

Hertziana Studies
in Art History



BIBLIOTHECA HERTZIANA
MAX PLANCK INSTITUTE
FOR ART HISTORY

Visualizing Complexities

Practices and Heuristics of Digital Models in Art History

Edited by Nicola Camerlenghi, Tanja Michalsky & Elisabetta Scirocco



BIBLIOTHECA HERTZIANA
MAX PLANCK INSTITUTE
FOR ART HISTORY



Hertziana Studies in Art History

Editors

Tanja Michalsky & Tristan Weddigen

Managing Editor

Elisa Bastianello

All articles of the present volume have undergone an anonymous scholarly peer-review by international experts to whom we are grateful for their generous support.

Graphic Project

Sergio Polano (2019)

Michele Elia (2023)

Page Layout

Michela Maguolo

ISBN | 978-3-949381-01-0

DOI | <https://doi.org/10.48431/hsah.02>

Published online on 31 October 2023

© 2023 Bibliotheca Hertziana

Cover image: Rome, San Paolo fuori le mura, main altar, ca. 1823.
Reconstruction by Nicola Camerlenghi; 3D model by Evan Gallitelli;
image by Andrew Maurer.



Visualizing Complexities

Practices and Heuristics of Digital Models in Art History

edited by

Nicola Camerlenghi, Tanja Michalsky & Elisabetta Scirocco

Contents

7

Tanja Michalsky, Nicola Camerlenghi & Elisabetta Scirocco (eds.)
Introduction

13

Giacomo Landeschi
What is a 3D Model and Why Do We Model?
Some Reflections Built Upon Archaeological
Case Studies

19

Lex Bosman
The Fourth-Century San Giovanni in
Laterano in the Twenty-First Century: Digital
Approaches and Reconstruction

29

Angelica Federici
Visualizing Medieval Rome. The Basilica of
Sant'Agnese fuori le mura

37

Giulia Bordi
Visualizing Medieval Rome. Digital Storytelling
about the City and its Churches

47

Nicola Camerlenghi
Virtual St. Paul's Basilica 2.0. Developing an
Open Educational Resource

55

*Fabrizio Nevola, Donal Cooper, Chiara Capulli,
Luca Brunke*
Bringing Together Geospatial Information, 3D
Modeling, Experiential Learning, and Research
Data. The Ospedale degli Innocenti: A Case
Study of the Florence 4D Project

63

Andrea Giordano, Paolo Borin
Visualizzare la complessità: Fondamenti BIM
per il progetto *Visualizing Cities*

71

Ruggero Longo
Digitizing Cultural Heritage. Methodology,
Potential, and Limits of the Palermo Royal
Palace Project

83

Piotr Kuroczyński
Serious 3D in Art and Architectural History

Abstract

Giulia Bordi

Visualizing Medieval Rome. Digital Storytelling about the City and its Churches

keywords – 3D models, Virtual Reality, Medieval artistic heritage, Atlas, EHEM project



Since 2006, we have embraced the challenge to recontextualize and visualize wall paintings, mosaics, and panel paintings in medieval Rome's sacred buildings with digital technologies. We started with the project Atlas. Visual paths, setting paintings in space, rejoining them visually with architecture through plans and 3D digital models. We continued with the Santa Maria Antiqua Exhibition (2016–2021) experimenting with a multimedia path marked by video mapping, light mapping and videos aimed at displaying the history and complexity of the pictorial phases of the monument to a wider audience. 2020 marked the start of a new venture – EHEM (Enhancement of Heritage Experiences: The Middle Ages. Digital Layered Models of Architecture and Mural Paintings over Time). This is a three-year project, managed by a consortium of the Universities of Barcelona, Roma Tre, Tuscia (Viterbo) and the CYENS (Cyprus), and funded by EU Horizon 2020 (JPICH-0127). The project aims to obtain virtual reconstructions of medieval artistic heritage – architecture with mural paintings – over the centuries incorporating art historical knowledge and the diachronic perspective of heritage, as an instrument for researchers, restorers, and heritage curators and to improve the visitor's perceptions and experiences.

DOI: [10.48431/hsah.0205](https://doi.org/10.48431/hsah.0205)

Visualizing Medieval Rome. Digital Storytelling about the City and its Churches

Giulia Bordi

My interest in the world of 2D and 3D digital reconstructions began in 2004, when I started working on the project *Corpus and Atlas of Medieval Painting in Rome* (313 to 1431).¹ The *Atlas. Visual Paths* was designed by Maria Andaloro who challenged a group of her PhD students to find ways to reposition medieval Roman paintings – often reduced to fragments – within their context.² This entailed visually reuniting them to the architectural elements for which they were originally conceived (fig. 1). The *Atlas* was born with the specific goal of recontextualizing wall paintings, mosaics and panel paintings in Rome's sacred buildings, following a topographical order articulated on two levels: the topographic location of the monument within the city, organized in its historic districts, and its spaces. The *Atlas* was developed over eleven years through the use of plans and sections together with 2D and 3D digital models.³

In synthesis, the *Atlas*:

- virtually relocates the detached paintings onto their original walls;
- displays decorations that have since disappeared, but are documented by drawings, watercolors and engravings;
- magnifies the decorations, now reduced to fragments, inside their original architectural contexts, despite their having been modified over the centuries;
- showcases the different chronological decorative phases on a wall.

The *Atlas*, therefore, allows us to visually re-read pictorial documents within an integrated system.

Our aim was not to advance ideal or evocative reconstructions, but to create 2D and 3D graphic elaborations designed to emphasize the link between the wall paintings and the architectural contexts as they were originally designed.

We started from a 3D model derived from the direct survey of the architectural structures (at first using a total station and subsequently a 3D surface point cloud).⁴ When the monuments were destroyed or significantly modified by subsequent interventions, we used indirect surveys on the basis of historical documentation, rebuilding exclusively the internal space of the churches.

Onto the latter we then added images of:

1. existing paintings;
2. detached paintings;
3. drawings, watercolors or engravings in the case of lost artifacts.

These reconstructions were originally conceived for printed volumes, but this is only the first step of many, which aim to visually transmit Rome's medieval heritage to a wider audience, using mainly the Web. We now aim to integrate 2D and 3D reconstructions with visual and textual content in a specific geolocated digital environment. Our intention is to offer visual paths through which diverse audiences can enjoy the paintings of the Roman Middle Ages within their original architecture in and around the city. The aim for the near future is to join a digital platform such as DynASK–Dynamic Atlas of knowledge developed in the Department of Architecture of the Roma Tre University (scientific coordinator: Antonio Pugliano). This digital

1 The project was created and directed by Maria Andaloro (Tuscia University of Viterbo) and Serena Romano (Université de Lausanne).

2 Andaloro 2006a; Andaloro/Bordi/Viscontini forthcoming.

3 Bordi 2018, pp. 61–67.

4 The survey was carried out by Pasquale Tunzi and Pierpaolo Palka from the Gabriele d'Annunzio University of Chieti and Integra Software e rilievi s.r.l and then by Marco Carpiceci and his team from the Engineering

Department at La Sapienza University (Rome). Arch. Gianni di Benedetto was instead responsible for the graphic and modeling of the renders.

Figure 1
Rome, St Paul Outside the Walls, nave, south wall, 3D model.
Photo: Andaloro 2006a.

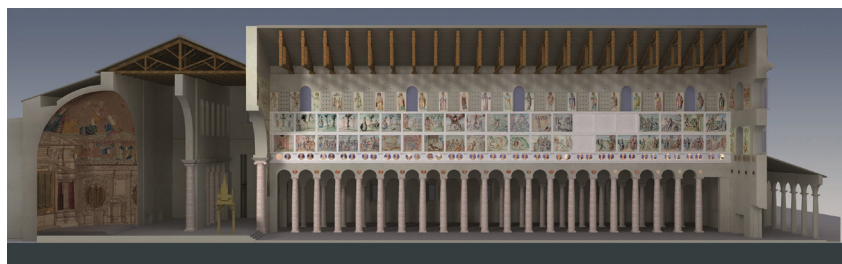
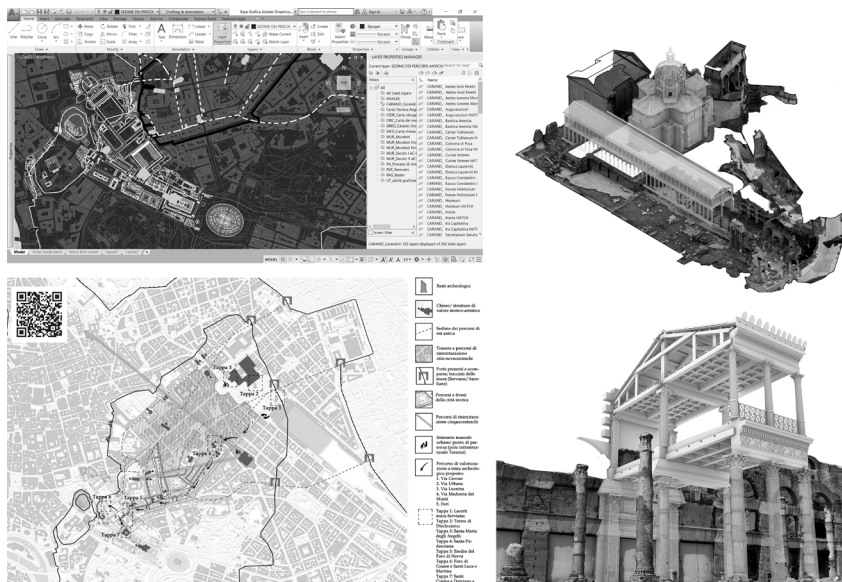


Figure 2
DynAsk project: a) Rome, archaeological central area, geographical DB; b) example of an urban itinerary in the central area of the city; c-d) Archaeological central area, 3D models of lost buildings.
Developed by Marco Piccoli and Max Vita, in Pugliano 2021.



information system on a geographical basis aimed at deepening the knowledge of Rome and its Metropolitan Area by protecting the urban fabric from exploitation while at the same time forecasting seismic and hydrogeological risks.⁵ The platform already comprises several cartographies of Rome ranging from the *Forma Urbis* to Nolli's map, from the Gregorian Land Registry, to both Lanciani's and Muratori's maps. All geographical and historic information are collected in a database both textual and graphic; the information in the GeoAI system is redrawn in AutoCAD and implemented into a GIS. At the moment the system manages over two thousand thematic information layers.⁶ In this frame, our 3D models of churches (from 4th to 15th century) will be linked to the maps of medieval Rome, such as Muratori's, which, in the future, will allow the larger audience to explore the city and discover its pictorial treasures (fig. 2).

Santa Maria Antiqua Exhibition

To this end, the 2016 exhibition *Santa Maria Antiqua. Between Rome and Byzantium*, was a crucial test for us. The exhibition was curated by Maria Andaloro, Giuseppe Morganti and me on the occasion of the extraordinary reopening of the church after a restoration phase which lasted fifteen years.⁷ The church of S. Maria Antiqua at the Roman Forum was discovered in 1900 on the west slope of the Palatine Hill. Its surviving wall paintings represent a unique heritage in the Christian world between the 6th and 10th centuries. The pictorial decoration testifies to the development in the Middle Ages of both painting in Rome, and – due to the destruction brought upon sacred images by Iconoclasm – that of the entire Byzantine civilization.⁸ The 'palimpsest wall', considered by many scholars a milestone in the history of medieval

⁵ The project is presented in detail in a recent volume edited by Pugliano 2021.

⁶ Pugliano 2021, pp. 19–32.

⁷ Andaloro/Bordi/Morganti 2016.

⁸ See now the volume: Rubery/Bordi/Osborne 2021.

Figure 3
Rome, Santa Maria Antiqua: a) interior; b) the
'palimpsest wall'.
Photo: Gaetano Alfano.



Figure 4
Still frame from the film projected on the
video wall in Santa Maria Antiqua. Virtual
restoration of the sanctuary wall paintings.
© Katatexilux



painting, bears witness to the development of the decorative phases of the church through the overlapping of eight layers of murals (fig. 3).⁹

The exhibition exposed to a wider audience a multimedia path marked by video mapping and light mapping, used for the first time in the Roman Forum, alongside videos aimed at displaying, through an emotional journey, the history and complexity of the pictorial phases of the monument. The *Santa Maria Antiqua* video, projected inside the monument on a video wall, allowed one to browse, with the aid of dynamic images, the extraordinary pictorial palimpsest preserved on the apse wall of the church and to follow, by means of virtual reconstructions, the metamorphoses undergone by the pictorial decoration on the walls of the monument over five centuries (fig. 4).¹⁰

After a long and often painstaking physical restoration of the frescoes, a virtual restoration

was used. This enabled the general public to 'read' the iconographic fabric in its entirety, as opposed to its fragmented surviving state. Based on the 3D reconstructions proposed in the *Atlas*, the video mapping, then, allowed to project – with an immersive approach – directly onto the walls of the chapels on the sides of the presbytery, the complete pictorial fabric as well as the decoration in opus sectile. The projection started with a line-drawing and finished with a complete virtual restoration of the painted decoration (fig. 5).¹¹ The installation was enormously successful and is still open to the public as part of the special route offered to visitors of the Archaeological Park of the Colosseum. The exhibition was conceived as a temporary installation, but became a permanent attraction. This will require a review in the short term, giving the opportunity to reflect in greater detail around the necessity of tailoring and creating bespoke experiences for different and often diverse users.

⁹ Bordi 2021, pp. 387–422.

¹⁰ Bordi 2018, pp. 67–68.

¹¹ Immersive reality and video narrative developed with Progetto Katatexilux. [https://](https://www.katatexilux.com)

www.katatexilux.com (26/09/2021).

Figure 5
Rome, Santa Maria Antiqua. Chapel of
Theodotus, video mapping of the lost opus
sectile decoration.
© Katatexilux



EHEM Project

With this new problem in mind we took part in the project called EHEM,¹² *Enhancement of Heritage Experiences: the Middle Ages. Digital Layered Models of Architecture and Mural Paintings over Time*, funded by EU Horizon 2020, JPI CH Conservation, Protection and Use (JPICH-0127).¹³

EHEM is a three-year project, managed by a consortium of the Universities of: Barcelona,¹⁴ Roma Tre,¹⁵ Tuscia (Viterbo),¹⁶ and the CYENS Center of Cyprus.¹⁷ The EHEM team comprises art historians, CS engineers, restorers, and scientists.¹⁸

The project aims to obtain virtual reconstructions of medieval artistic heritage — architecture with mural paintings — over the centuries by incorporating art historical knowledge and the diachronic perspective of heritage, as an instrument for researchers, restorers and heritage curators and to improve the visitor's perceptions and experiences.

In the 3D models elaborated we intend:

1. To reach a real understanding of the construction of a building and its structural “anomalies”.
2. To solve chromatic problems. This will allow us to obtain digital reproductions

that are as close as possible to the originals and distinguish them from the restoration campaigns.

3. To raise and advance a resolution tied to the original lighting of these complexes. Improve the analysis of natural lighting, and deal with artificial lighting by chandeliers or oil lamps, which produced effects of painting vibration at the moment when, for liturgical reasons, the images get activated.
4. To digitally approach the different perspectives of the medieval building and their paintings according to the categories of users (namely the laity and clergy).

We selected three case studies:

- Santa Maria Antiqua in the Roman Forum (Rome, Italy);
- The hermitage of St Quirze de Pedret in Catalonia (Spain). This site has a complex architectural genesis with paintings ranging from the 10th to the 12th centuries. The major part of them was detached and transferred to the MNAC (Museu Nacional d'Art de Catalunya – Barcelona) and the MDCS (Museu Diocesà i Comarcal de Solsona) in 1921 and 1937 (fig. 6).¹⁹
- The Engleistra of Agios Neophytos Monastery in Paphos (Cyprus), an oratory half built in

¹² Ehem in Latin means: Oh! Look!

¹³ <https://www.heritageresearch-hub.eu/homepage/heritage-projects/>.

¹⁴ PI Milagros Guardia Pons, she is also the

Project leader.

¹⁵ PI Giulia Bordi.

¹⁶ PI Paola Pogliani.

¹⁷ PI Panayiotis Charalambous.

¹⁸ <https://www.ehemproject.com>.

¹⁹ See Cayuela Vellido 2022.

Figure 6

Catalunya, St Quirze de Pedret: a) interior of the church without wall-paintings; b) Museu Diocesà I Comarcal de Solsona, wall-paintings detached.
© Katatexilux.



Figure 7

Paphos, The Engleistra of Agios Neophytos Monastery: a) exterior; b) interior, wall-paintings.
Photo: Carles Mancho.



stone and half excavated in the rock comprising up to five decorative phases executed from the 12th century (fig. 7).²⁰

By working at the same time on the three monuments we will be able to understand the benefits and limitations of adopting an ontology that drives workflows and standardizes methods.

In relation to Santa Maria Antiqua, one of the aims of the project is to display and showcase each and every phase tied to the ten layers of fresco that we mapped inside the church. We will create 3D digital models that incorporate this information in layers in the form of a database that allows us to collect archaeological, architectural, art historical documentation, textual and graphic data, together with the current state of knowledge on the site. According to the EHEM approach, the lifecycle of the building will be digitally reproduced in all its temporal phases, like a time machine. Layer upon layer we want to piece together the pictorial decoration of the church through its iconography.

The 3D model will also incorporate information on the different materials and techniques linked

to the ten pictorial phases gathered in more than fifteen years of surveys and restoration campaigns.

EHEM Methodology

The project is structured into four blocks (fig. 8). Block 1 specifies the actions required to acquire the data and associated information of the temple; Block 2 embraces the different research activities that deal with generating the faithful and complete models; Block 3 consists in storing and enriching the models in a common open access platform; Block 4 is about making results available to different users. We organized the project into nine work packages (fig. 9). WP3–7 refer to scientific activities; the others are functional: for example, management (WP1); specifications (WP2); evaluation (WP8); and dissemination (WP9).²¹ WP3 encompasses the tasks from the acquisition of images, to the placement of the paintings onto the digital model of the building.²² These tasks include: acquisition of faithful color specification using a Hypercolorimetric Multispectral Imaging (HMI) technique;²³ digital color restitution; virtual restoration of murals; collection within

²⁰ <https://vimeo.com/538552468> (26/09/2021). See Mango/Hawkins 1966, Paschali/Minasidis 2023.

²¹ Guardia *et al.* 2021, pp. 40–41.

²² In WP3, in order to improve image quality

we developed an acquisition protocol for photogrammetry, for the 3D survey and for the photographic campaigns to use the same parameters for visualizing the wall paintings of the three case studies.

²³ This approach was developed by Profilocore and set in the project by the team of DEIM Department of Tuscia University. See Ricci *et al.* 2021; <https://www.profilocolore.com/>.

Figure 8
EHM project: Conceptual research structure.

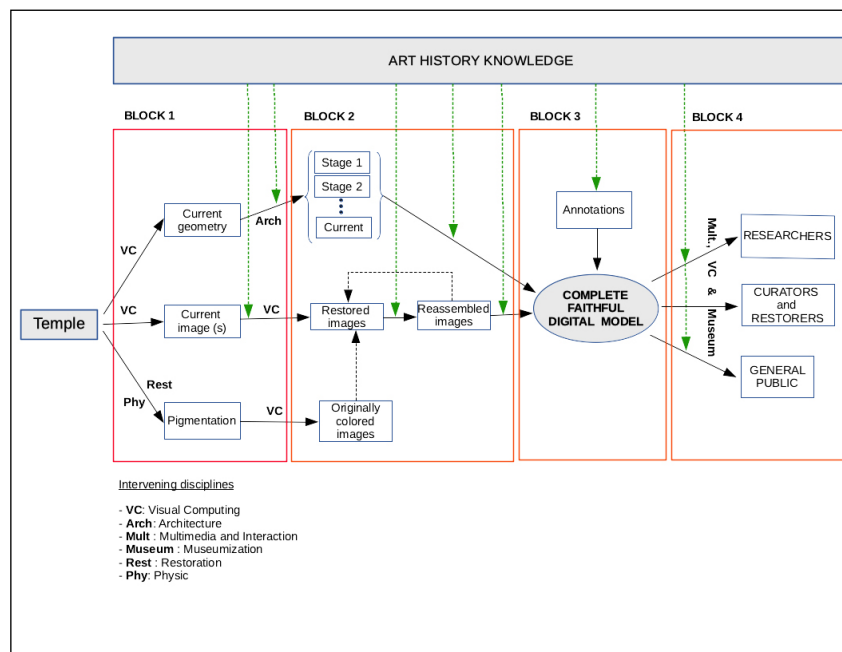
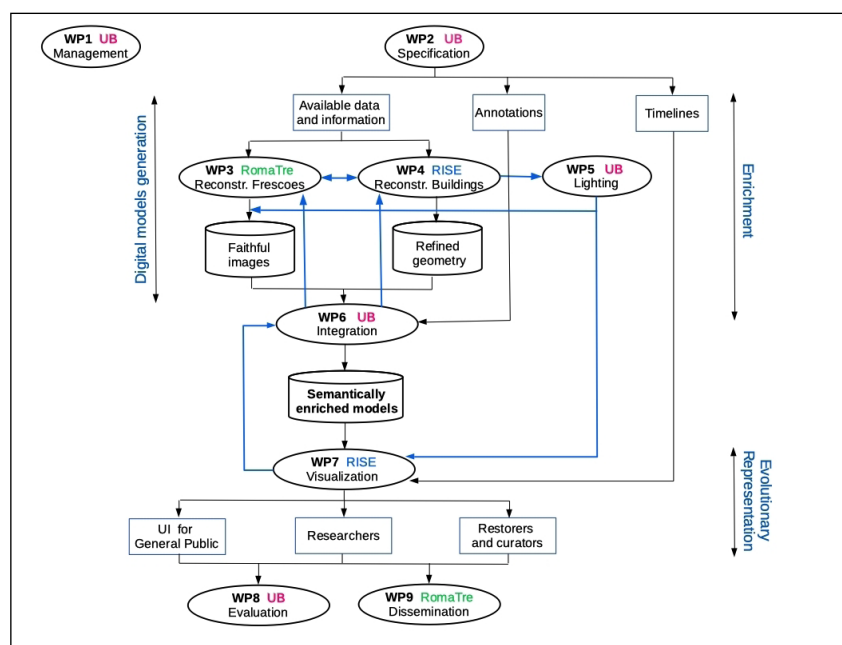


Figure 9
EHM project: Work packages scheme.



the digital model of the detached paintings stored in different locations. WP4 foresees the digitization of buildings and their geometric processing in order to obtain a mesh adapted to the needs of the project (intended to interact with WP3).²⁴ WP5 involves providing the simulation of the lighting suited to each period and to associate it with distinct visualization phases (WP7). It includes natural lighting through openings, simulated according to weather

conditions and seasons, and artificial lighting produced by different sources such as candles and oil lamps. To simulate the lighting, Unreal Engine 5, a modern, high-performance game engine in combination with Radiance (lighting simulation tool) and Lumen (lighting software by Epic Games) are being used in the 3D models of each site.²⁵ WP6 concentrates on storing in an adequate platform that enables one to analyze, document, share and enrich the

²⁴ Concerning WP4, in St Quirze de Pedret, MNAC, MDCS and Santa Maria Antiqua laser survey was carried out by the team of Virvig - Research Center for Visualization,

Virtual Reality and Graphics Interaction (Universitat de Girona, Universitat politècnica de Catalunya, Universitat de Vic) using a LIDAR scan (Leica RTC360) combined with

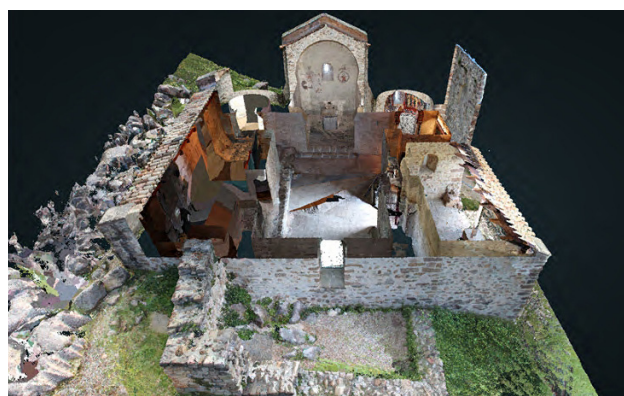
photogrammetry; the Enkleistra was done exclusively with photogrammetry. Munoz-Pandiella et al. 2022.

²⁵ See Munoz-Pandiella et al. 2022, par. III.A.4



Figure 10
HMI acquisition carried out in the Museu Diocesà i Comarcal de Solsona. Photo: CYENS Photo Archive.

Figure 11a-11b
Inspection of St Quirze de Pedret pointcloud.
© Katatexilux



models produced by WP3 and WP4. We foresee to annotate the models. For annotations requiring simple regions, we plan to use the Annotorious JavaScript library, as far as targets with complex boundaries, we have developed a tool prototype (based on TagLab).²⁶ WP6 will provide feedback to WP3 and WP4. WP7 is intended to present the results to the different targeted users (general public; CH restorers and curators, the academic community) designing and implementing the suited GUI to each community, guided by the evolutionary approach of the project.²⁷ WP7 provides feedback to WP6.

Conclusions

I would like to conclude with a reflection that occurred to me while observing the visitors at Santa Maria Antiqua and which touches on our anxiety to produce 3D models that are increasingly realistic and seductive from an aesthetic

point of view. In the Theodotus chapel spectators enter, watch the video mapping and leave without dwelling on what is really painted on the walls. A few months ago, I read a small but illuminating book entitled *Bassa risoluzione* (Low resolution) by Massimo Mantellini, a leading expert on the Italian Internet network.²⁸ Mantellini states that although we live in an era of high resolution, low-resolution contents are passed off to the audience. The Internet has radically changed our approach to depth, information, social relations, markets and culture. Therefore, the choice of low resolution is a choice of reduction, a renunciation of complexity. Working on the virtual restitution and storytelling of contexts found in medieval wall paintings, which are almost always fragmentary and difficult to understand, I wonder if the real cultural challenge that awaits us is, paradoxically, that of using all available technology to activate the general public's imagination. In

²⁶ See Munoz-Pandiella et al. 2022, Barreiro Díaz et al. 2022.

²⁷ For point cloud models, a web application based on Potree has already been realised that allows the model to be inspected, clipping planes to be used and

measurements to be taken (see Munoz-Pandiella et al. 2022). For 3D mesh models, on the other hand, a VR prototype has been developed, based on an extension of the client-server system PhotoCloud, which allows the user to explore both the model

and image sets at the same time (see Farràs/Comino/Andujar 2021).

²⁸ Mantellini 2018.

this manner, we might seek out tools that help them read history, contexts, and, in my specific field, architecture with paintings in their fragmented and complex nature, and thus we would forgo presenting them with depictions that are intact and mimetically restored in a virtual world.

I believe that elaborating high-resolution, realistic 3D models is more useful to the academic community, than for the public. The latter are likely to experience the models as spectators, and often they passively take in our visualizations of a monument without stimulating their imagination of how it could have been in the past.

References

- Andaloro 2006
La pittura medievale a Roma 312-1431. Atlante, percorsi visivi: I Suburbio, Vaticano, Rione Monti, ed. Maria Andaloro, Milan, 2006.
- Andaloro/Bordi/Morganti 2016
Santa Maria Antiqua. Tra Roma e Bisanzio: due tempi: Exhibition Catalogue Rome, Santa Maria Antiqua, 17th March -11th September 2016, ed. Maria Andaloro, Giulia Bordi and Giuseppe Morganti, Milan, 2016.
- Andaloro/Bordi/Viscontini forthcoming
La pittura medievale a Roma 312-1431. Atlante, percorsi visivi, ed. Maria Andaloro, Giulia Bordi and Manuela Viscontini, vol. 2, forthcoming.
- Barreiro Díaz et al. 2022
 Albert Barreiro Díaz, Imanol Munoz-Pandiella, Carles Bosch and Carlos Andújar "An Annotation Tool for Digital Restoration of Wall Paintings: The Eurographics Association", in *GCH 2022: GCH 2022 Eurographics Workshop on Graphics and Cultural Heritage* ed. Federico Ponchio, Ruggero Pintus, The Eurographics Association 2022, pp. 33–36. Doi: <https://doi.org/10.2312/gch.20221220>
- Bordi 2018
 Giulia Bordi, "Corpus e Atlante della pittura medievale a Roma (312-1431): Un modello possibile", *Hortus Artium Medievalium*, vol. 24, (2018), pp. 60–70, Doi: <https://doi.org/10.1484/J.HAM.5.115936>.
- Bordi 2021
 Giulia Bordi "The Apse Wall of Santa Maria Antiqua (IV-IX Centuries)", in *Santa Maria Antiqua: The Sistine Chapel of the Early Middle Ages*, ed. Eileen Rubery, Giulia Bordi, John Osborne, Turnhout, 2021, pp. 387–422.
- Cayuela Vellido 2022
 Begoña Cayuela Vellido, *Sant Quirze de Pedret, un paisatge pictòric romànic*, Ars picta. Temes, Edicions de la Universitat de Barcelona, Barcelona, 2022.
- Farràs/Comino/Andújar 2021
 Arnau Farràs, Marc Comino and Carlos Andújar "Immersive Geometry-based and Image-based Exploration of Cultural Heritage Models", in *GCH 2021 - Eurographics Workshop on Graphics and Cultural Heritage* ed. Vedat Hulusic, Alan Chalmers, The Eurographics Association 2021, pp. 21–30. Doi: <https://doi.org/10.2312/gch.20211402>.
- Guardia et al. 2021
 Milagros Guardia, Paola Pogliani, Giulia Bordi, Panayiotis Charalambous, Carlos Andújar, Imanol Munoz-Pandiella and Xavier Pueyo "Digital Layered Models of Architecture and Mural Painting over Time", in *CEIG2021 - Spanish Computer Graphics Conference*, ed. Antonio Chica, Lidia Ortega, 2021, pp. 39–42. URL: <https://diglib.eg.org:443/handle/10.2312/ceig20211363>.
- Mango/Hawkins 1966
 Cyril A. Mango and Ernest J.W. Hawkins, "The Hermitage of St. Neophytos and its wall paintings", *Dumbarton Oaks Papers*, (1966), pp. 119–206. Doi: <https://doi.org/10.2307/1291245>
- Mantellini 2018
 Massimo Mantellini, *Bassa risoluzione*, Torino, 2018.
- Munoz-Pandiella et al. 2022
 Imanol Munoz-Pandiella, Carles Bosch, Milagros Guardia, Begoña Cayuela Vellido, Paola Pogliani, Giulia Bordi, Maria Paschali, Carlos Andújar, and Panayiotis Charalambous "Digital Twins for Medieval Monuments: Requirements from Art Historians and Technical Challenges for Analysis and Restoration", in *2022 International Conference on Interactive Media, Smart Systems and Emerging Technologies (IMET)*, ed. Fotis Liarokapis, Maria Shehade, IEEE 2022, pp. 1–8. Doi: <https://doi.org/10.1109/IMET54801.2022.9929510>.
- Paschali/Minasidis 2023
 Maria Paschali and Dimitris Minasidis, "Seeing beyond Seeing: Light and Theophanic Contemplation at the Enkleistra of Neophytos, Cyprus", in *Natural light in Medieval churches*, ed. Vladimir Ivanovici, Alice Isabella Sullivan, Brill, Leiden and Boston, 2023, pp. 128–150.
- Pugliano 2021
 Antonio Pugliano, "Il Patrimonio nel Paesaggio. Forme organizzate di conoscenza e infrastrutture di ricerca: DynASK. L'Atlante Dinamico di Roma e della sua Area Metropolitana", *Ricerche di Storia dell'Arte*, vol. 134, 2, (2021), pp. 19–32. Doi: <https://doi.org/10.7374/101465>.
- Ricci et al. 2021
 Marco Ricci, Stefano Laureti, Hamed Malekmohammadi, Stefano Sfarra, Luca Lanteri, Claudio Colantonio, Giuseppe Calabrò and Claudia Pelosi, "Surface and Interface Investigation of a 15th Century Wall Painting Using Multispectral Imaging and Pulse-Compression Infrared Thermography", *Coatings*, vol. 11, 5, (2021), URL: <https://www.mdpi.com/2079-6412/11/5/546>. Doi: <https://doi.org/10.3390/coatings11050546>.
- Rubery/Bordi/Osborne 2021
Santa Maria Antiqua: The Sistine Chapel of the Early Middle Ages, ed. Eileen Rubery, Giulia Bordi, John Osborne, Turnhout, 2021.