Paint handling in Leonardo’s Mona Lisa: guides to a reconstruction

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Introduction

1. From the moment it was created, writers and researchers have been eager to penetrate the processes Leonardo used when creating the Mona Lisa. Ranging from vast historical interpretations to narrow technical studies, it might seem that research in this area has been exhaustive. But, due to the simple reason that Leonardo’s surviving writings do not contain any explicit references to the methodological innovation he introduced in his paintings, his sfumato technique still remains a target for many art researchers.

2. Leonardo da Vinci was the first writer who systematically examined shadow projection in relation to painting (Kaufmann, 1975). His theoretical studies in the Treatise on painting, were inspired by the achievements of Flemish painters who became the undisputed masters of the handling of the oil medium. Leonardo’s detailed investigations were motivated by the absence of harsh outlines and the illumination of the glazed paint layer that these painters achieved (Dunkerton et al., 1991; Dunkerton et al., 1999). Yet, Leonardo’s glazes are infinitely more complex. Not only do they have their own colour according to the nature of the genuine light source used by the painter, but they also contain subtle reflected lights from surrounding objects (Ackerman, 1980). This effect of blending has fuelled the interest of past as well as contemporary researchers. Both Giorgio Vasari in 1550 and Gian Paolo Lomazzo in 1584 admired the painting’s appearance.
and Leonardo’s manual dexterity in applying subtle stratifications of dark glazes, to define the shadow areas (Lomazzo, 1844; Vasari, 2008).

Over the years, the fascination with his technique has continued to attract experts from various fields. Mona Lisa’s masterful effect has even been interpreted by physicists and placed in the context of entropic skin geometry (Queiros-Conde, 2004). One art historian has described sfumato as a pointillism technique consisting of numerous microdots (Franck, 1993), while others point out the application of translucent glazes, for instance (Kemp, 2007). The first comprehensive evaluation of Leonardo’s painting technique on the Mona Lisa started in 2004, and was preformed by the experts of the Centre for Research and Restoration of French Museums (C2RMF). The scientific quest has continued over the years revealing the majority of the painting’s technical features (Mohen et al. 2006; Blais et al. 2008).

Apart from the recorded medium, solvent and pigments, the most fundamental element of sfumato effect was, of course, the paint handling of the master. While it is common to elaborate on the process of the applied materials (De Viguerie et al., 2008), published reports rarely show any evidence or discussion of the possible methods used to obtain such effects. Several researchers have put forward the theory that fingers and palms were used as blending tools, but they do not define the exact sequence of the process (Brachert, 1969; Gage, 1990; Dunkerton et al., 1991; Bull, 1992; Fiorani, 2008). How the portrait evolved from the sketch onwards, remains an alluring mystery. Therefore, it seems indispensable to further investigate the published results of scientific analyses as well as historical sources and provide their application in experimental reconstruction of the painting. This research tends to offers a better understanding on what lies beneath the surface of the painting and at the same time provides valuable experience into the creative process of the master.

The first part of this paper is an overview of certain records on Leonardo’s painting technique and aims at creating a documentary base of evidence for a precise reconstruction of the Mona Lisa. The second part is dedicated to the practical execution of this plan: the author will develop an idea of the appearance of the panel as it evolved at the various principal stages of its creation. Each stage of the creation of the painting will be investigated with the objective of providing a better understanding of the working processes, materials and techniques used by Leonardo. Finally, a discussion will be proposed about the leveling and the brushing properties during reconstruction of the painting with the intention of defining a plausible theory on the method that Leonardo used to create such delicate shading. 1

**Documentary base for the reconstruction**

In order to understand the construction of the original paint layer and the materials used in the painting the available historical and scientific documentation was examined. Leonardo’s own writings were first evaluated in this context. Unfortunately there are very few descriptive notes on the painting materials and their handling that can be considered consequential for his painting practice. Although his interest in understanding the appearance of colours is mostly focused on the presentation of shadows, reflections and blurred outlines (Shearman, 1962; Filipczak, 1977; Farago, 1991), it does seem, however, that the oil as a medium attracted his attention more than other materials in order to achieve a new radical and chromatic tonal composition. Unlike
those of Armenini, Vasari, Borghini and Bisagno, Leonardo’s notes on the preparation of oils are quite detailed. For instance, he carefully described the process of the purification of various oils and the renewal of dry oil colours (Merrifield, 1849; Richter, 1970: 232)

7 Besides the cautious directions for varnishing delicate verdigris to prevent its degradation, notes on pigment preparation are absent in his writings. In those instances where the materials and/or techniques used by Leonardo were obscure, historical sources were examined to inform the method (Hawkins, 1802; Eastlake, 1847; Merrifield, 1849; Cennini, 1960; Vasari, 1960; Richter, 1970; Olszewski & Armenini, 1977).

8 There are few indications concerning pigment selection and paint handling by Leonardo that could be used as guidelines in this work. For mixing the flesh tints, he advised the mixture of opaque pigments ‘white, lake and Naples yellow’ and for shades a mixture of ‘black, umber and a little lake’, whereas for glazing he instigates the importance of transparent pigments such as azurite, lake, etc. (Hawkins, 1802: 121). Da Vinci also taught how to add intermediate shadows (ombre mezzane) over the universal shadow – what he called the general ground shadow of a painting – and how to mix black with other pigments using measuring spoons to obtain quantifiable and incremental tonal variations (Fiorani, 2008).

9 However, the most important scientific source that was used in this paper, were studies performed and published by C2RMF during the last decade. With the use of completely non-invasive and non-destructive scientific methods, these tests meticulously explained the technical features of the painting, making it possible to distinguish the majority of the building materials at various stages of its construction (Mohen et al. 2006; Blais et al. 2008). Scientists have described the composition of stratified layers verifying the use of the glaze technique in the upper layers of Leonardo’s sfumato. The umber pigment was confirmed for its important role in the subtle chromatic transitions in the flesh tones (Elias & Cotte, 2008).

10 In order to provide a better understanding of Leonardo’s painting technique, historical sources have been investigated to list the possible glaze recipes. In addition, accurate reconstructions of the renaissance painting mediums were examined (Hawkins, 1802; Eastlake, 1847; Merrifield, 1849; Cennini, 1960; Vasari, 1960; Richter, 1970; Olszewski & Armenini, 1977; De Viguerie et al., 2008). Scientific findings concerning the glaze thickness on the original painting have also been taken into account; according to the scientist the smooth shading of the iconic face is the result of astonishingly fine control of glaze thickness (De Viguerie et al., 2010). The measuring data available on how the composition and thickness of the layers varies from light to shadow on the face of the Mona Lisa, made it possible to anticipate the amount of layers needed in the reconstruction process.

11 Analyses of Leonardo’s earlier works such as Ginevra de’ Benci, Lady with an Ermine and The Virgin of the Rocks (National Gallery, London), in which he used a variety of materials and techniques, including wet-in-wet technique in the flesh tones, served as a reference in detecting habitual methods of the master within the painting process. Frequently fingerprints were registered on the surface of the paint layer indicating that Leonardo was using his fingers to blend delicate brushstrokes in some parts of these paintings (Brachert, 1969; Dunkerton et al., 1991; Bull, 1992; Syson & Billinge, 2005). Scientific investigations and visual observations of his unfinished paintings, St. Jerome and Adoration
of the Magi, were analyzed as aesthetic patterns for the application of the basic paint layers (Colalucci, 1994; Syson & Billinge, 2005).

In addition, study of Leonardo’s drawings at Royal Library in Windsor Castle and observations of The Virgin and Child with Saint Anne at the Conservation studio of C2RMF, contributed to authors understanding of Leonardo’s drawing and painting methods.

Experimental reconstruction

Reconstruction of the painting was preformed in five principal stages: preparation of the panel, preparatory sketch of the composition, underpainting, glazing technique and scumbling technique. All used materials were either identical or at least equivalent to the ones Leonardo used. Where traditional pigments were hard to obtain, due to their toxicity and/or price on the market, contemporary substitutions were applied. For example, a mixture of titanium and zinc white was used instead of lead white pigment. Similarly natural lapis lazuli was replaced with artificial ultramarine. As in original recipes all pigments were prepared in multiple operations of grinding and washing (Cennini, 1960: 20-36) and afterwards they were bound with oil medium. The selection of painting tools correspond to the historical context of the original painting; all brushes used in reconstructing the paint layer were made of natural hair (Cennini, 1960: 40, 42; Harle, 1972).

Preparation of the panel

Scientists believe that Leonardo used the typical technical procedure for that period in the preparation of the panel that includes a layer of lead white primer over the traditional gesso (Mohen, 2006: 56). In order to reproduce the ground preparation of the Mona Lisa with as much accuracy as possible certain historical recipes were observed in the process (Eastlake, 1847; Merrifield, 1849; Cennini, 1960; Vasari, 1960; Richter, 1970; Olszewski & Armenini, 1977; Uzielli, 1998).

It was common practice for Italian painters at the end of the fifteenth century to make their sketches on top of the insulating and nonabsorbent, coloured grounds. First of all, damages like knots and holes must be covered and next the panel is sized with two or three coats of slightly warm animal glue. Then the gesso needs to be applied successively and, finally, made completely smooth. In order to reduce it absorbance an intermediate layer, called priming, has to be spread over the whole surface.

Following these instructions the panel was first well planed and then sized with rabbit skin glue. Fine gesso, made from calcium sulfate and rabbit skin glue, was applied in several layers. After drying, the ground was intensely polished, and white priming was evenly deposited on the surface. As previously stated, a mixture of titanium and zinc white was used instead of toxic lead white pigment with the intention of matching the refractive index of lead as much as possible.
Preparatory sketch of the composition

Although the analysis of infrared reflectography was unsuccessful in finding the preliminary drawings, scientists have found evidence that Leonardo had made a general preparatory sketch of the composition using some sort of brown paint (Mohen, 2006: 64).

The deep browns on the Mona Lisa’s face, especially around the eyes, were not produced by a final application of glaze alone. Leonardo painted these shadows directly onto the white ground and some of them indicate the use of black carbon pigment (Mohen, 2006; Elias & Cotte, 2008; De Viguerie et al., 2010).

This innovative technique in representation of preparatory shadows can be observed on his unfinished paintings such as St. Jerome, Adoration of the Magi and unfinished parts of Virgin of the Rocks (National Gallery, London). It is clearly visible that the initial modeling in monochrome browns was exceptionally liquid and often blurred without signs of brush marks (Dunkerton et al., 1991; Colalucci, 1994; Uzielli, 1998; Syson & Billinge, 2005).

Thus, the reconstruction of the preparatory sketch was largely done in soft, semi-transparent washes in umber pigment and oil medium. Only here and there details were defined by marked darker strokes of black carbon pigment (ill. 1). These shadows were regarded as a fundamental building material in the following steps of the painting’s reconstruction (ill. 2).

Fig. 1 Preparatory sketch of the composition
Underpainting

By studying the X-ray image of the *Mona Lisa*’s face, it was possible to follow Leonardo’s construction of the flesh tints in underpainting. Only the principal raised areas of the face were highlighted in lead white, which by contrast reveals the position of the main shadows: eye sockets, nose, mouth, cheeks, and neck (Mohen, 2006:84,89). Most of the pigments that have been identified belong to the traditional palette of contemporary painters. Luminous areas of the face are largely composed of lead white and small amounts of vermilion in the flesh tints (Mohen, 2006: 62,88). Further examinations defined this layer as a mixture of 1% vermilion and 99% lead white that served the painter as a base for subsequent transparent layers of paint. On the other hand, the presence of an earth pigment was detected in the shadow area and was characterized as umber (Elias & Cotte, 2008).

The reconstruction of this layer was carried out using wet-in-wet painting technique. This required a fast way of working because the smooth modeling of the skin tones had to be finished before the first layers have dried. Few grains of vermilion were added to a white base and the mixture was evenly spread over the skin areas leaving the white priming (in highlighted areas) and umber (from the preparatory sketch) partially visible on the surface (ill. 3-4).
The blending of tones required a great deal of preparation and was applied successfully only after a lot of experimentation. Besides fingertips and palms, the use of draftsman's brushes also contributed to the final result.
tools such as soft dry brushes, sponges and absorbent leather cloths turned out to be adequate methods for eliminating excess paint sediments, while leaving the layer smooth and blended (ill. 5).

Fig. 5 Building the shades in the flesh tones using wet-in-wet technique

24 According to scientists (Mohen, 2006: 64), the colour of the Mona Lisa’s dress is a result of skillful mixture of pigments that partly eluded all analyses used to study them. However, they excluded the constituents of the coloured glazes and indicated the elements of copper acetate, yellow ochre and lead tin yellow. The reconstruction of the that area was executed almost integrally in semi transparent underpainting. The different parts of the garment were painted in verdigris, a pigment most frequently mentioned by Leonardo himself in the Treatise. Yellow ochre and Naples yellow were used for the light areas and the embroidery of the dress.

25 Scientific examinations have revealed pigments containing iron as creative elements of various portions of the landscape. According to these results, red ochre was used for the reconstruction of the reddish path at the left and green earth pigment for some of the gradations in the mountains. Scientists have also implied that the artist used azurite, lead tin yellow and Verona green, which helped him to achieve such transparency (Mohen, 2006: 64).

26 The reconstruction of the landscape was set up very lightly with thin touches of paint ranging from pure blue to white (ill. 6).
These provide varying degrees of opacity following Leonardo’s definition of the rules for rendering aerial perspective. Thus the background elements were made in a manner that appears less clear, with less defined lines in comparison to the foreground; the depth of field was rendered by a colour gradation (Hawkins 1802; Richter, 1970). The area of the sky was painted in a lighter tone of blue using finely ground azurite that also served as a base layer for following glazes.

**Glaze technique**

When the underpainting was entirely dry, the long process of reconstructing highly transparent coats of pure pigments was initiated in order to bring out the tone of the paint in the layer immediately beneath. In this procedure the painting was placed in horizontal position, which allowed a greater control over the glaze application and prevented possible leakage of the coatings.

Highly transparent oil glazes were used over completely dried underpainting in many parts of the painting, especially on skin tones, to give soft enamel-like effects (ill. 7).
According to the results of scientific research that analyzed the composition of stratified layers, thin vermilion glazes were spread over cheeks, mouth, and hands, unlike glazes of umber, raw sienna and carbon black that were applied successively over the shadow area (Mohen, 2006: 70; Elias & Cotte, 2008) (ill. 8).

As Leonardo noted ‘no white or black is transparent’ (Richter, 1970: 277), hence the use of white pigment was stopped at this stage of reconstruction, in order to preserve the transparency of glazes.
Great caution while working with layers was necessary due to the fact that every glazed coating had to be completely dry before applying the next one. The majority of the glaze layers, made of umber pigment in various quantities, were concentrated in the shadow areas (Hawkins, 1802; Eastlake, 1847). As in the case with the tools used in underpainting, it was observed that all sharp edges of the glazes, particularly in modeling the skin tones, needed to be softened while they were still wet, in order to produce high quality tonal transitions. This was achieved using a soft dry brush to gently tap the glaze perimeters until they become invisible (ill. 9).

Fig. 9 Reconstruction of the sfumato effect on the hands (detail)

Scientists believe that the technique used by Leonardo when painting the sky involves two layers of paint: the first obtained by mixing lead white and copper blue in the form of natural azurite, and the second tinted with lapis lazuli (Mohen, 2006: 62). Hence, the glazes of ultramarine were spread on the surface of the sky (ill. 10).
34 Finally, the sitter’s translucent veil was setup in several glaze layers on top of the dried colour of sky and landscape in the background.

The layering of skin tones – alternation of glazing and scumbling techniques

35 Due to the darkening effect that the glaze technique had on the light areas of the skin tones, it was necessary to readjust their brightness. Thus, after the surface had partially dried, pure white pigment was scumbled (ill. 11) with a small fine brush to emphasize all the convex shapes of the figure such as forehead, nose, chin and cheeks, and was also applied on the hands (ill. 12-13). The edges of the treated area were smoothed as well, using the soft dry brush in the same manner as described earlier.
Fig. 11 Finishing with highlights

Fig. 12 Detail of the embroidery on the dress
In order to reinforce the three-dimensional stratification of the skin tones, alternation of glazing and scumbling techniques had to be performed. Thus, once the paint layer was dried again, the glaze technique was reused on entire surface; the idea was to apply the glaze layer and then readjust the value of the light convex areas by scumbling white paint into the partially dry glaze. During this process white areas were reduced with each exchange of glazing and scumbling techniques. Accordingly, the glazes have gradually built the richness and the depth of the concave shadowed areas, while the successive application of white pigment increased the convexity of the highlighted areas. Perimeters of all applied layers were gently tapped with soft dry brush while still wet. This layer blending method turned out to be the only efficient way of producing a desirable effect of sfumato in the final stages of the reconstruction process (ill. 14).

Fig. 13 Detail of the face with highlighted convex areas

Fig. 14 Scumbling the highlight areas on skin tones

Credits: Mario Cvetkovic
Discussion of the method

This research shows that there are several crucial elements to be considered while reconstructing Leonardo’s sfumato technique. (ill. 15).

Fig. 15 Stratigraphy of the reconstructed layers

Credits: Mario Cvetkovic

The first step in the process was the method of preparing the gesso layer. In his treatise, Leonardo wrote about the characteristics of glossy and polished surfaces, highlighting their ability to reflect other colours while hiding their own true colour (Hawkins, 1802: 116). These observations can be related to the effects of textural metamerism that arises on glossy surfaces creating deliberate variations of colour rendering according to the nature of the light source (Mcloughlin, 2005). Due to the porcelain-like surface that Leonardo has generated on the Mona Lisa and Virgin and a Child with St. Anne, the painted layer shows reflecting ability when it is exposed to different lighting circumstances (Ackerman, 1980; Delieuvin, 2011; Curie, 2011).

The glossy finish of his paintings prevented light scattering, which is a characteristic of rough surfaces. In other words, if two objects made from the same material have different surfaces, they will appear to have different colours (Mathew & Hanlin, 2004). Thus the reconstructed gesso needed to be extremely smooth and polished, in order to obtain an adequate foundation for creating the effects of lumiance in the final paint layer. The ensuing application of white priming has increased the reflectance of the gesso ground and reduced its absorbance. This step in the process enabled the retention of the maximum amount of oil medium in the painted layer, thus enabling glass like surfaces in further stages of the painting’s construction.
However, smoothness of the surface had to be preserved in every subsequent paint layer as well, starting with the preliminary sketch. The decision to copy the sfumato effect from the sketch onwards was based on the close visual examination of Leonardo’s unfinished paintings. Although sfumato was technically regarded as a finishing operation added to a painting once the forms had been depicted, these paintings clearly show that even at the early stages of painting construction, Leonardo was adopting this revolutionary technique (Colalucci, 1994; Paoletti & Radke, 2005; Syson & Billinge, 2005: 274). The copy has confirmed such interpretations, showing the relevance of the sketching method within the complete painting construction and regarding it as a primary step for initiating Leonardo’s sfumato effect.

In order to understand Leonardo’s sketching and underpainting methods, it was necessary to evaluate Leonardo’s drawing methods as well. Hazy transitions of light and shade are a common feature of his chalk style drawings (Clayton 2002: 143,155; Clayton, 2010; Clark & Pedretti, 1968). To blend the shadows draftsmen usually use clean fabric, sponges and dry brushes beside their fingertips. Is it possible that Leonardo imported some of his drawing methods and perhaps tools into the manipulation of the oil medium and used them as a simple physical means towards creating complex artistic ends? If we consider this possibility, the failure of scientific analysis in the quest for Leonardo’s brush marks on the Mona Lisa can be explained as well (Mohen, 2006: 64,84; Blais et al., 2008; Elias & Cotte, 2008; De Viguerie et al., 2010). Thus, the creation of sfumato effect could have started immediately in the sketching process (as is the case in his unfinished paintings) and effectively have followed in every other stage of the painting’s construction.

In the reconstruction process of the underpainting this theory was tested through the use of a wet-in-wet system of paint application. In fact, while referring to the mode of painting on canvas or linen cloth, Leonardo advised to arrange the paint while it is still ‘fresh or moist’, also adding the shadows, well ‘softened and blended together’ (Hawkins, 1802). Accordingly, the opaque paint of the flesh was applied on the surface and all interface places were shadows blend into the lighter areas were spread and blended while they were still wet. Besides fingertips and palms, soft dry brushes turned out to be very efficient blending tools. However, these tools must have been cleaned or replaced with new ones as soon as they were dragged.

Using this method every previous brush stroke was eliminated and the soft modeling of the surface was achieved. This procedure of blending tones removed any excess sediments of paint leaving the surface smooth and polished. The resulting gradation of the flesh tones appeared similar to those that Leonardo painted on the Ginevra Bennci and La Belle Feroniere, in which he didn’t apply any glaze layers (Bull, 1992; De Viguerie et al. 2010; Spring et al., 2011). However, in the case of the Mona Lisa, this gradation served as a base for the subsequent transparent coats of paint, and therefore it was regarded as the second step of the sfumato.

The painter himself advised on how to procede in further stages: ‘After you have softened this first coat, or dead colour, and let it dry you may retouch over it with lake and other colours’ (Hawkins, 1802: 121). Hence the long process of building transparent coats of pure pigments was only started after the underpainting was completely dry.

Glazes were made according to the way in which every colour varies in its reaction to light. In addition, Leonardo’s writings reveal that the relationship of the saturation of a
local colour to the chiaroscuro depends upon the specific tonal intensity of the pigment. White, yellow and red are the bright colours, which require little or no adjustment to make an effective tonal contrast to the shadow; on the other hand blue, green and brown are obscure colours, and can therefore appear at full intensity only in the increasing shadow (Shearman, 1962; Hawkins, 1802). By varying the pigment volume concentration and by varying the numbers of glaze layers the tonal intensity of a pigment was adjusted to suit the visual appearance of the original paint layer. This manipulation of hues played an essential role in the glaze modeling of the subject. Thus it was regarded as a third step in the process of reconstructing the sfumato effect.

Scientists have implied that Leonardo carried over the delicacy of watercolour technique into his glazing methods. They have noticed the similarity between descriptions of Cennini’s recommended methods of painting and Leonardo’s performance (Mohen, 2006: 62). In fact, this reconstruction has confirmed their anticipations for the upper layers of sfumato. By following the instructions of Cennini in his chapter on working with watercolours it is possible to reproduce a similar effect of sfumato in glaze technique (Cennini, 1960: 17,18). “When you have mastered the shading, take a rather blunt brush; and with a wash of ink in a little dish proceed to mark out the course of the dominant folds with this brush; and then proceed to blend the dark part of the fold, following its course. And this wash ought to be practically like water, just a little tinted, and the brush ought to be almost always practically dry. Without trying to hurry, go on shading little by little, always going back with this brush into the darkest areas. Do you know what will come out of it? – If this water is just a little tinted, and you shade with enjoyment, and without hurrying, you will get your shadows well blended, just like smoke.”

Unlike the use of fingertips as one of the blending tools in the underpainting, only the dry brush was proven to be an adequate tool to subtly eliminate the perimeters of the glazes. In fact there were undesirable fingertip marks and uneven glaze accumulation on the surface, hence the perimeter of the glaze was gently tapped with a smooth dry brush in a convenient size. This treatment has gradually softened the edge of the glazes, thereby producing blurred effects of shading.

Fourth step of obtaining sfumato effect included the reuse of white pigment. It was scumbled into partially dry glazes on the flesh tints to highlight all convex shapes and was smoothed with a dry brush treatment as well. While referring on the use of white pigment, Leon Battista Alberti advises “no surface should be made so white that you cannot make it a great deal whiter still” (Alberti, 1966; Filipczak, 1977). This consistent avoidance of the most extreme tonal values was probably very important to Leonardo as well. It was noticed that in order to reproduce his effect of dimly illuminated skin, the highlights should never be painted completely white, while the darkest shadows need to maintain their chroma and richness.

Vasari stated that Leonardo worked on the *Mona Lisa* for four years and resumed his work just before he died (Vasari, 2008: 294). It is probable that the alternation of these last two stages described here – glazing and scumbling - continued for years due to the long drying time between the application of each layer, until he finally achieved the desired three-dimensional stratification and effects of constant refraction on the painted surface.
Conclusion

What is it about the artist’s materials, or the way of employing them, which makes the finished painting what it is? The nature of the ground, the pigments, the binders and the selection of the tools for their application - all influence the physical appearance of the work. The concept for the gradual reconstruction of the Mona Lisa painting was guided by scientific analysis, historical sources, and visual scrutiny of Leonardo’s unfinished and highly finished paintings. As a conclusion of these preliminaries certain steps in the process of reconstructing the painting had to be observed, in order to obtain high quality tonal transitions.

Leonardo’s sfumato effect was not only the product of final glazing operations in oil technique, but rather the result of careful application method of each paint layer in the painting process. The gradual building of sfumato needs to be initiated right from the sketching process and proceed in every other stage of the painting’s construction. Clearly, this kind of approach required a lot of preparation and thus the painting could not be executed rapidly. Also, in order to ensure a smooth surface at each step of the process, the careful selection of painting tools has to be made. Besides using fingertips, a crucial factor in obtaining the desired visual effect is the use of clean and dry draftsman materials –especially soft brushes– on specific areas where transition of tones is necessary.

This reconstruction research has provided significant amount of information about Leonardo’s painting methods, highlighting the complexity of his creative process and the role that each step plays in the quality of the final sfumato effect. The method adopted in this contribution and its application in experimental reconstruction of the painting will hopefully enhance the understanding of Leonardo’s painting technique and provide a starting point for new discussions, where historical sources, scientific tests and direct observations may all play their part.


NOTES
1. This project was initiated at the Arts Academy of the University of Split, Croatia, during the author’s diploma thesis in 2007. Parts of the research were presented on several occasions, among which are: the symposium in conservation science “The Technical Examination of Old Master Drawings” at the British Museum in 2010, the technical meeting on Conservation of Leonardo’s Virgin and Child with St. Anne at the conservation studio of C2RMF in 2011 and the “Mimetic retouching workshop” coordinated by the author at the Escola Artística e Profissional Árvore in Porto in 2013.
2. Refractive indices of these pigments are: Lead White: $n_\alpha=1.803$ $n_\beta=2.074$ $n_\gamma=2.076$; Zinc Oxide: $\varepsilon=2.02$, $\omega=2.00$; Titanium Dioxide: $n=2.72$ (rutile)
Mona Lisa, the precious legacy of Leonardo da Vinci, represents a zenith of methodological innovations in painting. How the painter managed to obtain such delicacy of the tonal transitions still occupies the mind of contemporary art researchers. Based on published results of scientific analyses performed on the painting and relying on historical sources, a copy of the painting was made using materials that were identical or at least equivalent to the ones Leonardo used. This paper is an effort to provide an idea of the built-up of the paint layers at various stages as the painting evolved. The author discusses the detailed and painstaking method used by the painter at each step of the creation of the painting to obtain sfumato effect.

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