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Late Antique *Domus* of Via Dogana in Faenza: The *Vestibulum* Mosaic. Completion of the Restoration Work, New Methods for Conservation and Enhancement

Faenza'daki Geç Antik Çağ Via Dogana *Domusu: Vestibulum* Mozaiği. Restorasyon İşleminin Tamamlanması, Yeni Koruma ve İyileştirme Metodları

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Abstract

This paper describes the multidisciplinary study and the completion of the restoration work conducted on an important floor mosaic from the fifth century AD. The floor, a big polychrome and figured mosaic, was discovered in the 1970s in the city center of Faenza and belonged to the vestibulum of a late antique domus.

An effective collaboration between the Parco Archeologico di Classe - RavennAntica Foundation and the University of Bologna Master Degree in Conservation and Restoration has allowed to experiment, test, and improve some methodologies concerning mosaic restoration and enhancement.

Specifically, some experimental studies regarding the use of lime mortars were carried out, in order to reintegrate the small gaps in the mosaic. Furthermore, in addition to a three-dimensional relief of the whole floor, some virtual integration proposals were created. At the same time, some information panels were proposed to integrate the museum project.

The restoration was thus a moment of study and active experimentation, that did not neglect the enhancement of such a significant artistic testimony.

Keywords: *Mosaic, Late Antique, domus, vestibulum, restoration, conservation.*

Öz

Bu makale, İS 5. yüzyıla ait önemli bir taban mozaiği üzerinde yürütülen multidisipliner çalışmayı ve restorasyon çalışmasının tamamlanmasını anlatmaktadır. Faenza şehir merkezinde 1970 lerde keşfedilen renkli ve figürlü büyük bir mozaik zemin Geç Antik Çağ'a ait bir domusun vestibulum bölümüne aitti.

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Parco Archeologico di Classe - RavennAntica Vakfı ile Bologna Üniversitesi Koruma ve Restorasyon Yüksek Lisans Programı arasındaki etkili bir işbirliği mozaik restorasyonu ve iyileştirmesi ile ilgili bazı metodolojilerin denenmesine, test edilmesine geliştirilmesine olanak sağlamıştır.

Mozaik üzerindeki küçük boşlukların tamamlanması için özellikle kireç harç kullanımına ilişkin deneysel çalışmalar yapılmıştır. Ayrıca, zeminin tümünün üç boyutlu rölyefine ek olarak bazı sanal birleştirme önerileri de oluşturulmuştur. Aynı zamanda müze projesine dahil edilmek üzere bazı bilgi panelleride önerilmiştir.

Restorasyon, bu haliyle böylesine önemli bir sanatsal tanıklığın geliştirilmesini ihmal etmeyen bir çalışma ve aktif deney anı olmuştur.

Anahtar Kelimeler: *Mozaik, Geç Antik, domus, vestibulum, restorasyon, koruma.*

This article describes the multidisciplinary study and the completion of the restoration work made on an important floor mosaic of the fifth century AD (Fig. 1).

The floor, a large polychrome and figured mosaic, measuring about 35 sqm, was discovered in the 1970s in the city center of Faenza, during an archaeological campaign, and it belongs to the *vestibulum* of a late antique *Domus*[1] (Fig. 2). The pavement was detached in sections from the excavation and placed inside the warehouses of the Faenza archaeological deposits.

Figure 1
Late Antique *Domus* of via Dogana in Faenza: Location and orientation of some mosaics. The *vestibulum* mosaic is highlighted in red (Reworked by Maioli 1987: 230 fig. 6).

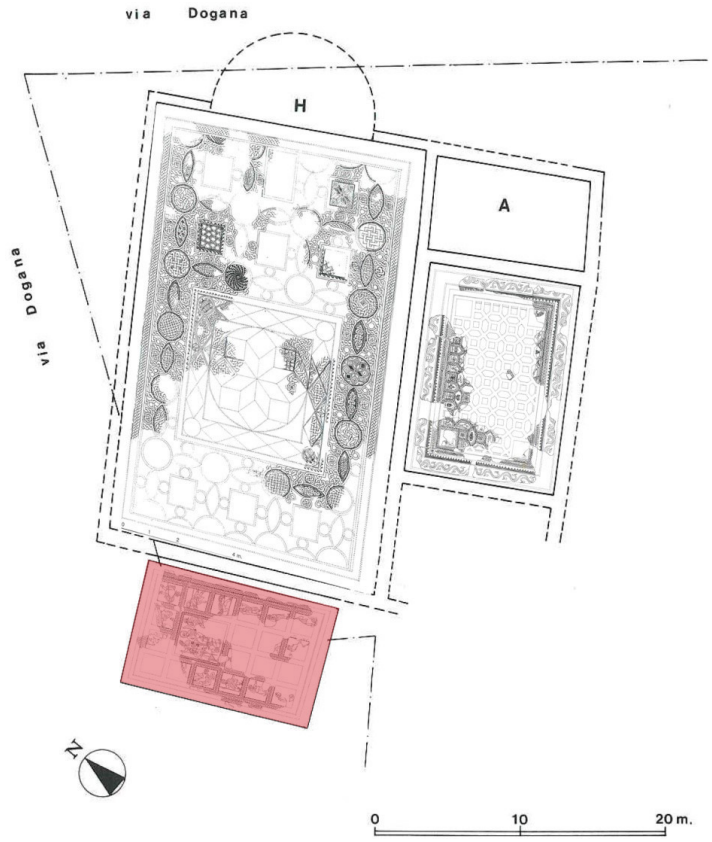
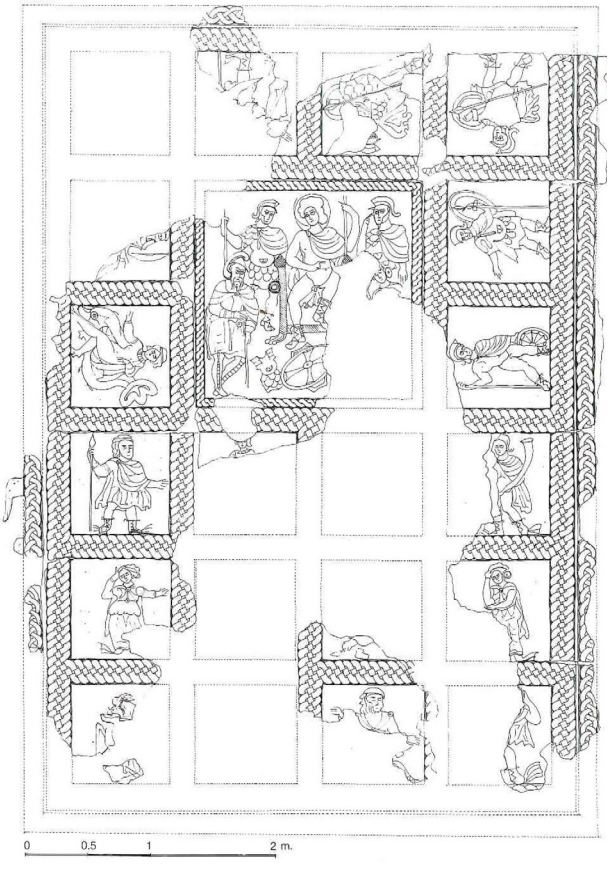


Figure 2
Late Antique *Domus* of via Dogana in Faenza: Reconstructive drawing of the site (Maioli 1995: 191 fig. 2).



The central *emblema*[2] shows a significant scene that takes us back to the myth of Achilles, it retains the typical stylistic peculiarities of late antiquity even though

1 The archival documents relating to the excavations are kept at the current Archaeological, Fine Arts and Landscape Superintendence for the metropolitan city of Bologna and the provinces of Modena, Reggio Emilia and Ferrara.

2 Specifically, a pseudo-*emblema* that means: «*emblema* privo del supporto indipendente, lavorato quindi sul posto nella tecnica dell'*opus tessellatum* insieme a tutto il mosaico pavimentale circostante» (Farneti 1993: 154).

it is openly inspired by a classical tradition (Fig. 3)[3]. The choice of this figurative theme is to be referred probably to the expression of a cultural and artistic *koinè* with a refined taste, most likely identified in the owner of the *domus* (Dunbabin 2018: 357-358).

Figure 3
Vestibulum mosaic, section on cement: Central pseudo-*emblema* (Lab. P.R.P. Restauro e Mosaici d'Arte 2005).

Effective collaboration between the Parco Archeologico di Classe - RavennAntica Foundation[4] and the University of Bologna Master Degree in Conservation and Restoration has allowed us to experiment, test, and improve some methodologies related to mosaics restoration and enhancement[5].

Specifically, some experimental studies regarding the use of lime mortars were carried out, in order to reintegrate the small gaps in the mosaic.

Furthermore, in addition to a three-dimensional relief of the whole floor, some virtual integration proposals were created. At the same time, some information panels were proposed to integrate the museum project.

3 Over the years, the mosaic of the *vestibulum* has been the subject of numerous studies for the figurative decoration that distinguishes it (in particular see Gentili 1980: 468-479; Maioli 1987: 229-234).

4 Parco Archeologico di Classe - RavennAntica Foundation was established on 23 October 2001 with the aim of enhancing and protecting the archaeological, architectural and historical-artistic heritage of Ravenna.

5 RavennAntica is one of the institutional partners of the Master Degree in Conservation and Restoration of Cultural Heritage, Alma Mater Studiorum University of Bologna. Thanks to an active agreement, RavennAntica was able to give the University specific restoration phases, aimed at recovering the entire flooring, in view of the exhibition at the Classis Ravenna - city and territory Museum. Within this context, the two Thesis projects have been launched from which the studies covered in this publication derive (Franzoni 2020; Sagripanti 2021).

Methodology and Experimentation for the Choice of Integration Mortars

The first study talks about the results achieved through experimental studies of lime mortars for the conservation of mosaics. This work was possible thanks to the collaboration and support of the ISTEC-CNR of Faenza[6] with reference to the analysis and development of lime mortars suitable for the integration of small-medium gaps in the mosaic[7].

More in detail, this research focused on the development of two new specially formulated and alternative mortars, compatible with ancient mortars in physical-chemical and technological characteristics: one for the tesserae bedding and one for the integration of the gaps due to missing parts by using the engraved tesserae method.

This experimentation allowed to identify, following the purely practical-operative aspects of doing restoration and the purely theoretical principles, a range of products to be used during the mosaic restoration.

Study Phase

The study was conducted starting from commercial raw materials to facilitate its reproducibility and realization. These materials were chosen according to their reversibility, chemical stability, lightness, and compatibility in terms of chemical-physical and historical characteristics with the original materials and techniques.

In addition, the required functions were considered (tesserae bedding and engraved tesserae integration) and the environmental conditions to which the mortars would be subjected (Macchiarola 2015: 700).

Mainly the following materials were considered as binders: lime putty, natural hydraulic lime NHL 3.5, and natural hydraulic lime NHL 5, so that the formulated mortars guaranteed maximum compatibility, were in line with the guiding principles of the restoration, and could guarantee good results in terms of workability, durability, and economy.

To improve the mechanical performance of the mortars (such as increasing the hydraulic properties, and reducing setting times)[8] it was decided to carry out tests by adding pozzolanic materials to the mixes, such as metakaolin[9], in addition to micronized pozzolana and cocciopesto.

Regarding the aggregate, it was decided to use mainly Botticino marble powder and river sand.

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6 The Institute of Science and Technology for Ceramics of Faenza.

7 This experimentation is part of a scientific-technological research line launched over fifteen years by the CNR-ISTEC of Faenza, which involves the development and fine-tuning of innovative and environmentally friendly materials and technologies for restoration (archaeological-architectural) and the recovery of the historical building.

8 Reducing setting and hardening times is particularly important in the restoration sector both to be able to make quality interventions in the shortest possible time, limiting timing and costs, and because sometimes a certain time reduction is required in emergency interventions which often leads to the choice of ready-made premixed products.

The addition of the hydraulic admixture has also been tested for natural hydraulic limes, already hydraulic by their nature, by evaluating the increase in the degree of hydraulicity, the improvement of the mechanical properties and the reduction of setting times, without having to add compounds typical of cement or other additives of a resinous and sticky nature.

9 It is known that the reactivity between lime and metakaolin is very high, and the resulting mortars have characteristics suitable for restoration (Gameiro et al. 2012). In particular, the addition of metakaolin to geopolymers but also in some cases to limes has been studied in various experiments conducted at the CNR-ISTEC of Faenza, which have demonstrated the increase in hydraulic and mechanical properties with the addition of metakaolin to mortar.

The mortar for the engraved tesserae was compared with a commercial premixed mortar proposed for mosaic restoration: *Adesilex P10*[10]. During the research, an attempt was made to study the composition of this product to establish an alternative mortar as similar as possible in terms of its specific physical-mechanical properties.

After choosing the materials, an analytical study was conducted through diffractometry analyses, thermal analyses, and X-ray fluorescence analyses, for the quality control and characterization of the raw materials to propose, in the testing phase, more suitable formulations thereby formulate product compositions with a predictable and verifiable behaviour in compliance with the data provided by the manufacturers' technical datasheets[11].

After the characterization of the raw materials and verifying their conformity based on the real chemical-mineralogical composition, some important factors emerged that were taken into consideration for the execution of the tests.

From the analysis, the NHL 3.5 lime shows the chemical characteristics of an NHL 2. To be classified as NHL 3.5, the product must contain a quantity of free lime above 25% (as prescribed by the legislation, which does not provide upper limitations (UNI EN 459-1: 2015); in this case, the content is higher enough to pass into the NHL 2 range (above 35%). It is important to underline this limit in the legislation for the formulation of mortars: lime, although classified as an NHL 3.5, has chemical and consequently physical-technological characteristics much more similar to an NHL 2[12].

Metakaolin is the addition that guarantees greater reactivity with a pozzolanic effect (Fabbri et al. 2013: 2-10). It can guarantee a decisive hydraulicity and a better mechanical resistance to mortars based on NHL 3.5 and lime putty (Grilo et al. 2014: 287-294), which, in this case, chemically contain approximately the same quantity of lime hydroxide.

Lime NHL 5 and lime putty have the standard chemical composition.

Adesilex P10 is confirmed to be a complex cement product mainly consisting of a hydraulic binder, whose primary compounds are obtained by firing at high temperatures (1200-1400 °C) of natural or artificial mixtures of limestone, limestone marly, and clays. The premix also has a high content of filler-carbonate aggregate and a consistent quantity of organic substance. The latter, undoubtedly, is the component that determines its excellent processing properties for the engraved mortar method.

Experimental Phase

Afterward, various restoration mortars were formulated, specific for the required functions, using prototypes made in the laboratory to evaluate their actual application and suitability to perform the required function.

The goal was to experiment with different formulations of "traditional" lime mortars, created starting from a limited number of well-known raw

10 Produced from Mapei SpA.

11 To create a mortar that corresponds exactly to the function for which it is intended and that is compatible with the work, as required by UNI 11488, it is necessary to make appropriate choices for each of the components that constitute it and to have a thorough knowledge of the behaviour of the materials (UNI 11488: 2021).

12 The manufacturer, in compliance with the law, sells a product that does not correspond to the performance that would be expected. This example denounces the limits of the legislation that allows the sale of products defined as "equal" but in reality profoundly different.

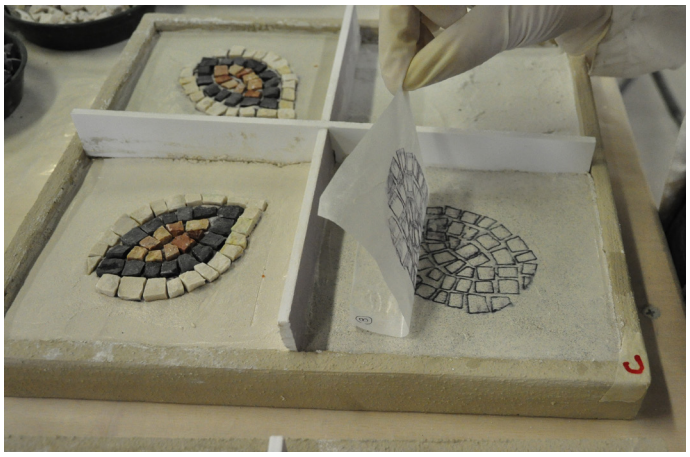
materials, choosing a specific mortar according to the required parameters such as functionality, workability, and aesthetic performance. By varying the combinations of the raw materials, 24 tests were carried out for the bedding mortar and 12 tests for the engraved tesserae mortar, for a total of 36 tests.

In this experimental phase it was decided to proceed along two different lines of activity, one for the tesserae bedding mortar and one for the engraved tesserae mortar.

For the tesserae bedding mortar, various types of mortars were formulated and tested through the creation of small mosaics (Figs. 4-5). After careful evaluation, it was found that the best formulation for the bedding was made up of a mixture of several binders (lime putty, NHL 3.5, and NHL 5) and aggregates[13]. With this formulation, a good degree of hydraulic property and, therefore, resistance has been achieved, together with good plasticity, which is necessary for the lodging of the tesserae.

Figure 4
Tesserae bedding mortar: printing the lattice on fresh mortar (Franzoni 2020).

Figure 5
Tesserae bedding mortar – Test with "direct method" on final mortar (Franzoni 2020).



Various mixtures were formulated for the engraved tesserae integration mortar, and small mosaics were made with the engraved tesserae technique on fresh mortars (Figs. 6-7). This second experiment aimed to formulate a mortar with physical and aesthetic properties as similar as possible to *Adesilex P10* without resorting to the use of cement and synthetic additives.

After the tests, it was decided that the best formulation for the making of the engraved tesserae, closer to the workability and aesthetic performance characteristics of the premixed mortar, was the mix of putty and metakaolin (10%) with sieved aggregate[14], resulting in a very workable and plastic mortar with good resistance thanks to the pozzolanic addition and the aggregate, duly sieved, guarantees the creation of a smoother and finer mortar.

The best pictorial retouching technique, for practicality and aesthetic performance, turned out to be the mixed technique with a tempera base and final watercolor retouching.

13 The test consists of a mixture of marble dust and three binders, putty lime, NHL 3.5, and NHL 5, in a proportion in which the NHL 5 portion guarantees water and more resistance to the mortar, while the putty and NHL 3.5, which chemically contain approximately the same percentage of air fraction (one 50% the other 43%), lighten the mortar. The putty lime gives plasticity to the processing and the NHL 3.5 gives body to the mixture, keeping the level of lime hydroxide high.

Binder and aggregate ratio 1: 2.

Percentages of binders: 40% NHL 5, 30% NHL 3.5, 30% putty lime. The percentages of binders refer to the total weight of the binder component (for putty lime the half by weight which consists of water is excluded).

14 Binder and aggregate ratio 1: 2,5.

Figure 6
Mortar for engraved tesserae integration - Test with engraved tesserae method (Franzoni 2020).

Figure 7
Mortar for engraved tesserae integration - Test of pictorial retouching (Franzoni 2020).

The two selected mortars and the premix were then tested to quantify the open porosity and the mechanical strength, compression, and bending, to evaluate their performance and some physical characteristics.

In summary, concerning the porosity tests, all three samples showed high porosity. With reference to the mechanical tests of flexural and compressive strength, traditional restoration mortars generally have reduced flexural and compressive strength. The mechanical tests showed that the two mortars made in the experimentation were not particularly resistant. The samples of *Adesilex P10* showed resistance values that were not entirely expected, demonstrating high values, even if much lower than those of a classic cement mortar. As it happens, the data obtained are useful to demonstrate the safe and full reversibility of all three products because of not too high mechanical performance.

Conclusions

At the end of this research, the results can be summarized in some salient points:

- Metakaolin and limes turned out to be excellent materials, suitable for mosaics restoration, because they are ecological materials, produced with low carbon emissions, and are not poisonous (no chemical additives). They are suitable for green restoration too because they are materials suitable for a sustainable and ecological vision (Gizzi 2015: 25), with a low environmental impact, increasingly welcomed by the European Union.

- Experimentation done on two distinct lines of work obtained different results. The mortars specifically made with combinations of binders, aggregates, and additives made it possible to evaluate the advantages of specifically made mortars based on the knowledge of the raw materials, obtaining satisfactory results from the point of view of workability, functionality, and aesthetics, enhancing the importance of the practice and research as a basis of the restoration activities.

- The know-how about the "ingredients", the raw materials, and the composition of the products on the market allows one to make mortars with raw materials with similar performance to the premixed mortars, or even better, to perform the required function. The restorer, in the variety of cases he may encounter, should be able to adapt to each situation and select the most suitable and feasible choices, taking into account numerous variables that affect the technical operational level of a restoration project.

Good knowledge of all the subjects and their influence are driving the choices with full knowledge of the facts and responsibility related to the most suitable material for each situation (Mosca et al. 2010: 77).

- In a conservative solution in line with the restoration of the mosaic of the *vestibulum*, the experimentation has made it possible to study and obtain specific products to be used during the restoration. Periodic control and maintenance will allow, after many years, to verify the effective prowess, efficiency, and behaviour of the mortars over time.

Thanks to a campaign of specific investigations on materials and the implementation in the practice of countless mortar samples, conclusions were reached that allowed us to agree on the purely practical aspects of doing restoration with the most correct methodologies.

This research not only led to the definition of two alternative lime mortars, specially formulated for the restoration of ancient mosaics, but in addition to this, it underlined practical aspects of the restoration intervention: from the choice of materials to the methods and times of working the dough, to the implementation, and aspects of ethics and methodology.

In full awareness of the proposed research's limits, it is hoped that this work will enrich the database of lime mortar formulations for mosaic conservation and offer useful references for future works and insight into the compositions and characteristics of restoration mortars.

New Methods for Conservation and Enhancement

This second study conducted on the Via Dogana mosaic discusses the creation of a three-dimensional relief of the whole floor, the realization of some virtual integration proposals, and finally the creation of some information panels, to enrich the exhibition project.

This second part of the project was possible thanks to a collaboration with FrameLab – Multimedia and digital storytelling, the informatic laboratory of the Department of Cultural Heritage of the University of Bologna[15], which assisted me in the photographical documentation and 3D relief making. After the photographic acquisition and the 3D relief of the mosaic surface various image processing methods were tested, in order to create ortophotographies of the whole floor. These ortophotographies were a useful start to creating damage mappings and virtual restoration interventions.

3D model completion

The realization of the 3D model started in 2019 by my colleague Agnese Franzoni, in relation to the first-degree thesis related to the Via Dogana mosaic (Franzoni 2020), and so when the mosaic was still being restored. The relief lacked the two central sections: one with the *emblema*, portraying the return of Hector's body from Achilles to Priam, and the other portraying two young

15 FrameLAB - Multimedia & Digital Storytelling is a research laboratory of the Department of Cultural Heritage, University of Bologna, born in 2015 from the aggregation of humanistic, scientific, and technical skills and knowledge. The FrameLAB carries out research, teaching, and third mission activities in the various areas of cultural heritage, to communicate and enhance objects, monuments, contexts, memories, and cultural traditions.

The projects carried out and still in progress consist of various possible declinations of the concept of 'virtual museum', aimed at combining the most advanced results of research with public communication and the socialization of knowledge of cultural heritage.

men in heroic nudity, immediately to its right. These two sections, at the time of the initial 3D acquisition, were still exhibited at the TAMO – *Tutta l'avventura del Mosaico* - Museum in Ravenna. In 2020, the two missing sections were moved from the TAMO museum to the *RavennAntica* Foundation laboratories (Fig. 8), to complete the restoration and musealize the whole floor in the new section of *Classis Ravenna* – city and territory museum. This transfer allowed us to complete the 3D relief and obtain a single rendered 3D object: a real, measurable, and scaled model built on dimensional and morphological data of the entire floor.

Figure 8
Handling of the two central sections from the TAMO Museum to the RavennAntica laboratories (RavennAntica 2020).

The chosen 3D acquisition technique used is based on the principles of Reverse Engineering: a process that reproduces real objects transforming them into three-dimensional outputs, which are then built from the data provided by the real object (Monti 2017). In this case, the acquisition is remote and there is no need to touch the mosaic, thus allowing a non-invasive investigation.

The acquisition is based on structured light optics, producing light waves at a single and constant frequency. By moving the source and guiding its orientation it is possible to acquire the object in its entirety. In addition, in the instrumentation, there is a camera that pairs with the use of structured light to capture images of the surface, a fundamental operation for the application of textures in post-processing (Menghi 2017: 42). The image obtained is dynamic, as you get a real scale model of the work in question, which can be oriented and moved by the operator in a virtual space. The applications in the field of cultural heritage are manifold and comprehend the documentation enrichment, historical-artistic protection, the degradation monitoring, up to the application of virtual restoration techniques, such as the integration of gaps and the juxtaposition of fragments, in cases where it is not possible to perform these operations in reality.

For the acquisition of the two sections, the selected instrument is the Eva structured-light 3D scanner by Artec3D. The instrument, which is portable and hand-held, can be used directly by the operator, and thanks to its small size it is ideal for on-site acquisitions. The scanner has a sampling density of not less than one-tenth of an mm and is therefore preferable in the case of acquisitions of medium and large objects. In the case of the Via Dogana mosaic the total surface to be scanned measures 34.4 square meters; thus, this instrument was chosen

compared to scanners with lower sampling density, which are suitable for smaller objects. The acquisition steps include primarily the acquisition of point data of the surface, which are processed in a point cloud in space; at every point, precise spatial coordinates are assigned. Secondly, the specific software connected to the scanner, Artec Studio 15, creates a mesh of polygons by connecting the points of the cloud. The texture must then be applied to the mesh, and detected by the scanner via a series of photographic images.

The acquisition work was carried out across two days, including both the acquisition and the model creation, and did not present any problem whatsoever; in order to capture the entirety of the missing section 10 scans were performed[16] or a total working time of 40 minutes (Fig. 9). Once the scans obtained in the software were selected, we proceeded with a series of preliminary operations, such as selecting the characteristics of the object.

Figure 9
Scanning of the mosaic surface (University of Bologna, LMCU Conservation and Restoration 2020).

Subsequently, the editing phase followed, which consisted of modifying the scans, and selecting and erasing useless or wrongly acquired portions. Then we attempted to automatically align the scans, but the first attempt was not successful, probably because of the repetition of geometrical motives in the pictures.

Therefore the scans were manually aligned, selecting couples of homologous points to stitch together. The first attempt consisted in merging all of the scans with texture, but the results were once again not successful, showing poor texture quality and multiple alignment errors. The third attempt, therefore, consisted in creating three different models, merging them, applying the simplify mesh[17] command in the software, and just then, once the model was complete, applying a texture with a high resolution (2048x2048). The final result (Figs. 10-11) was a clear, clean model of the surface, which was then uploaded to the 3D modeling software Blender and merged with the preexisting model of the rest of the floor (Fig. 12).

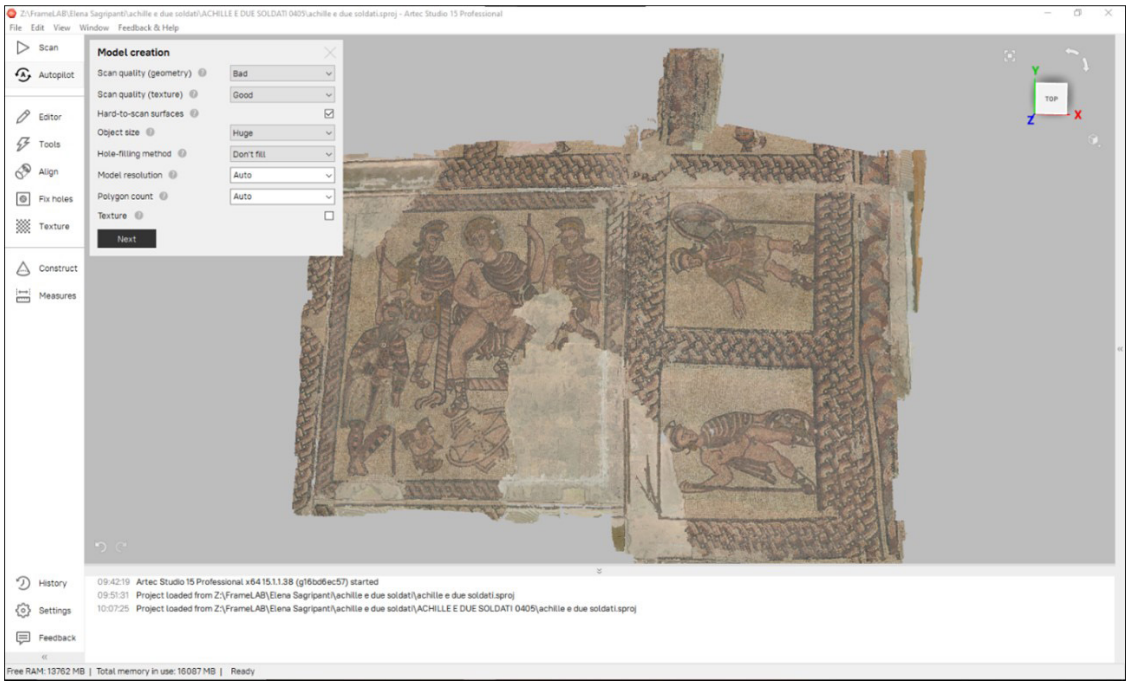


Figure 10
Failed alignment of the scans (Sagripanti 2021).

16 8 Frames per second relief.

17 The control acts on the *mesh* by decreasing the polygons and consequently decreasing the weight of the model, without compromising its quality.

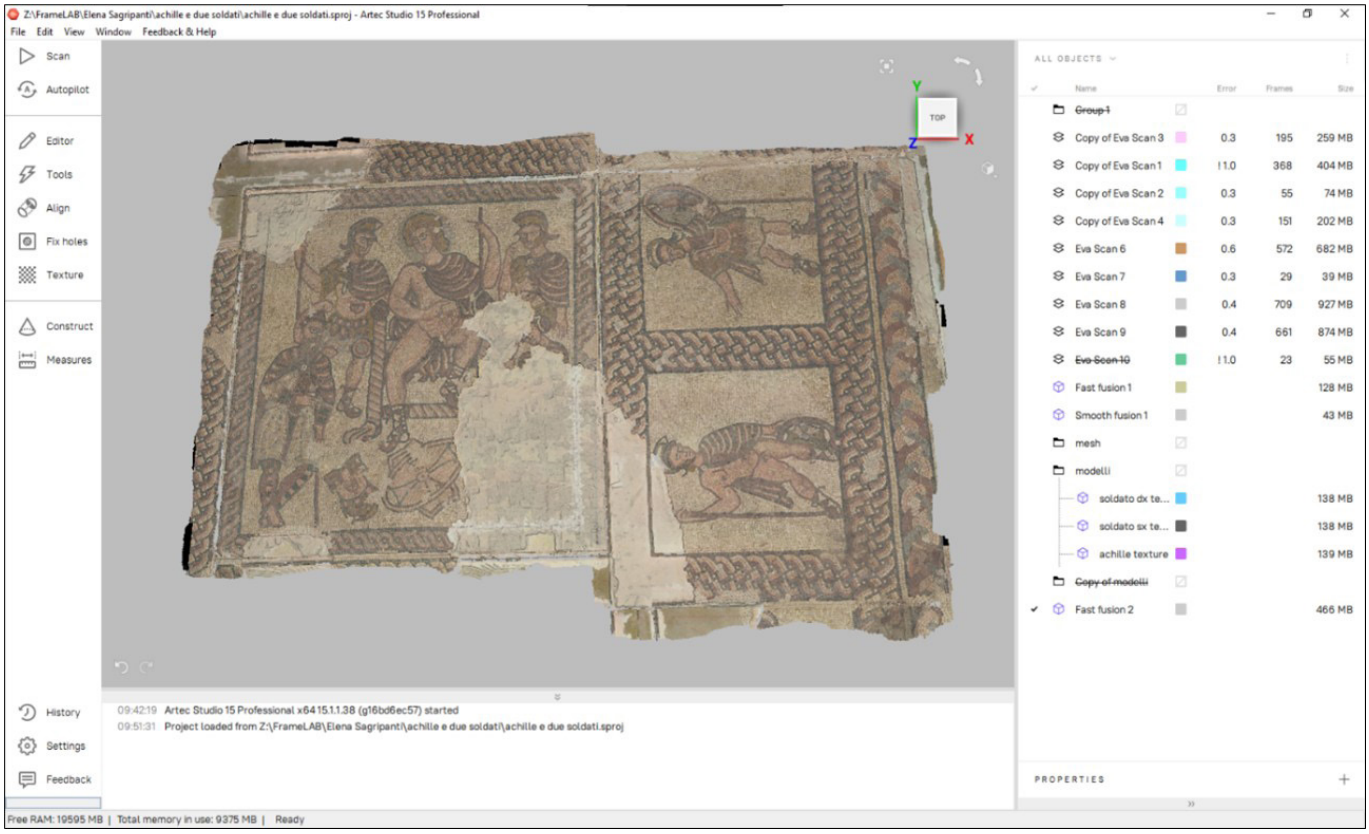


Figure 11
Final result of the 3D scan of the central sections (Sagripanti 2021).

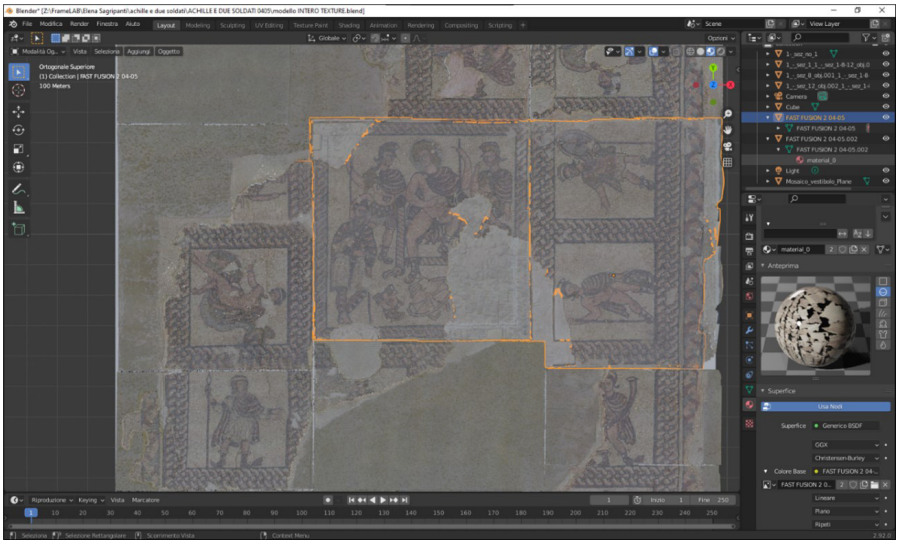


Figure 12
Merging of the central sections 3D model with the preexhisting model (Sagripanti 2021).

Virtual Restoration

The goals of the virtual restoration of the floor are as follows:

- Reconstructive hypothesis of geometries that, due to the high extension of the gaps, would not be possible to carry out during the restoration in the laboratory, as a complete integration would create a historical counterfeit;
- Visual restitution of the geometric integrity of the floor, to minimize the impact of large gaps, thus allowing the observer to appreciate the totality of the original decorative motive;
- Creation of a digital reproduction of the mosaic to be placed next to the original floor in the musealization process;
- Creation of a digital image to be inserted in an information panel as a support to musealization.

Realization of the Orthophotos

The thesis work (Sagripanti 2021) involved the realization of two orthophotos at two different times of the restoration: the first was carried out during the restoration, to provide a basis for the construction of conservation, interventions, and deterioration mappings. The second was carried out once the restoration was completed, excluding the final operations to be carried out at the same time as the musealization, to use it as a starting point for the virtual restoration operations.

After photographing the entire floor, maintaining the same camera settings and point of view for each shot[18], two different methods of joining the images were used: for the first photomosaic the function Photomerge of Adobe Photoshop CC 2018 software was chosen; for the second photomosaics, the images were aligned using Agisoft Metashape photogrammetric processing software. The goal was to describe and compare the two methods of image processing, with the purpose to draw useful conclusions for the methodologies to be used in the course of future work. Here we chose to report only the final results, but more information on the whole process can be found in the complete degree thesis.

The result of the operation conducted with Adobe Photoshop CC 2018 was a photomosaic of the entire floor, which was metrically corrected during the post-production phase by comparing the measurements of the real panels with those in the image. The final resolution is 6024x8170 pixels and was suitable for the execution of the state of conservation and restoration mappings (Fig. 13).

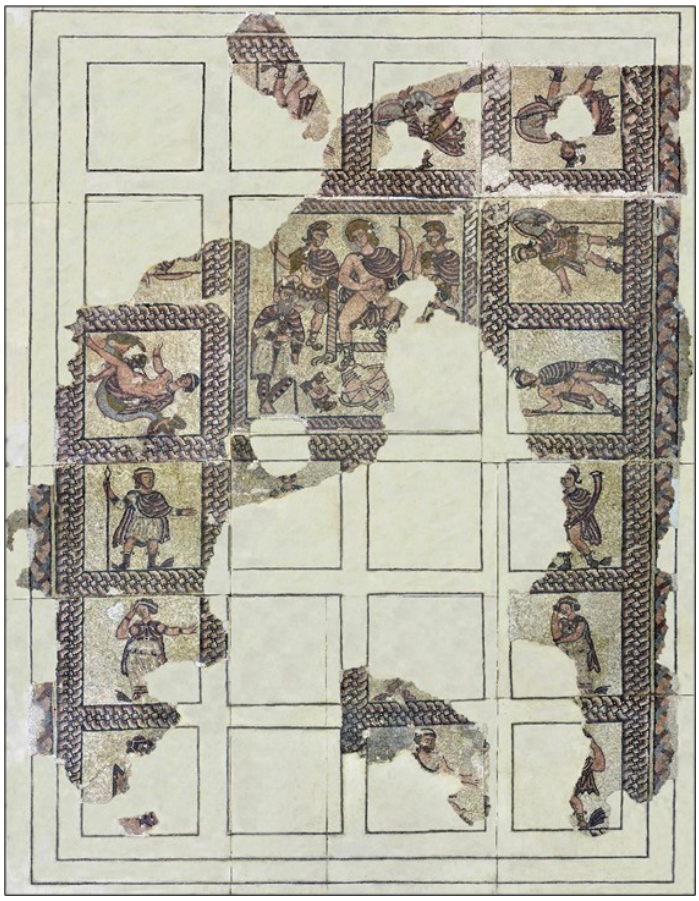


Figure 13
Adobe Photoshop CC 2018 orthophoto result (Sagripanti 2021).

18 The camera used is NIKON D90 with a 16.0-85.0mm f/3.5-5.6 lens. Camera settings: f/4, t 1/60”, focal length 16 mm, ISO-200. The captures were saved in nef and .jpg format. The white balance was performed during the shot. The photographs were taken with overlapping of 60% between them from a constant distance of 1.80 mts. The lens distortion has been corrected using the function Camera Row in Adobe Photoshop CC 2018.

The result obtained with Agisoft Metashape was a metrically correct image of the entire surface of the mosaic, with a 14501x19714 resolution, much higher than the previous one, and the model has no alignment errors (Fig. 14). Overall, the realization of the orthophoto with Agisoft Metashape proved to be extremely effective, faster, and more accurate than the alternative used previously.

Figure 14
Agisoft Metashape Professional orthophoto result (Sagripanti 2021).

The purpose of the realization of the second orthophoto, as said, was to obtain a metrically correct and high-resolution photograph of the mosaic floor, which would provide the basis for carrying out all the virtual restoration operations of the case, using the software Adobe Photoshop. The first phase was the closure of gaps in photography caused by defects in image processing in the Agisoft Metashape software.

The next phase included all the operations of real virtual restoration aimed at simulating the appearance of the mosaic during musealization: the creation of a uniform plaster and of neutral tone for the compensation of large gaps, the creation of the missing points of contact between the different panels and the

cocciopesto filling of one of the gaps, which was not possible to perform before the musealization because it is located between two sections (Fig. 15).

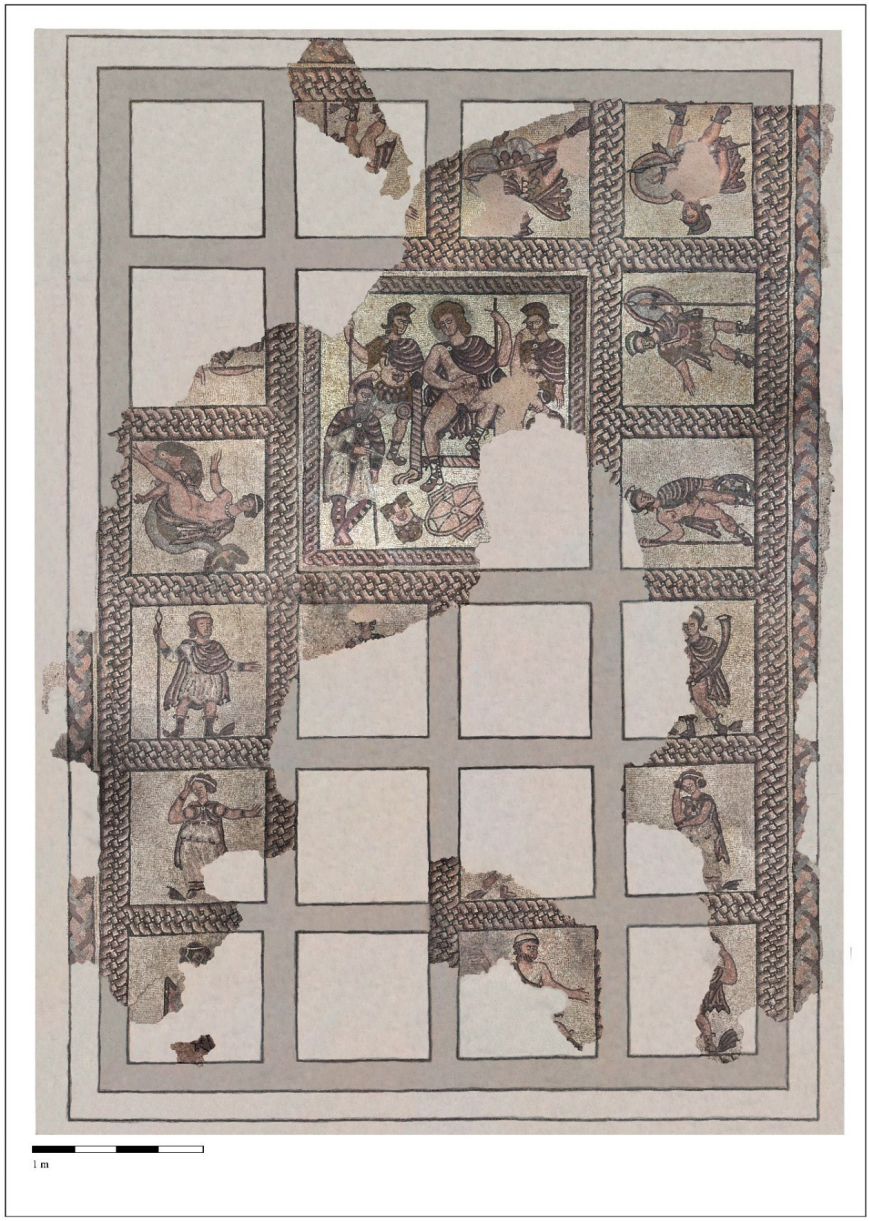


Figure 15
Virtual restoration of the floor, showing the conditions it will assume during the musealization phase (Sagripanti 2021).

All these operations were performed with the Clone Stamp function, selecting the target area to outline its contours and choosing a similar area of the floor to be taken as a model to create the virtual image. This led to the simulation of the appearance that the floor will take on once the restoration is completed during the musealization.

The third phase involved the virtual integration of the gaps in the geometric parts of the mosaic floor, completely reconstructing the braided patterns: it was carried out combining Clone and Transform functions.

Two hypotheses of virtual integration were realized: one of the camouflage type (Fig. 16), that is, with the braids and geometric patterns repeated exactly as they are in the mosaic floor; the second displaying a slightly undertoned integrative solution of the braids (Fig. 17).

Figure 16
Virtual restoration of the floor, showing the conditions it will assume during the musealization phase (Sagripanti 2021).

Figure 17
Virtual integration of the braids - undertone (Sagripanti 2021).

The final part of the work comprehended the creation of two informative panels, following the current design of the *Classis Museum* informative material (Mandara 2018). The goal is to offer the visitor a further look at the conservative history of the mosaic, focusing on its iconography and restoration. The panels are presented as a proposal made for the study and expansion of the thesis project, considering the already present proposals, formulated by the scientific committee (Scientific Committee Classis Ravenna 2018), especially regarding the historical-artistic introduction and technical information relating to the work, which during the musealization phase will be curated by the archaeologists and art historians in charge[19].

The text of the first information panel will contain a historical-artistic introduction to the mosaic and a description of the floor that takes into account the iconographic study carried out in the first chapter of the first part of the degree thesis, as well as the virtual restoration result (Fig. 18); the second panel will be about the various phases of the restoration that have taken place over time, focusing

19 The Commission that elaborated the project of the Museum:
President Prof. Andrea Carandini, Members Prof. Carlo Bertelli (Honorary Professor at the University of Lausanne and Professor Emeritus of the Università della Svizzera Italiana); Arch.Carla Di Francesco (Regional Director for Cultural Heritage); Dr. Luigi Malnati (Superintendent of Archaeological Heritage of Emilia Romagna); Prof. Giuseppe Sassatelli and Prof. Andrea Augenti (University of Bologna) Arch. Antonella Ranaldi (Superintendent of Architectural and Landscape Heritage for the Provinces of Ravenna, Ferrara, Rimini Forrlì Cesena); Dr. Sergio Fioravanti (Director of the Archaeological Park Foundation of Classe-Ravennantica); Dr. Chiara Guarnieri and Dr. Maria Grazia Maioli (Superintendence of Archaeological Heritage of Emilia Romagna). In: Scientific Committee of the *Classis Ravenna* Museum, *The new Classe museum: name and scientific project*, Ravenna, 2018.

on the collective aspect of the work done and on the educational character of the conservative campaign (Fig. 19). The text will be flanked by some images, selected and representative, to provide the observer visual feedback of the text.

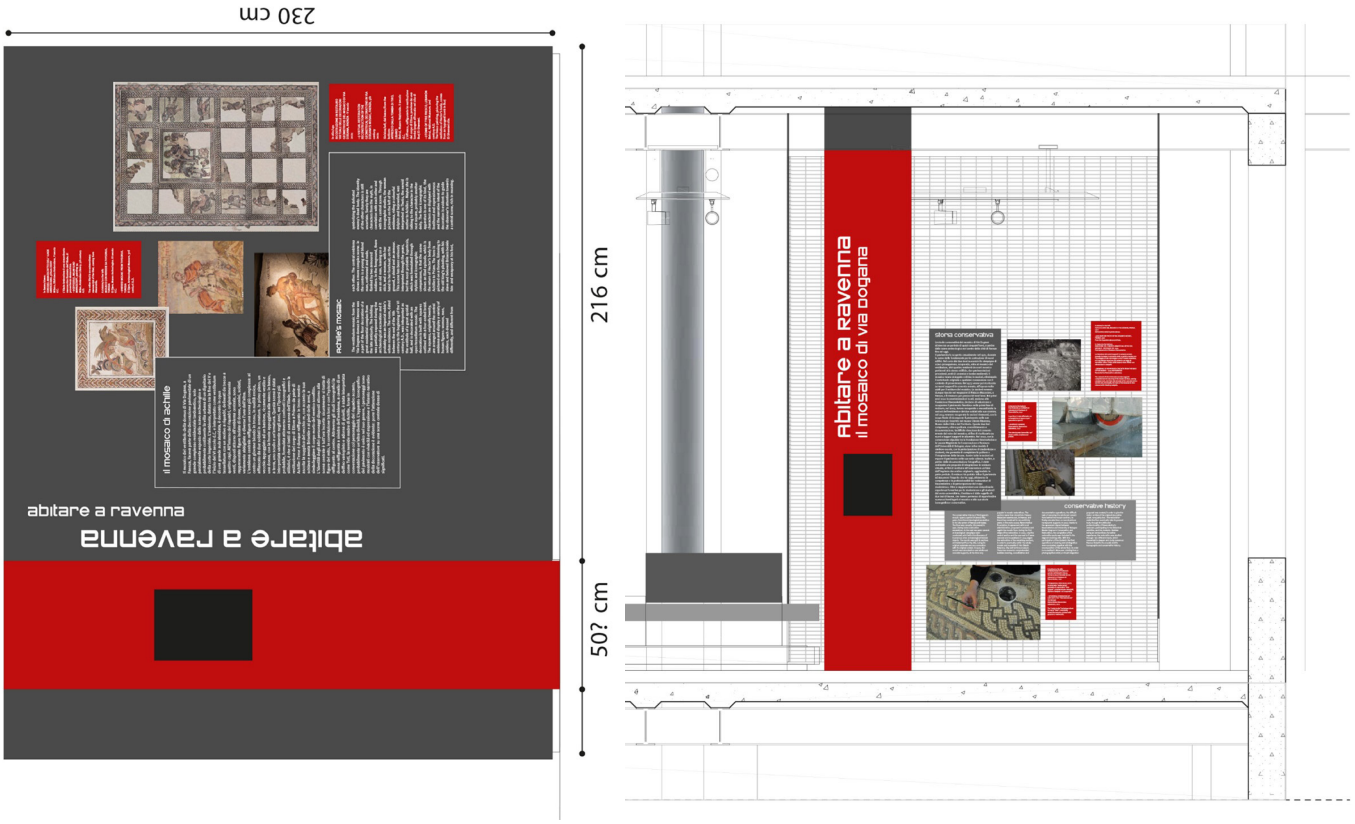


Figure 18
First informative panel (Sagripanti 2021).

Figure 19
Second informative panel (Sagripanti 2021).

The realization of the panels was carried out using the Adobe Illustrator CC 2018 software and was based on the exhibition project developed by the architect Andrea Mandara, in particular on the panels already proposed for the Abitare a Ravenna section (Mandara 2021). In addition, some of the information walls currently in the museum were taken into consideration, using study and photography, to create coherent proposals, in line with the current arrangement of information in the museum area.

Conclusions

In the case of the mosaic in Via Dogana, the virtual restoration operations turned out to be extremely effective in the visual fruition of the work, because the reconstruction of geometric patterns and braids offers the observer a vision without a doubt closer to the original appearance of the mosaic floor. The proposed additions will be inserted in an informative video to be displayed by the mosaic in the exhibition venue and will bring a significant contribution to the current musealization proposal. 3D scanning of sections of mosaic previously placed at the *TAMO* museum has been joined to the model previously made by Dr. Franzoni, to complete the documentation graphics of the floor and have a full-scale, excellent resolution model of the mosaic in its entirety. In addition, the application of different IT strategies to create high-resolution photogrammetry has allowed here to expand the knowledge of the use of these tools and provide the basis for approaching interventions of this type in future works.

The hope at the end of this work is to give the future visitors of the *Classis Ravenna* – city and territory Museum an insightful view of the Via Dogana Mosaic, comprehending all its aspects: the archaeological context, the artistic value, the study of materials and the restoration work.

In conclusion, the restoration was thus a moment of study and active experimentation, that did not neglect the enhancement of such a significant artistic testimony. Soon the mosaic will be exhibited in the new section of the *Classis Ravenna* - city and territory Museum, *Living in Ravenna*, and therefore it will be accessible to the general public.

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