon, G. (2017). *Sulla tecnica.* Napoli - Salerno: Orthotes.

Toscano, M. A., & Gremigni, E. (2008). *Introduzione alla sociologia dei beni culturali. Testi antologici.* Firenze: Le Lettere.

Volpicella, S. (1847). *Storia dei Monumenti del Reame delle Due Sicilie II/1. Principali edificii della città di Napoli.* Napoli: Stamperia e cartiere del Fibreno.