Reconstruction of lost architectural decorations by integrating archival photographs with 3D survey of the *status quo*: an investigation into Gaetano Vaccani's *grisaille* technique

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Abstract

The research issue underlying this article stems from the will to recover memory and visually restore, through the potential offered by virtual reconstruction techniques, the lost image of the rich decoration that adorned the ancient *Salone Napoleonico*, the lecture hall of the Brera Academy of Fine Arts, destroyed following the devastation of the Second World War. The perimeter walls withstood the impact of the bombings, while the barrel vault was completely compromised: during the post-war reconstruction, the rich pictorial decoration was deemed irrecoverable, and efforts were concentrated on faithfully restoring the hall in terms of volume. This premise allowed us to adopt the photogrammetric model of the existing structure as a solid base to ensure metric accuracy and correspondence to the original architectural layout. The 3D model was then mapped and assembled with decorative registers extracted from historical black-and-white photographs, subjected to a preliminary orthorectification process, adopting criteria aimed at recognizing hierarchies between portions with varying degrees of detail and reliability. To approximate the original visual and chromatic characteristics, a comparative analysis of contemporary monochrome decorations by the ornamental painter Gaetano Vaccani, preserved in the *Palazzo di Brera*, led to the formulation of color hypotheses through RGB sampling, achieving an informed chromatic and stylistic interpretation. The multidisciplinary framework, based on historical, archival, and bibliographic sources, integrated into the workflow, ensured the achievement of results that balanced methodological rigor with cultural and historical sensitivity, suitable for online publication and access to the scientific community and the wider public.

1. Introduction

The vulnerability of tangible cultural heritage has been, and continues to be, a serious threat to the integrity of collective historical memory, as cultural heritage is a tangible testimony to identity, history and traditions. The significant transformations and losses suffered over time, caused by various factors - both natural events and processes and human-induced interventions and disasters - compromise the link between past, present, and future, with a negative impact in both social and economic terms. In this context, the introduction of digital methodologies and 3D acquisition and modeling technologies aimed at limiting this process of loss of value has been perceived as necessary, leading to the development of strategies that make it possible to repair the breaks, preserving and communicating the messages conveyed by cultural heritage. The application of various representation tools can enable the generation of a digital simulation of a real or historically existing artifact, digitally restored to a hypothetical previous state through a scientific process of three-dimensional reconstruction (Guidi and Russo, 2011). In this case study, the current layout of the *Salone Napoleonico* of the Brera Academy of Fine Arts, which welcomes students and occasional visitors to the building with direct access from the Courtyard of Honor, appears very different and significantly impoverished compared to its original configuration. Populated by a selection of works representative of the richness and variety of the artistic media that compose its educational collections - such as plaster casts, preparatory cartoons and large-format paintings - the environment is now characterized by an elaborate architectural structure (Figure 1), legible in the purity of its forms and deprived of its rich original decoration: the *grisaille* wall paintings created by the ornamental painter Gaetano Vaccani in the early decades of the 19th century were destroyed by bombing during the Second World War. The loss of the ornamental apparatus of a space with a strong identity, such as the lecture hall of a historic university institution, is now a silent absence, almost imperceptible, were it not for the survival of a small series of photographs and rare graphic evidence, known only to a small number of experts, whose analysis and elaboration gave rise to the initiative to visually recover, by means of a virtual reconstruction, the original appearance of the ancient *Salone dei Premi*.

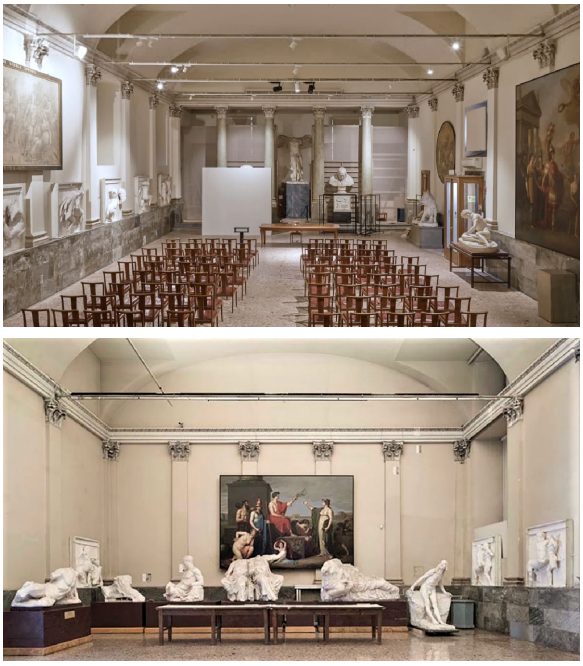

Figure 1. Current configuration of the *Salone Napoleonico* of the Brera Academy of Fine Arts.

2. The case study

Towards the end of the Second World War, on the night between 7 and 8 August 1943, the city of Milan was one of the main targets of Anglo-American air raids. With the aim of forcing the Kingdom of Italy to break its alliance with Germany, the Allied command planned a massive air campaign to destroy the infrastructure of the Industrial Triangle, striking the cities of Turin and Genoa simultaneously. Milan was hit hardest, as it was a strategic target and the heart of Italian industry: in addition to the extensive damage suffered by the railway lines and industrial areas, the city's monumental buildings were not spared.

2.1 War damage to the Brera complex

The Brera complex was severely damaged by the air raid: a barrage of incendiary bombs devastated the entire structure, triggering a fire that burned the roofs and rooms of the Pinacoteca on the first floor for two weeks. The south and west wings of the building were the most severely damaged, precisely in the section where the *Salone Napoleonico* - the subject of our research - was located on the ground floor.
Even after the armistice of September 3, 1943, the aerial threat continued until April 1945: in the almost two years that passed before the end of the war, the immediate damage caused by the bombing was compounded by the deleterious effects of prolonged exposure to the elements. Although the paintings had been promptly saved at the beginning of the war, the identity of the ancient Palace of Science and Arts had been dramatically damaged by heavy collapses and the state of the load-bearing structures was such that the stability of the building could not be guaranteed (Garufi, 2004), as effectively testified by photographs taken by Antonio Paoletti, Claudio Emmer, and Bruno Stefani (Ghibaudi, 2009; Paoli, 2009), who were called upon several times to record the desolate state of the ancient building.

2.2 The effects on the *Salone Napoleonico*

The condition of the *Salone Napoleonico* appeared critical from the outset (Figures 2) and began to cause increasing concern among the conservation authorities: from early 1944, the Superintendence of Monuments highlighted its precariousness, calling for timely intervention by the Civil Engineering to install temporary structures to avert the risk of collapse of the vault, which was already showing clear signs of subsidence (De Stefani, 2009). The request led to the closure of the room and the declaration of the Pinacoteca's upper rooms as unfit for use, but the lack of funding and the difficulty in finding materials meant that the uncovered corner of the building, at the base of

Figure 2. Publifoto, The immediate effects of the bombing on the *Salone Napoleonico*, 1943. Milan, Brera Academy of Fine Arts, photographic archive.

which the *Salone Napoleonico* still stood, was not included among the areas to be provided with temporary cover and remained exposed to rain and bad weather.
In July 1944, the Academy's board, noting that the pictorial decorations of its ceremonial hall were suffering from the effects of moisture infiltration, decided that they needed to be photographed, placing particular emphasis on the condition of the lunette at the back with its composition on the arts. The task, commissioned to the Paoletti studio, led to the acquisition of three photographic prints preserved in the Academy's photographic archive (Figure 3), made with the clear purpose of documenting the serious cracking on the back wall, which extended along the barrel vault. These precious photographs represent, on the one hand, the most accurate and detailed documentation that has come down to us of the modules and registers of the rich ornamental apparatus of the vault; on the other hand, they bear witness to the strenuous attempt to protect the physical integrity of the architectural space by installing an intricate scaffolding made of metal tubes, beams, and wooden planks, clearly visible in the peripheral areas of the photographs. However, the safety measures were not sufficient to prevent the collapse of the structure, as reported again by the Superintendence of Galleries in February 1945, concerned about the slow but progressive collapse of the floor of its rooms on the upper level (Garufi, 2004). Shortly thereafter, the documentation of the collapse of the vault, once again entrusted to Paoletti's lens, dramatically shows the total devastation of the hall and the tearing of the entire ceiling, reduced to piles of rubble at the foot of the shoring structures (Figure 4).

Figure 3. A. Paoletti, Details of the *Salone Napoleonico* supported by temporary structures after the bombings, 1944. Milan, Brera Academy of Fine Arts, photographic archive.

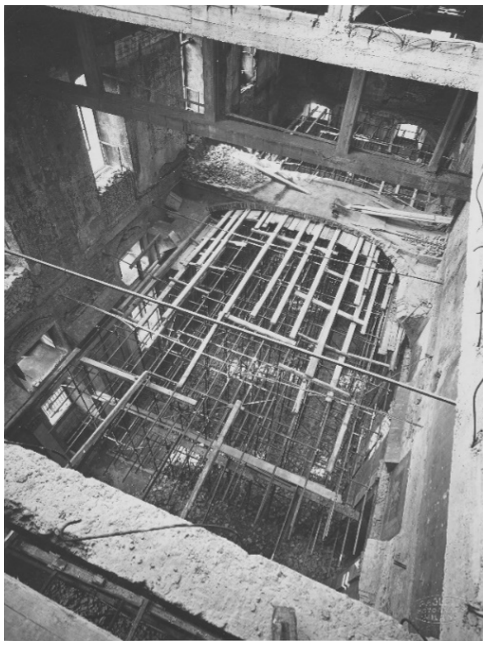

Figure 4. A. Paoletti, The *Salone Napoleonico* after the collapse of the vault, 1946-1949. Milan, Brera Academy of Fine Arts, photographic archive.

2.3 Post-war reconstruction

Following the collapse, the fate of the hall became the subject of a heated conflict between the Superintendence of Galleries, concerned with ensuring a solid supporting structure for the exhibition rooms of the Pinacoteca above, and the Superintendence of Monuments, opposed to the changes introduced by the museum's reconstruction project, which would have altered the appearance of the building: among the most criticized was the decision to provide a flat ceiling for the *Salone Napoleonico*, introduced in April 1947 (Garufi, 2004).
Once the pressure to reopen the museum as a matter of priority in 1950 had been overcome, the will of the Superintendence of Monuments prevailed. In agreement with the Academy, work began to restore the environmental conditions that existed prior to the damage: between 1951 and 1952, the structure of the *Salone Napoleonico* was faithfully restored, preserving its original architectural features, which can still be appreciated today; the usability of the spaces in the Academy's *Aula Magna* was thus finally restored. In view of the symbolic, political, and economic implications inherent in the reconstruction of the building, a proposal was finally put forward - though not carried out - to entrust Achille Funi with the task of providing the hall with new fresco decorations, ultimately having to surrender to the evidence that a *quo ante* restoration of the stucco and fresco decorations was impracticable.

3. Methodology for data acquisition and processing

3.1 Historical and archival sources

The first phase of data collection for virtual reconstruction involved the preparation of a solid knowledge base founded on historical, archival, and bibliographic sources, which was essential to ensure the achievement of results that could be validated in terms of philological rigor. The initiative arose primarily from the study of photographic documentation from 1944 preserved in the Academy's photographic archive, taken from close range, which constitutes the main source for the project. The general image of the architectural and decorative structure was obtained from rare, printed publications, dating back to shortly after the decoration was completed (Cassina, 1840) and in the early decades of the last century (Milano, 1920). These are joined by a small group of photographic prints dated 1940, which show the hall during inaugural events dating back to the Fascist period (Figure 5). As regards gathering information on Gaetano Vaccani's *grisaille* paintings, it was necessary to resort to indirect sources, extending the study to similar and contemporary works by the decorative painter, who worked in the Milan and Lombardy areas, focusing the research on the colors used in monochrome decorations. The data obtained from these fundamental documents and visual evidence were supplemented by information found in archival and bibliographic sources relating to the design and construction of the hall, as illustrated below.

3.1.1 The *Salone dei Premi*. From architectural design to decorative layout: Although the current name of the *Salone Napoleonico* immediately suggests Bonaparte, the hall was not built in his honor, but only after the period of French domination, during the Restoration. However, entrusting its design to architect Pietro Gilardoni - who had previously been involved in the renovation of the then Royal Gallery on the upper floor - represented an element of coherence in the adoption of criteria and values during the transition between the two regimes, ensuring continuity with the broader program of renovation of the palace that had begun prior to the resettlement of the Austrians. The hall, known at the time as the *Salone dei Premi* because it was used for awarding prizes to the winners of competitions held at the Academy, underwent a complete structural overhaul: the plans put forward in 1817 completely changed both the configuration of the masonry and the covering, providing for the construction of a barrel vault with a lowered arch profile, at the base of which windows and openings would be created for optimal lighting. Once the structural work was completed, Gaetano Vaccani, one

Figure 5. Inauguration of the 1940/41 Academic Year in the *Salone Napoleonico*, October 16, 1940. Milan, Brera Academy of Fine Arts, photographic archive.

Figure 6. F. Cassina, Cross-section of the *Palazzo di Brera* and longitudinal section of the *Salone dei Premi*, 1840. The dotted frames highlight the dimensions of the *Salone Napoleonico*.

of the most accomplished decorative painters of the time, who had already demonstrated his skills in one of the rooms of the Pinacoteca, was selected to decorate the hall (Scotti Tosini, 1979). Following a lengthy design process that saw the rejection of an initial proposal, presented through drawings and some on-site painting tests, the final layout of the hall was only achieved between 1824 and 1825, as a result of close collaboration between the architect and painter: the final solution is effectively documented through two prints by Ferdinando Cassina, dating from around 1840, which reproduce the interior of the hall along the transverse and longitudinal sections (Figure 6), showing a perfect fusion between architectural and ornamental design (Cassina, 1840). The joint intervention led to a further enrichment of the wall volumes, introducing a rhythmic series of lesenes with Corinthian capitals surmounted by an architrave grafted to the base of the vault, eurhythmically associated with four columns placed only on the short side towards the western front; the rich ornamental decoration painted on the vault, starting from a central register of faux hexagonal and rhomboidal coffers, was structured according to a sequence of panels connecting the vault and the windows, while the back wall was dominated by a lunette densely populated with classical figures, all skillfully rendered in an illusory volumetric effect.

3.1.2 Similar case studies. Gaetano Vaccani's *grisaille* decoration in the *Palazzo di Brera*: To gain a deeper understanding of the visual, iconographic and chromatic characteristics of Gaetano Vaccani's work, the analysis was extended to include a comparative study of other contemporary monochrome decorations by the ornamental painter, searching for the greatest similarities among those found in the *Palazzo di Brera*. Vaccani enjoyed a certain continuity of work in Brera, indicative of the preference shown to him by the palace's institutional authorities and the appreciation in those years for the *grisaille* technique, mastered by the artist, which was effective in enhancing the refined ability to blend classical models and 16th-century relief decorations borrowed from the figurative repertoire of Lombard Renaissance sculpture. This combination, enhanced by the choice of monochrome execution, ultimately became the hallmark of the painter, whose distinctive and refined work established his role as the undisputed protagonist of decorative painting in Milan and Lombardy in the first half of the 19th century.

In the long period between the design and completion of the *Salone dei Premi*, Vaccani received important commissions from the director of the Braidense Library. In 1818, he was called upon to decorate the vault of a room under construction, finding himself collaborating with the architect Gilardoni on another project. For this new room, now known as the *Sala Cataloghi*, Vaccani imagined a monochrome composition characterized by three faux coffered domes with a strong perspective effect, completed in 1821. The following year, it was the turn of the *Sala Maria Teresa*, the institution's main hall. For the room dedicated to the Empress of Austria, founder of the Brera Enlightenment center, Vaccani designed and completed by 1824 a faux coffered ceiling surrounded by registers with classical motifs and busts of illustrious men from classical Greek and Roman antiquity. Also in the library, Vaccani is credited with the contemporary ornamental apparatus of the entrance hall ceiling, painted in 1823, and the later decorations in the Consultation Room and the Manuscript Room; the latter, built in 1834 to a design by engineer Carlo Caimi - who had taken over from Gilardoni in the meantime - was painted in accordance with the other rooms in 1835 (Scotti Tosini, 1979).

3.2 Historical photographic documentation processing

From a technical point of view, the workflow for generating the virtual reconstruction of the *Salone Napoleonico* involved, as a first step, the graphic processing of historical photographic documentation, starting with the extraction of decorative registers from photographic prints made for conservation purposes in 1944 (Figure 3), shortly before the date of the collapse: the high level of detail in the original photographs made it possible to obtain representative modules of the compositions of coffered ceilings, panels and pendentives while maintaining a good degree of definition, which were then subjected to a process of orthorectification in Adobe Photoshop (Adobe, 2025). By means of the functions offered by the software, the extracted images were digitally restored (Figure 7), repairing the portions where there were fractures, detachments and signs of collapse, which

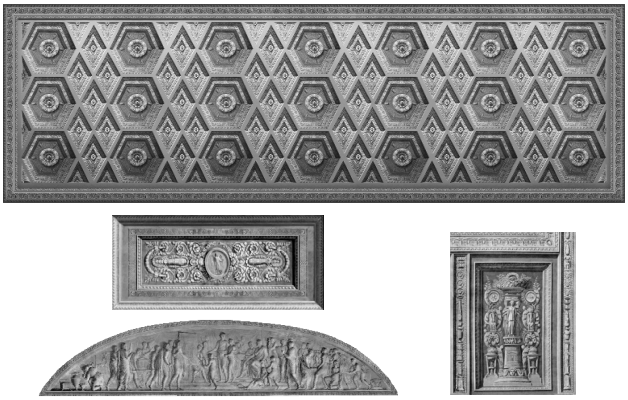

Figure 7. Representative modules of the decorative registers, subjected to orthorectification and virtual restoration.

had been deliberately captured in those shots. For the integration of decorative elements that were not documented in detail, but for which a rough composition could still be obtained from the graphic and photographic documentation of the context, a method was adopted to ensure their distinguishability from the well-defined elements. This principle of discrimination, achieved in other virtual reconstruction processes by mapping different colors corresponding to a hierarchy of reliability levels (Demetrescu et al., 2021; Ferdani et al., 2023), was ensured using the stippling technique (Figure 9a), derived from the painting restoration methodologies established in the Italian tradition. Graphically, this effect was achieved using Photoshop tools, exploiting the "Noise" filter [Filter > Noise > Add Noise. Amount: 25%. Distribution: Gaussian. Monochromatic: Checked]. The stippling integration technique is a well-known method commonly used in conservation work on cultural heritage and has the characteristic of being clearly distinguishable on close inspection, without however affecting the harmonious reading of the overall observation.

3.3 Formulation of hypotheses on original color

The preliminary study on Vaccani's *grisaille* production was fundamental in achieving a rigorous chromatic and stylistic interpretation. The investigation, aimed above all at formulating possible hypotheses on the original coloring of the decoration of the *Napoleonic Hall*, focused on two exemplary case studies in the ornamental painter's production: the decorations of the *Sala Cataloghi* and the *Sala Maria Teresa* of the Braidense National Library. These, among all others, show the greatest affinity with the lost decoration, both chronologically, having been designed and created around the same time, and in terms of architectural layout and figurative repertoire. For accurate color recording, a close-range photogrammetric survey campaign was launched in both rooms, using a Fujifilm GFX100S mirrorless camera equipped with a large 43.8 × 32.9 mm BSI CMOS sensor, which provides a very high resolution of 102 MP (11648 x 8736 pixels), capable of generating a native file size of 70 x 100 cm at 300 DPI. High fidelity in realistic color reproduction, rendered with a rich range of tones, was optimized through the combination with a Fujinon GF lens. After setting the camera to ISO 400 sensitivity, the focal length was set to 50 mm and kept unchanged throughout the entire survey, as was the diaphragm aperture, modulated with priority given to exposure times, which were reduced as much as possible since the shots would be taken without a tripod; the sharpness of the shots is nevertheless favoured by the characteristics of the camera, which is equipped with a five-axis stabiliser and is not affected by the movement of the mirror found in common reflex cameras. The shots were concentrated exclusively on the vaulted areas, with a total of around 700 frames captured for each room, photographed from two different height levels, taking advantage of the elevated shooting position offered by the balcony that runs along all the walls of the two halls.
Following the photomodeling process (Figures 8a and 8b), carried out through Structure from Motion (SfM) algorithms in Agisoft Metashape (Agisoft, 2024), particular attention was given to white balance and the removal of unwanted color casts, performed directly on the two textures, with reference to the Kodak Color Control Patches and Gray Scale standards included in the detected areas: correcting the tone shift caused by the color temperature of the lighting systems, which interferes with and distorts the perception of tonality when viewed in person, was an essential step. The extraction of chromatic values was carried out based on the two orthomosaics exported from the photorealistic 3D models (Figures 8a^{I} and 8b^{I}), sampling the monochrome painted surfaces using the Eyedropper tool in Photoshop (Aldrovandi et al., 2010; Triolo, 2020). The results of the

Figure 8. Acquisition and processing of SfM photogrammetric data (a, b). Orthomosaics exported from textured 3D models of the vaults of the *Sala Cataloghi* (a^{I}) and the *Sala Maria Teresa* (b^{I}), with respective color samples (a^{II}, b^{II}).

sampling, expressed in the form of RGB colorimetric coordinates (Figures 8a^{II} and 8b^{II}), revealed a strong similarity between the palettes used for the two decorations, encouraging the subsequent phase of transferring the color values detected to the grayscale decorative registers obtained from historical photographic documentation (Figures 9b and 9c).
The color was assigned using the manual colorization functions offered by Photoshop, acting on the RGB colorimetric

Figure 9. Representative modules of the decorative registers rendered using the stippling technique (a) and colorized with reference to the *Sala Cataloghi* (b) and the *Sala Maria Teresa* (c).

coordinates [Image > Adjustments > Color Balance] and orienting the choice of chromatic values to be assigned to the virtual reconstruction on an average between the parameters obtained from the two samples.

3.4 Photogrammetric data collection

The current architectural layout of the *Salone Napoleonico* faithfully reflects the original layout of the hall, which was restored in terms of volume during the post-war reconstruction. For the purposes of the project, this premise allowed us to adopt the 3D model of the existing structure - created in 2021 as part of the virtual exhibition "Napoleone e l'Accademia" (Berizzi et al., 2023) - as a solid basis for ensuring compliance with the original architectural layout. For the survey of the hall, a stereophotogrammetric detection was carried out using Blender (Blender Development Team, 2020): starting from a pair of context photographs, taken from two different angles, it was possible to calculate the actual focal length (which may differ slightly from the nominal length) and calculate the lens distortion coefficients[1]. The parts accessible without moving to a higher level, the lower portions and a selection of levels of the vault were surveyed mainly with a longimetric method, using trilateration and progressive measurements, typical of architectural surveying. The Leica Disto D5 distance meter was used as an instrumental aid, with a declared accuracy of ±1 mm and a resolution of 0,1 mm. It was mainly used for vertical measurements, as this instrument is equipped with a slope meter. The results obtained from Blender elaborations made it possible to integrate measurements of inaccessible parts at certain heights, comparing and validating the measurements taken manually. The accuracy of the output depends directly on the quality of the marker placement, which in this case was done manually. In this situation, a single pixel on the back wall is less than 0,5 cm and the re-projection process, the inverse verification, has an average error of 0,22 px. Compared to other photogrammetry systems where the ultimate goal is to create a point cloud, that is very dense even in flat and continuous areas, this technique aims to obtain a few samples at specific points: 25 in the scene in Figure 10, of which only 15 are actually useful for reconstruction and the other 10 are auxiliary.

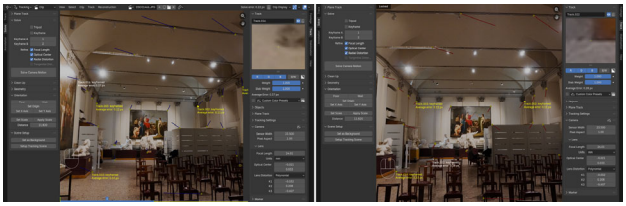

Figure 10. Stereometric pair in Blender's tracking interface. Some markers are highlighted and their reprojection errors are displayed, all of which are less than one pixel.

3.5 Reality-based 3D modeling

The markers placed during the survey phase were used as reference points for the construction of the 3D model: through an extensive manual modeling process, still using Blender software, the polygonal mesh was created directly on the basis of the recorded measurements, so that it could be easily visualized without conversions. The result is a model with a minimum number of polygons, with less than 40000 vertices, in which the surfaces are made up of geometries that fully replicate the shape. This feature is especially evident on all flat surfaces, which, using this method, are described with very few vertices. The geometries were created immediately using the correct topology, facilitating subsequent modifications to the model and eliminating the need for additional steps, such as retopology, to obtain a low poly model.

3.6 UV mapping

The UV mapping process of the 3D model was a key step leading up to the subsequent phase involving the integration of 2D graphic documentation, ensuring full compatibility between the two media and enabling the precise application of textures. The operation was processed automatically by specific algorithms in Blender (Blender Development Team, 2025) and further manual modifications refined the result. The absence of double-curved geometries allowed the polygonal mesh to be developed on a two-dimensional plane with negligible distortions, and the manual process of marking the segments made it possible to obtain a non-fragmented map of the various surfaces, a common feature in automatic unwrapping algorithms.

3.7 Integration between two- and three-dimensional data

Once the 3D model had been optimized and, in parallel, the graphic processing of the various colorized decorative registers had been completed, it was possible to begin assembling them together. The integration of the two-dimensional images on the basis of the model's UV map was carried out in Adobe Photoshop, organizing a series of overlapping layers with the aim of harmonizing the different parts of the composition (Figure 11), paying particular attention to the impact that the artificial lighting introduced would have in relation to the shadows historically reported by the photographic images. The

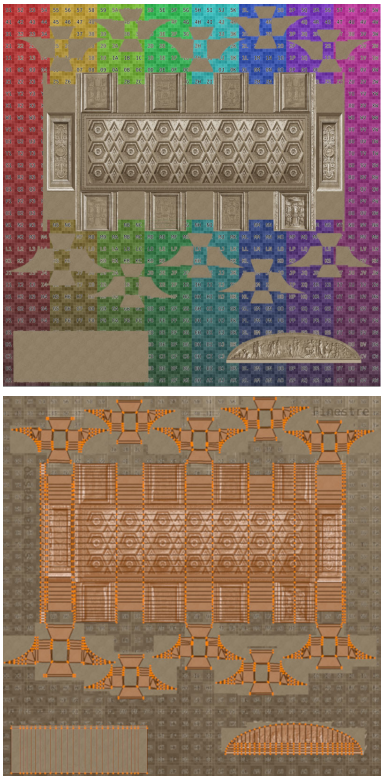

Figure 11. UV maps of the vault and lunette exemplifying the assembly process performed in Photoshop (top) and verified in Blender (bottom).

[1] The distortion model is compatible with OpenCV: it can be calibrated automatically, as in this case, or manually. https://docs.opencv.org/4.x/dc/dbb/tutorial_py_calibration.html

correct alignment of the decorative portions and the overall organic view were checked several times during the assembly process, importing the updated version of the UV map into Blender and employing the historical photographic documentation of the context, kept in the background, as a verification tool.

4. Results, future developments and discussion

The result of the mapping and harmonization process is shown in the rendering in Figure 12, which simulates the navigation experience of the virtual reconstruction.

Figure 12. Rendering of the virtual reconstruction of the *Salone Napoleonico*, formerly the *Salone dei Premi* of the Brera Academy of Fine Arts.

4.1 The fruition model for heritage dissemination

To ensure maximum accessibility and dissemination of the results, the textured 3D digital model was published online, opting for a visualization based on static renderings processed from strategic viewpoints within the virtual space[2]. This mapping technique translates the polar coordinates of the 3D scene (360° longitude by 180° latitude) onto a two-dimensional Cartesian plane with a 2:1 aspect ratio. The virtual panoramic camera was positioned in the reconstructed space in order to create equirectangular projection images. The texture is then reprojected onto the inner surface of a virtual sphere: in this way, the user positioned at the geometric center of the sphere perceives a continuous environment, without visible vanishing points and perspectively correct in every direction. The web experience was implemented using A-Frame[3], an open-source framework that allows the development of Virtual Reality (VR) experiences using a declarative syntax based on HTML. A-Frame operates as an abstraction layer on Three.js[4], the standard JavaScript library for rendering 3D graphics and complex scenes in the browser using the WebGL API. This technological architecture ensures cross-platform enjoyment of 360° content: in a desktop environment, exploration is managed via mouse navigation; on mobile devices, the interface uses the Device Orientation API to synchronize the point of view with the device's gyroscope; finally, the framework natively supports the WebXR standard, enabling immersive mode through the use of VR headsets (Head-Mounted Displays).

4.2 Future developments

This preliminary publication, aimed at making the research results immediately available, will be followed by a further process of refinement and enrichment of the data included in the virtual reconstruction. The celebrations marking the 250th anniversary since the foundation of the Brera Academy of Fine Arts, which falls in 2026, will provide an opportunity to relaunch an improved version of the model on the institution's official channels: the model is ready for export in glTF format[5], the standard for viewing 3D content on the web, which will offer an immersive experience of the hall in a navigable and interactive 3D environment. The supports developed would also be suitable for the installation of a video mapping system for on-site viewing, an operation that would have a significant economic impact and would not be easy to design, whose main limitation seems to be the presence of a track lighting system with spotlights, which would physically generate unwanted projections of shadows on the vault.

4.3 Discussion

Concerning the degree of reliability of the results, always presented in the form of a “virtual” model - that is, “potential” in the etymological sense of the term - the rigor in reconstructing the image of the vault is entrusted to the adoption of techniques, such as stippling, designed to ensure the distinguishability between the portions presented as certain and those integrated as hypothetical; thus, even the chromatic characteristics, assigned on the basis of accurate research on the painter's distinctive *grisaille* technique, are confirmed to have a good level of reliability and coherence.
In the assembly process, the pair of historical photographs reproducing the context of the room - imported into the modeling software and kept in the background with respect to the progressively advanced textured model - provided the main control tool, ensuring that the digital geometries complied with the original volumes of the hall and verifying the correct framing of the mapped decorative registers.

5. Conclusions

The colorized digital model obtained at the end of the virtual reconstruction process (Figure 13) effectively fulfils the intention of visually restoring the original configuration of a space that had a strong identity value for the institutions of

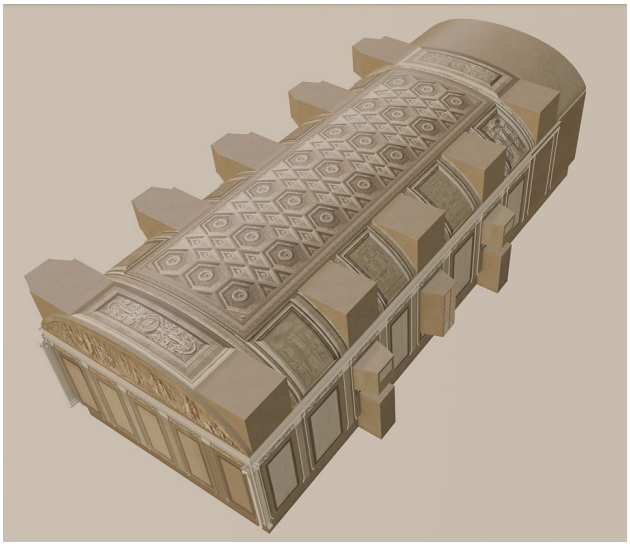

Figure 13. The colorized 3D digital model of the *Salone Napoleonico* obtained at the end of the virtual reconstruction process.

[2] https://www.brixelstudio.it/private/SaloneNapoleonico/
[3] https://aframe.io
[4] https://threejs.org
[5] https://www.khronos.org/gltf/

Brera, providing the scientific community and the wider public with an immersive experience conveyed online and made freely accessible in the long term. In closing this contribution, a reflection on the role played by culture in response to the devastating effects of war is in order: among the tragic events that took place in Milan during the Second World War, the bombings severely damaged not only the urban and social structure, but also the identity of the city and its capacity to preserve its memory intact. The deeper meaning of this study is to mitigate and partially repair the physical and moral fracture represented by the loss of a monumental complex that our predecessors strenuously attempted to safeguard, recovering the image of the ancient *Salone dei Premi* and restoring an unknown piece of the memory and history of the *Palazzo di Brera*, the hub of artistic and cultural life that, today as in the past, the city of Milan offers to the rest of the world.

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