Ge-conservación
Conservação | Conservation

5TH EDITION OF THE INTERNATIONAL MEETING ON RETOUCHING OF CULTURAL HERITAGE
UNIVERSITÀ DEGLI STUDI DI URBINO "CARLO BO"
SCUOLA DI CONSERVAZIONE E RESTAURO DEI BENI CULTURALI
18TH - 19TH OCTOBER 2019

Gilding on a 15th century stone relief from Dubrovnik: technical study vs. Cennini's recipe

Sandra Šustić, Vinka Marinković, Jure Balić, Martin Zohil, Vinko Lipanović, Ema Bonomi

Abstract: During 2016, the Croatian Conservation Institute carried out a demanding conservation and technical research on a 15th century gilded polychrome stone relief from Dubrovnik, attributed to Pietro di Martino da Milano (c.1410-1473). The process proved to be a valuable opportunity to better understand the materials degradation and the techniques used by the Master. Due to the difficulty of determining the existence of impregnation and ground layers, two experimental reconstructions were created as part of a student project – one based on the interpretation of research results obtained during the conservation treatment, and the other based on art technological source research, namely the Cennino Cennini's recipe, CLXXIV. The aim was to evaluate the effectiveness of these layers on the final gilding and to get an insight into the Master's experience via the "learning-by-doing" method. The experimental results indicate that the cause of the damages and the consequent fragility of the original relief, might have its origin in the absence of impregnation and ground layers.

Keywords: gilding, stone relief, historically based reconstruction, ground layers, Cennino Cennini's recipe CLXXIV

Dorado sobre un relieve de piedra del siglo XV de Dubrovnik: estudio técnico vs. Receta de Cennini

Resumen: En 2016, el Instituto Croata de la Conservación, ha levado a cabo un exigente trabajo de conservación y pesquisa técnica, de un alto-relevo dorado del siglo XV, proveniente de Dubrovnik y atribuido a Pietro di Martini da Milano (c. 1410-1473). La intervención, ha probado tratar-se una valiosa oportunidad de mejor entender la degradación de los materiales empleados y de las técnicas empleadas por lo Maestro. La dificultad de identificar la existencia de las camadas de impermeabilización y de preparación, han levado a dúas reconstrucciones experimentales como parte de un proyecto de estudio – una de las reconstrucciones se ha basado en la interpretación de los resultados de pesquisa obtenidos durante la intervención de conservación y restauración, y la secunda en pesquisa histórica y tecnológica, nombradamente la receta de Cennino Cennini, CLXXIV. El objetivo ha sido la evaluación de la influencia de las dos camadas iniciales en el comportamiento del dorado, permitiendo en simultaneo una visión de la experiencia del Maestro, basada en una metodología de "aprender-haciendo". Los resultados experimentales muestran que la causa de los danos y fragilidad del dorado original, podrán ter su origen en la ausencia de las capas de impermeabilización y preparación.

Palabras clave: dorado, alto-relevo en piedra, reconstrucción histórica, capas preparatorias, receta de Cennino Cennini CLXXIV

Douramento de um relevo de pedra do século XV de Dubrovnik: estudo técnico vs. Receita de Cennini

Resumo: Ao longo de 2016, o Instituto Croata da Conservação levou a cabo um exigente trabalho de conservação e pesquisa, de um alto-relevo em pedra dourado e policromado, datado do séc. XV, proveniente de Dubrovnik e atribuído a Pietro di Martino da Milano (c. 1410-1473). A intervenção revelou-se uma oportunidade para melhor compreender os processos de degradação dos materiais e as técnicas utilizadas pelo Mestre. A dificuldade em determinar a presença das camadas de impermeabilização e preparação, levaram à criação de duas reconstruções experimentais, como parte de um projecto académico: a primeira reconstrução baseou-se na análise dos exames laboratoriais efectuados durante a intervenção, e a segunda teve por base uma pesquisa histórico-tecnológica, nomeadamente a receita de Cennino Cennini, CLXXIV. O objectivo foi o de avaliar a necessidade das camadas preparatórias no douramento, permitindo ainda experienciar o trabalho do Mestre, na forma de "aprender-fazendo". Os resultados experimentais apontam para que uma das possíveis causas de alteração do douramento e consequente fragilidade, tenha a sua origem na ausência das camadas de impermeabilização e preparação.

Palavras-chave: douramento, alto-relevo em pedra, reconstrução histórica, camadas preparatórias, receita de Cennino Cennini CLXXIV

Introduction

Over the past few decades, a lot of attention has been given to the research and the preservation of European polychrome and gilded stone altarpieces, sculptures and architectural objects. Although Croatian cultural heritage is rich in these kinds of objects, many of which are dated from the Renaissance period, in the literature there is a significant lack of comprehensive studies on the original construction methodology and polychrome schemes of the surviving artifacts. However, valuable information on material characterization and layer build-up, in particular on isolating sealant and preparatory layers, can be found in Andreuccetti (2008), Brecoulaki (2014), Bordignon *et al* (2008), Castelnuovo-Tedesco and Soultanian (2010), Skovmøller *et al* (2016) and Weeks (2006).

A 15th century gilded polychrome stone relief from Dubrovnik, part of a pulpit depicting four Dominican Saints (Peter of Verona, Thomas Aquinas, Vincent Ferrer and Margaret of Hungary), underwent a laborious technical study and conservation treatment in the Split Department for Conservation of the Croatian Conservation Institute in 2016 [Figure 1]. The treatment was carried out with the primary intent to present the relief in its original appearance by removing several campaigns of overpaint.

Since the relief was attributed to Pietro di Martino da Milano (c.1410-1473) (Fisković 2003: 29-48), this offered a valuable opportunity for understanding the degradation of the materials he used, as well as the technological choices of the original production. This paper will focus on one particularity of the analytical research – the difficulty of identifying the original isolation and ground layers. The aim is to answer practical questions regarding the construction of the gilding and whether or not this could be the proximate cause for the damage of the original gilding.

Methods

According to Castelnuovo-Tedesco and Soultanian (2010: 229), published studies about the polychrome and gilded stone objects from Italy and France, frequently reveal the presence of a distinct ground, usually identified as lead white, with or without an indication of isolation layer between this layer and the stone surface. They have argued that the lack of a ground layer, as it is presumably the case of the relief from Dubrovnik, is an unusual feature and it may reflect the influence of Venetian practice (2010: 230). This information is very interesting in the context of Pietro di Martino's working methods.

In order to further investigate this subject, two experimental reconstructions were made using historically informed materials – one based on the information of the paint samples taken during the conservation treatment and the

Figure 1.- Gilded polychrome stone relief (110x180 cm) depicting four Dominican Saints: Peter of Verona, Thomas Aquinas, Vincent Ferrer and Margaret of Hungary (left to right). Image taken after conservation by Jovan Kliska.

other based on documentary research of Cennino Cennini's recipe (M., CLXXIV), with six intermediate layers prior to the gilding. The aim was to evaluate the effectiveness of these layers on the final gilding and to get an insight into the maker's experience via the "learning-by-doing" method. Both reconstruction projects were carried out as part of the practical "Technical analyses and historical reconstructions" course, at the Arts Academy of the University of Split, in a summer semester of the academic year 2018-2019.

— *Interpretation of the research results obtained during the conservation treatment*

During the conservation-restoration treatment in 2016, a detailed analysis of the polychrome layers was carried out in collaboration with the Natural Science Laboratory of the Croatian Conservation Institute. The analysis of binders from individual layers of color were performed by Fourier Transformed Infra-Red Spectroscopy (FTIR) and thin layer chromatography; the stratigraphic analysis of the polychrome layers used reflected light and reflected fluorescent illumination; the pigments were studied by X-ray Fluorescence Spectroscopy (XRF). All these exams were performed and documented by Mudronja *et al* (2016-2017). However, due to various campaigns of overpainting, the majority of the data turned out to be rather incomplete, with the exception of the results gained from the XRF and cross section analyses, as shown in Table 1. The study has indicated that the gilding and the paint layers were applied without any distinct preparation layer. Only the red coating, laid directly on the stone, was visible to the naked eye but with no trace of sealant beneath it (Marinković, Šustić 2017).

— *Art technological source research*

According to Broecke (2018) numerous art objects dating from the period in which Cennino Cennini was writing his famous Libro dell'Arte (c. 1390) conform closely to his descriptions. Her research made evident that his treatise was - for the most part – an accurate source of the techniques and materials of the early renaissance period (Broecke 2018). Thus, his recipe on how to gild a stone figure (M., CLXXIV) was carefully analyzed (Cennini 1960) and reconstructed. His instructions, were in most parts of the recipe clear and easy to interpret, especially concerning the application methods. However, some directions betray a certain amount of confusion, such as the exact proportions and the required temperature for the ingredients, as shown in Table 2.

Experimental research

The information obtained from technical analyses and the data collected from Cennini's recipe, served as a starting point for the development of two historically informed reconstructions. Each of the models was carved in limestone from the island of Brač (Croatia). Two details from the original composition were selected and copied at a scale of 1:1. However, the main drawback of this research concerns the industrially processed materials used in the experiment; namely, their morphological characteristics are far more different from those of the materials available in the 15th century, thus the resulting reconstructions can only be considered as products which are historically informed, rather than accurate (Carlyle and Witlox 2008).

— *Reconstruction No. 1 - based on the interpretation of the research results obtained during the conservation treatment*

The Reconstruction No. 1 was developed to show three stages of the presumed original execution [Figures 2 and 3]. Each layer was made in accordance with the results of the visual observation and cross section analyses. The first layer shows the stone support, while the second layer is the base for the gilding (*poliment*). The third layer represents the burnished gold leaf, which is the unique top coat of the gilding process.

Table 1.- Original polychromy analyses based primarily on the XRF results. Data provided by the Natural Science Laboratory of the Croatian Conservation Institute, Zagreb.

ORIGINAL POLYCHROMY ANALYSES			
Technical studies	**Location**	**Detected features/elements**	**Possible materials/pigments**
Visual observation Cross-section X-Ray Fluorescence	Architectural elements	Red layer under the gold leaf Absence of ground layers (?) Absence of impregnation layers (?)	red clay (bole)
	Flesh tones	As, Pb, Zn, Fe, Ca, Hg, Mn, K	realgar/orpiment, lead white, azurite/ malachite, umber, ochres
	Architectural elements	Fe, Pb, Mn, Ca, Cu, Sr, Ba, Hg	bole, umber, organic black, calcium carbonate, lead white, azurite, red ochre, vermilion

Table 2.- Cennino Cennini's recipe: analyses and interpretation (Zohil *et al.* 2019).

CENNINO CENNINI'S RECIPE "HOW TO GILD A STONE FIGURE" (M., CLXXIV)					
Course of action		**Required materials**	**Required tools**	**Noted features**	**Execution details (Reconstruction No. 2)**
1. Preparation of the surface		/	/	**Procedure**: *"Sweeping and cleaning the surface of a figure"*	**Tool**: cotton fabric, bristle brush
2. Impregnation layers	a) First layer: sizing	**Animal glue** "*usual size*"	/	**Temperature**: "*get it boiling hot*" **Proportions**: "*strength with which you gesso anconas*" **Application**: "*coat or two"; "let it dry out well*	**Type of heating:** bain-marie **Cooking** time: ca. 15 min **Temperature**: ca. 60°C **Proportion**: 7% **Application**: two coats **Tool**: bristle brush **Absorption time**: 30 min
	b) Second layer	**Mordant**: **Linseed oil** "*cooked and brought to perfect condition of making a mordant*" **Liquid varnish** (?)	**Dish**	**Proportions** (linseed oil to liquid varnish) - 3:1 - "*mix a third of liquid varnish with it*" **Procedure and temperature**: "*Boil it all together thoroughly*"	**Type of heating**: bain-marie **Cooking time:** 30 min **Temperature**: ca 70°C **Proportion**: 45 ml linseed oil (+ 18 drops of siccative) + 15 ml mastic varnish **Amount of grind charcoal:** 4 sticks **Application**: one coat **Tool**: bristle brush **Drying time**: ca 14 days
		Pieces of oak "*or male-oak charcoal*"	"***Tamis***" (strainer)- for sifting the charcoal **Bristle** or **minever brush** – for application of the prepared impregnation layer	**Amount of grind charcoal**: "*make enough of them[siftings] in this way to serve your purpose*" **Procedure and temperature:** "*when it is quite hot, take a dish, put the siftings of the charcoal into it". "After this, put this mordant: mix it up well, and apply it". "Put it [figure] somewhere to dry thoroughly in the wind or sun"*	
	c) Third layer	**Animal glue** (same as above) **Egg yolk** (1)	**Sponge**	**Proportions**: "*glassful of it* [size] *to one yolk of egg*" **Procedure and temperature**: "*mix it up well while quite hot" "with sponge not to full, wipe a rub over every place to which you applied mordant and the charcoal*"	**Proportions**: one egg yolk (medium size) + animal glue (7%) **Overall weight of the solution prior application**: 175 g **Overall weight of the solution after application**: 150 g **Absorbed amount:** 25 g **Temperature**: ca 45°C **Tool**: sponge
3. Ground layers	a) First layer	**Animal glue** (same as above) **Gesso grosso** **Egg yolk** (1/2/3) Dust of pounded **bricks**	**Slice** (spatula / palette knife)	**Proportions**: "*put according to the quantity [?] one or two or three egg yolks*" **Temperature** (?) **Application and procedure**: "l*ay it* [the whole mixture] *over the job with the slice, two or three times" "let it dry thoroughly" "scrape it and clean it up"*	**Type of heating**: *bain-marie* **Proportions**: one egg yolk (medium size) + animal glue (7%) **Overall weight of the solution**: 175 g **Amount of gypsum**: ca 150 g **Amount of grind brick**: ca 20 g **Temperature**: ca 35°C **Application**: three coats
	b) Second layer	**Animal glue** (same as above) **Gesso sottile** or "**gilders' gesso**" **Egg yolk (1 - ?**)	**Palm** of a hand **Brush**	**Proportions** (?) "*you must put in a certain amount of egg yolk not so much as you do for gesso grosso*" **Temperature** (?) **Application and procedure**: First coat –"*rubbing it down with your hand very perfectly*" Next coats (4-6): "*lay the gesso with a brush*" "*when* […] *quite dry, scrape it down nicely*"	**Type of heating**: bain-marie **Proportions**: half egg yolk (medium size) + animal glue (7%) **Overall weight of the solution**: 175 g **Amount of gesso cakes**: ca 90 g **Temperature**: ca 35°C **Application**: five coats

4. *Poliment* – base for gilding	**Tempered bole** (same as for panel)	/	**Proportions** (?) **Temperature** (?) **Procedure**: "*lay it with tempered bole as you do on panel*"	**Proportions**: gilder's clay paste mixed with animal glue (7%) in volume 1:2. **Temperature**: ca 40°C **Tool**: kolinsky sable-hair brush **Application**: two coats
5. Gilding	**Gold leaves**	**Stone** or "**crook**" – for burnishing	**Procedure**: "*follow the same course and method in gilding* [as on panel]"	**Tools**: set of gilding tools **Gold leaf adhesive:** egg white mixed with water in volume 1:2.

Figure 2.- The making process of Reconstruction No. 1: (1) stone carving, (2) *poliment* polishing, (3) gold leaf application.

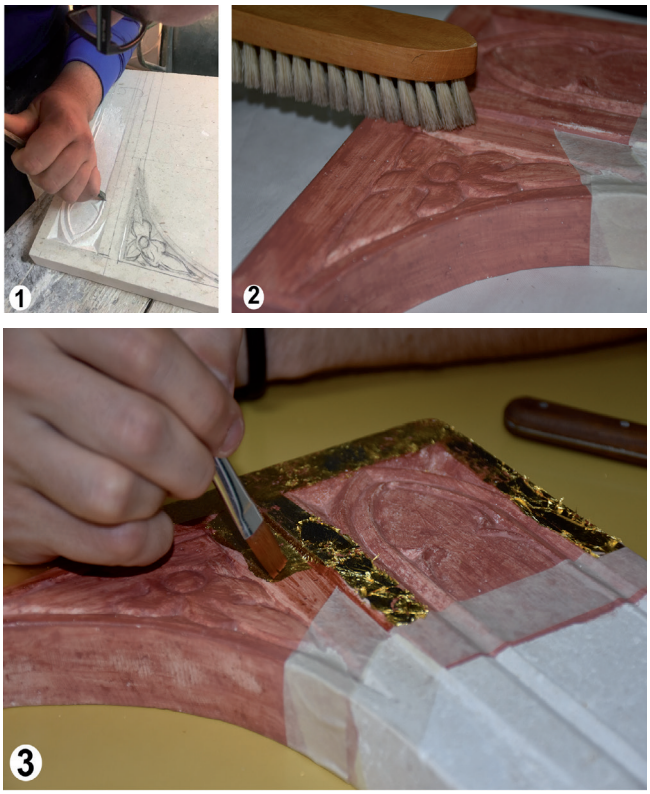

Figure 3.- Reconstruction No. 1. Description of the cut-away sections: (1) stone surface, (2) poliment, (3) gilding.

— Reconstruction No. 2 - based on Cennino Cennini's recipe (M., CLXXIV)

The historically informed Reconstruction No. 2, was made with ten cutaway sections representing crucial steps of the process described in the recipe [Figures 4 and 5]. Each layer was made following Cennini's instruction as shown in Table 2. Where original materials could not be found, contemporary equivalents were used. It is important to note that the data omitted within Cennini's recipe – for example the method for preparing the first impregnation layer, as well as the gesso grosso and gesso sottile - was compensated with the data found in his other recipes for panels and anconas (Cennini 1960: 59, 69-73, 79). The information was also enriched with important findings from other sources (Uzielli 1998, Broecke 2012, 2015).

Results and discussion

How important would have been if Pietro di Martino had used the impregnation and ground layers when gilding the stone relief? The only way to find out was to explore these coatings in two different experimental reconstructions: No.1, executed in the presumed manner of Pietro di Martino, without any intermediate coating between the stone and poliment, and No.2, with six different coatings beneath the poliment as prescribed by Cennini.

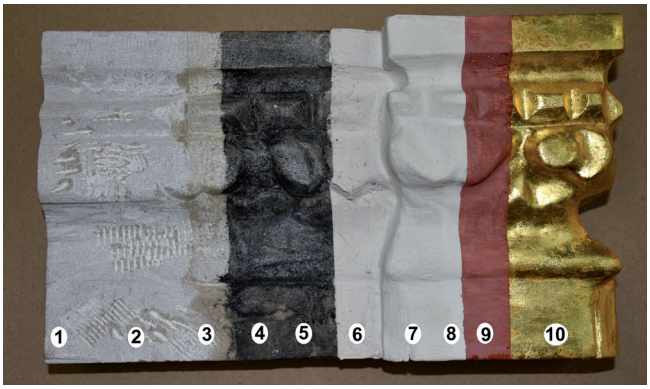

Figure 4.- Reconstruction No. 2. Description of the cut-away sections: (1) stone surface, (2) traces of sculpting tools, (3) first impregnation layer (sizing), (4) second impregnation layer (linseed oil + mastic varnish + charcoal), (5) third impregnation layer (animal glue egg yolk), (6) first ground layer (animal glue + gesso grosso + egg yolk), (7) second ground layer (animal glue + gesso sottile + egg yolk), (8) second ground layer after polishing, (9) poliment, (10) gilding.

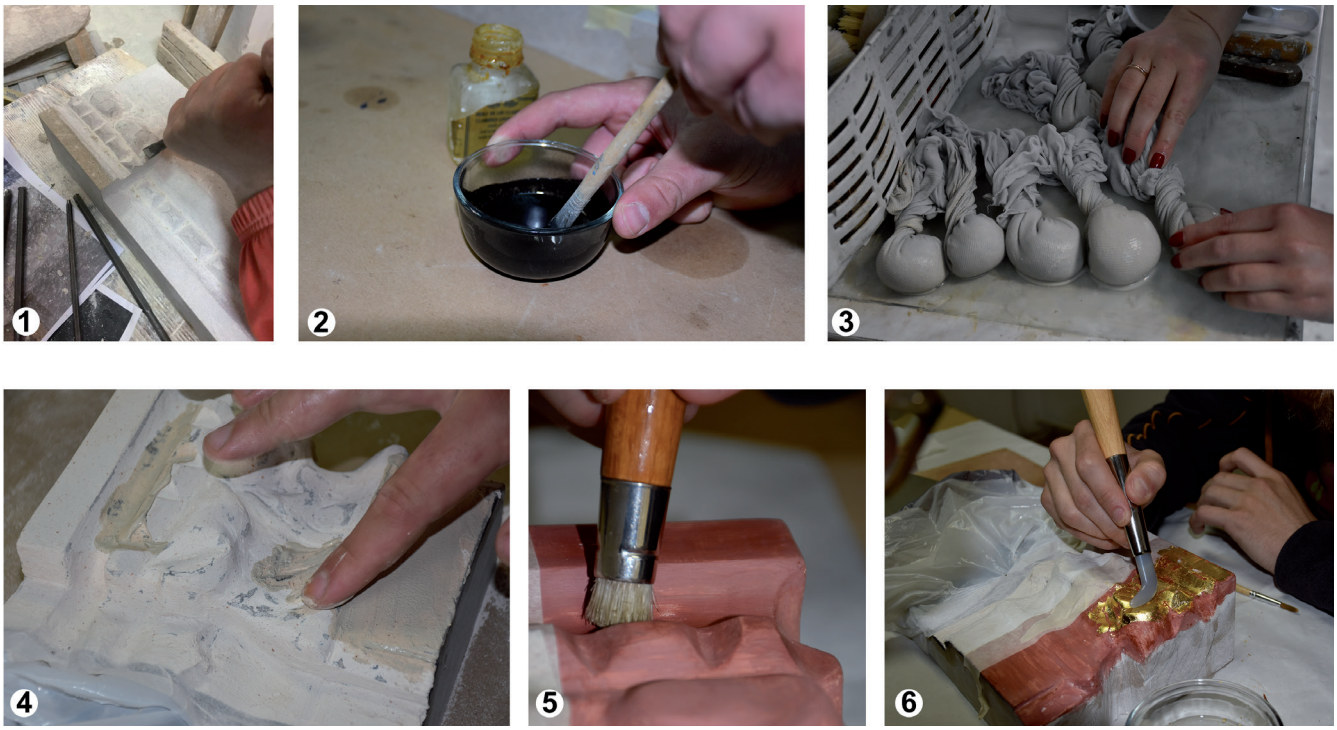

Figure 5.- The process of making Reconstruction No. 2: (1) stone carving, (2) preparation of second impregnation layer (linseed oil + mastic varnish + charcoal), (3) preparation of the second ground layer (gesso sottile), (4) application of the first coat of gesso sotille, (5) poliment polishing, (6) burnishing with agate stone.

The most valuable part of this experiment was the insight into the handling properties and function of each layer – in particular the isolating layers, their impact on the absorption features and in the drying time. Interestingly, the complex stratigraphy of Reconstruction No.2 is due to its protective function towards the gilding. Namely, according to Cennini (1960: 119), the stone always holds the moisture that corrupts the stability of the ground layer: "and so the oil and the varnish are the instruments and means of uniting the gesso with the stone". Cennini continues the argument by stating that the "charcoal always keeps dry of the moisture of the stone" (see Appendix). This knowledge could be indicative of the gilding degradation on the Pietro di Martino's relief.

However, since parts of Cennini's recipe remain ambiguous (e.g. the exact proportions and the temperature of the impregnation coatings, the amount of charcoal and brick dust, etc.), further research should be conducted. The whole process could be repeated but with variations in the proportion and types of materials, cooking time, temperature, etc. (Carlyle, 2012: 105-117). This aspect is of the outmost importance, because the quality of the used materials, condition the results obtained. For example, will the reconstructed impregnation made of linseed oil, mastic varnish and charcoal (see Figure 4) act as a vapor barrier as Cennini intended (Cennini 1960: 96-97)? How important element was the genuine mordant in this composition? Certainly, its fluidity and drying properties had superior qualities in comparison with the materials used in reconstruction.

Furthermore, both reconstructions demonstrated that the execution time was strongly influenced by the type of the sealant and preparation layers, in particular their drying time. Reconstruction No. 2, with impregnation layers containing linseed oil and egg yolk, was much more time consuming in comparison to Rreconstruction No.1. The heat of the impregnation coatings, frequently emphasized by Cennini, was found to influence the penetration qualities of the coatings, while the charcoal and brick dust affect the colour and the texture. Another noticeable difference was the surface absorption during the application of the red clay (bole) and paint. Reconstruction No. 1, showed reduced levels of absorption in comparison to Reconstruction No. 2. Also, during the application of the gold leaf, Reconstruction No.1 demonstrated a significantly lower level of adhesion to the surface. Attempts to polish the leaves resulted in cracking due to the limited levels of surface elasticity. Regarding the final appearance, Reconstruction No. 1 scattered more light, owing to the visible texture of the stone, while Reconstruction No. 2 displayed a uniform shine, which emphasized the decorative embellishment of the gold leaf.

Conclusion

This project gave a valuable insight into the working process and methods of Early Renaissance sculptural gilding. It has also provided an opportunity to imagine the original embellishment of the damaged areas of gilding,

as well as the highly decorative appearance of the entire relief after its production. In spite of certain limitations of this investigation, the project has demonstrated that the impregnation and ground layers could have been a time-limiting factor for Pietro di Martino. Furthermore, it has indicated that the cause of the damages and fragility of the original relief, might be the absence of these coatings. On the other hand, re-creating Cennini's recipe illustrated the high level of knowledge and artistic skill needed for this process. In the future, both reconstructions can be analysed and compared as a set of reference samples, to explore chemical interactions and durability of the applied layers.

Acknowledgments

This work was supported by the Croatian Conservation Institute (HRZ) and Arts Academy of the University of Split (UMAS). The authors would like to acknowledge the collaborators of the conservation-restoration project: Marin Barišić, Mate Roščić, Ivan Sikavica, Mate Pavin, Vedran Pehnec and Helena Ugrina of the HRZ. The head of the restoration project was Vinka Marinković, PhD. Laboratory analyses were performed by Domagoj Mudronja, PhD, Margareta Klofutar, Mirjana Jelinčić and Ivan Šolić, of the HRZ.

Both reconstruction projects were carried out as part of the practical course on "Technical analyses and historical reconstructions" at the UMAS, taught by Sandra Šustić, PhD. Co-mentor and consultant on both reconstructions was Vinka Marinković, PhD.

Suppliers

Rabbit Skin Glue (made from rabbit hide). Fine grind (63028). Kremer Pigmente GmbH & Co. KG, Hauptstr. 41 - 47, DE 88317, Aichstetten, Germany.

Linseed oil for oil paint (Art. 5840650). Maimeri (refined linen seed extract). Industria Maimeri S.p.a., Via Gianni Maimeri 1, 20060 Bottelino di Mediglia (MI).

Drying medium for oil painting (Art. 5816626). Industria Maimeri S.p.a.. Via Gianni Maimeri 1, 20060 Bottelino di Mediglia (MI).

Artist drawing charcoal. PENKALA. Tvornica olovaka, školskog i uredskog pribora, Zagreb d.d., Poljačka 56, 10090, Zagreb, Hrvatska.

Mastic Varnish (1:2 dissolved in double rectified turpentine), UV Stabilized (79350). Kremer Pigmente GmbH & Co. KG, Hauptstr. 41 - 47, DE 88317, Aichstetten, Germany.

Knauf Modelliergips. Knauf Gesellschaft m.b.H., Knaufstraße 1, A-8940 Wißenbach bei Liezen, Austria

Charbonnel Gilders Clay: LeFranc & Bourgeois Charbonnel Extra Fine Gilder's Clay Base (bole premixed with water). Magasin CHARBONNEL 13, Quai Montebello F-75005 PARIS.

Appendix: *Cennino Cennini recipe M., CLXXIV (1960: 118-119*)

(…) Into your hands comes a stone figure, large or small; you wish to lay it in burnished gold. For this you follow this method: sweep and clean your figure up nicely; then take some of the usual size, that is, of the strength with which you gesso anconas; and get it boiling hot. And when it is boiling so, put a coat or two of it over this figure, and let it dry out well.

After this, take pieces of oak or male-oak charcoal, and pound them; and take a tamis, and sift the dust out of this charcoal with it. Then take a sieve fine enough for grain such as millet to go through, and sift with charcoal, and put the siftings aside; and make enough of them in this way to serve your purpose. When this is done, take the linseed oil, cooked and brought to perfect condition for making a mordant, and mix a third of liquid varnish with it. Boil it all together thoroughly.

When it is quite hot, take a dish; put the siftings of the charcoal into it. After this, put in this mordant: mix it up well, and apply it with a good-sized bristle of minever brush evenly to every part, and all over the figure or other job. When you have done so, put it somewhere to dry thoroughly in the wind or sun, as you please.

When your figure is good and dry, take a little of this same size. Put into it, if there is one glassful of it, one yolk of egg. Mix it up well; and while quite hot, take a bit of sponge; soak it in this tempera, and, with sponge not too full, wipe and rub over every place to which you applied the mordant and the charcoal.

(…) Then when you wish to go on with your work, take gesso grosso and size, tempered in the same way you gesso the flat panel or ancona, except that I want you to put in, according to the quantity, one or two or three egg yolks; and then lay it over the job with a slice; and if you mix up with these things a little dust of pounded bricks it will be so much better. And apply this gesso two or three times with a slice, and let it dry thoroughly.

When it is perfectly dry, scrape it and clean it up, just as you do on panel or ancona. Then take gesso sottile or gilders' gesso, and temper and grind this gesso with the same size, just as you do for gesso on panel, except that you must put in a certain amount of egg yolk, not so much as you put into gesso grosso, and begin by putting the first coat on, lay the gesso with a brush, four or six coats, just the way you apply gesso on panel, with the same method and

diligence. When this is done, and quite dry, scrape it down nicely; than lay it with tempered bole as you do on panel, and follow the same course and method in gilding, and burnishing with stone or crook. (…)

References

ANDREUCCETTI, P. A. (2008). *La policromia della scultura lapidea in Toscana tra XIII e XV secolo*. Firenze: Edizioni Polistanpa.

CASTELNUOVO-TEDESCO, L. SOULTANIAN J., (with contributions by Richard Y. Tayar) (2010). *Italian Medieval Sculpture in The Metropolitan Museum of Art and The Cloisters*. New York: Yale University Press, New Haven and London, 226-234.

BORDIGNON F. et al. (2008). "The Formation of Metal Oxalates in the Painted Layers of a Medieval Polychrome on Stone, as Revealed by Micro-Raman Spectroscopy", *Studies in Conservation*, 53-3: 158-169, DOI: 10.1179/sic.2008.53.3.158

BRECOULAKI, H. (2014). "Precious Colours", *Revue Archéologique*, 57: 3-35.

BROECKE, L. (2012). "Reconstructing the preparation layers of a late fifteenth – century panel painting from Seville". In *Artists' Footsteps: the reconstruction of pigments and paintings*, Lucy Wrapson [et al.] (coord.). Archetype Publications, London, 17-29.

BROECKE, L. (2015). *Cennino Cennini's Il Libro Dell'arte: A New English Translation and Commentary with Italian Transcription,* Archetype Publications Ltd, United Kingdom.

BROECKE, L. (2018). "Truth and intention in the *Libro dell'Arte*". In: *Contribution à une histoire technologique de l'art*. Actes de journées d'étude de la composante de recherche Préservation des biens culturels. Claire Betelu et al (coord). Paris, 56-67.

CARLYLE, L. (2012). "Practical considerations for creating historically accurate reconstructions". *Fatto d'Archimia. Los Pigmentos Artificiales en las Técnicas Pictóricas*. Marián del Egido and Stefanos Kroustallis (coord.). Madrid: Ministerio de Educación, Cultura y Deporte, 105-117.

FISKOVIĆ, I. (2003). "Dodatak dubrovačkom opusu Petra Martinova iz Milana", *Peristil* 46: 29-48.

MARINKOVIĆ, V., ŠUSTIĆ, S. (2017). *Conservation-restoration report on a gilded polychrome stone relief from Dubrovnik,* Croatian Conservation Institute, Split.

MATIJEVIĆ, J., HRASTE, K. (2007). *Knjiga o umjetnosti, "Il libro dell'arte",* Cennino C. Zagreb: Institut za povijest umjetnosti.

MUDRONJA, D. et al (2016-2017). *Laboratory analyses report*. Zagreb: Croatian Conservation Institute.

SKOVMØLLER A., THERKILDSEN R. H. (2016). "The polychromy of Roman polished marble portraits", ASMOSIA X, *Association for the Study of Marble & Other Stones in Antiquity*, X. International conference, Vol. 2, Rome, 891-900.

THOMPSON, D. *The Craftsman's Handbook, 'Il Libro dell'arte". Cennino d'Andrea Cennini*. Dover Publications, Inc., New York, 1960, 118-120.

UZIELLI, L. (1998). "Historical overview of panel-making techniques in Central Italy. The structural conservation of panel paintings". In *Proceedings of a symposium at the J. Paul Getty Museum*, 24-28 April 1995, K. Dardes and A. Rothe (coord.), The Getty Conservation Institute, Los Angeles, pp. 110-135.

WEEKS, C. (2006). "Polychrome Stone". In *Stone Conservation: Principles and Practice*, Henry A. (coord.), Donhead, 237-255.

ZOHIL M. et al. (2019). *Making a historically informed reconstruction of gilded relief from Dubrovnik*. Seminar paper. Arts Academy of the University of Split, Split.

Author/s

Sandra Sustic
ssustic@h-r-z.hr
Šibenik Department for Conservation of the Croatian Conservation Institute

Has a degree in conservation-restoration of easel paintings and polychrome wood, at the Arts Academy of the University of Split (UMAS) in 2007 and a Ph.D. in Art History (Department for Protection of Cultural heritage), at the Faculty of Humanities and Social Sciences in Zagreb, Croatia in 2016. Presently, she is head of Šibenik Department for Conservation of the Croatian Conservation Institute, and associate lecturer at UMAS (Department for conservation-restoration). Her fields of research are theoretical and practical aspects of painting retouching, technical art history, historically informed reconstructions of paintings and history of conservation practice.

Vinka Marinkovic
vmarinkovic@h-r-z.hr
Croatian Restoration Institute in Split (Stone Department

Was born in 1983 in Split. She graduated in 2007 at the Art Academy of the University of Split. Since 2016 she holds a PhD in Archeology (University of Zadar). Marinković is employee of the Croatian Restoration Institute in Split (Stone Department). Participates and leads conservation-restoration, documentation and research projects of cultural heritage. She is an assistant professor at the Art Academy of the University of Split.

Jure Balic
jure.balic95@gmail.com
Student

Was born in 1995, in Split (Croatia). From 2009 to 2014 he attended School of Fine Arts in Split where he got his education as a painter. In 2014 he enrolled at the Academy of Fine Arts in Split where he is currently getting his degree in stone conservation.

Martin zohil
martinzohil1@gmail.com
Student

Was born in Pula, Croatia in 1996. He completed the Stonemason School in Pucisca, on the Island of Brac. He is currently a fourth-year student in the field of conservation-restoration of stone artefacts.

Vinko Lipanovic
vinko_pinta@hotmail.com
Student

Was born in Lumbarda, on the island of Korcula, in 1994. He completed the Stonemason School in Pucisca, on the Island of Brac. He is currently a fifth-year student in the field of conservation-restoration of stone artefacts.

Ema Bonomi
emabonomi34@gmail.com
Student

Was born in Split. She completed the School of Fine Arts in Split (The Design Department). She is currently a fourth-year student in the field of conservation-restoration of stone artefacts

https://doi.org/10.37558/gec.v18i1.856