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**The Reconstruction of a Trecento Italian Triptych:
*A focus on Construction and Assembly***

Kristin Holder
MS/MA Candidate in the Kress Paintings Program
Conservation Center, Institute of Fine Arts, NYU

Dianne Modestini and Shan Kuang
Seminar Laboratory in Paintings Conservation
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INTRODUCTION

A reconstruction involves researching and re-making an original work of art with historical materials for the purpose of education or research. It harnesses technical and formal analyses and joins them with the practical application of pigments, glues, oils, and other binders. The result, a back-and-forth between scientific and experimental knowledge, has been described as housewife chemistry.¹ The process must be tested, sometimes haltingly, and the layering of paint over drawing and gilding can only be understood by doing, and the result assessed by looking.

A reconstruction is modeled on the tradition of copying: the materials and tools may be quantifiable but the method must be tested. For centuries, apprentices have copied their masters and masterworks, hoping to unlock the secrets behind composition and color. Oftentimes the most insightful copies are the ones where the artists allowed themselves to be guided by an original artwork while being inventive at the same time.²



Figure 1. Follower of Duccio, *Madonna and Child with Saints and the Crucifixion*, 1300-1325, tempera and gilding on three wood panels joined with metal hinges, 10 3/8 x 16 3/4 inches (26.4 x 42.5 cm), Memphis Brooks Museum of Art, 62.100 (Kress K-1289). Image source: Samuel H. Kress Foundation.

¹ Spike Bucklow defines housewife chemistry as the overlap between housewifery, or cookery, and the science of chemistry. Bucklow, Spike. "Housewife Chemistry," in *In Artists' Footsteps*, eds. Lucy Wrapson, Jenny Rose, Rose Miller, and Spike Bucklow (London: Archetype Publications, 2012), 17–28.

² The benefits of artists copying each other can be seen in those who were almost contemporaneous, such as Titian and Peter Paul Rubens, as well as those whose lives were separated by centuries, such the *Boustophedons* made by Robert Morris in 2017 after the figures in Francisco de Goya y Lucientes's prints.

The goal for this reconstruction was simply to better understand the materials and techniques that went into making a portable triptych in the Tre- and Quattrocento. Based on a triptych titled the *Madonna and Child with Saints and the Crucifixion* by a Follower of Duccio (Fig. 1), this project presented unique opportunities to study and reconstruct the support, which includes an integral carved frame on the central panel and original hinges connecting the three panels together. The final painted colors and surface are by no means representative of early Italian panel painting, but they bookmark a place on the spectrum of possible prototypes.

CONTEXT AND REFERENCES

Some conservators and art historians, in the present and past, have contested the attribution of the *Madonna and Child with Saints and the Crucifixion* to a follower of Duccio, an artist based in Siena.³ This uncertainty proved to be helpful because it forced me to turn to the painting itself as a document of information, rather than relying on art historical sources or previous technical studies of the works of Duccio. Fortunately, in the Kress Paintings Conservation Program, paintings come to the Conservation Center from museum collections for long-term study and treatment, and this triptych was available for close examination, technical analysis, and treatment, which was critical to the reconstruction.

The materials and techniques of early Italian paintings have undergone extensive study, and most of the time the findings align well with Cennino Cennini's technical handbook *Il libro dell'arte*, probably written about 1390. Among other things, *Il libro* instructs young artists on how to draw, prepare panels, gild, and the order in which to apply layers of paint.⁴ Many artist treatises are difficult to understand to the modern reader, either because the writers assume existing knowledge on the reader's behalf, or there is a language barrier which straddles more than five hundred years, or simply because units of measure change—or are not included at all.

For most of the stages of the reconstruction, I first consulted *Il libro dell'arte*, working by trial and error, but in some cases I needed to learn by watching and found some YouTube videos particularly helpful.⁵ Spike Bucklow's advice for making reconstructions helped

³ In his undated examination notes, Alan Burroughs wrote that especially when compared with another Duccio in the Kress collection, "which is painted ... thinly and sensitively," this painting had an "enamel-like technique of the Greek School." Additionally in separate conversations, both Lawrence Kanter and Marco Leona said that the painting appeared more Florentine than Siense. (Conversations in December 2018 and May 2019).

⁴ I used two versions of *Il libro dell'arte* for my reconstruction. The first is a translation by Daniel V. Thompson in 1933, as well as a translation published in 2015 by Lara Broecke, which includes sections of Cennini's manuscript in Italian.

⁵ "Art in the Making: Italian Art before 1400" examines methods and techniques of Trecento panel painting from Tuscany. Conservators and experts demonstrate the stages

me assess the results: 1) if it does not work now, then it was not what the artist did, and 2) if it does work now, then it *may* be related to what the artist did.⁶

of making an altarpiece, including making gesso, water gilding, burnishing, and painting in egg tempera <https://www.youtube.com/watch?v=mskEvMDedwA>.

⁶ Italics mine. Bucklow, "Housewife Chemistry," 27.

THE MODEL

Samuel H. Kress owned the Follower of Duccio's *Madonna and Child with Saints and the Crucifixion* for about twenty-one years, during which time several notable conservators and art historians, including Alan Burroughs, Mario Modestini, Bernard Berenson, and Willem Suida, made attributions, examined, or treated the triptych. When Kress gave it to the Memphis Brooks Museum of Art, the painted surface had been impeccably retouched and a cradle had been applied to the wood to stabilize it, a treatment that was regularly applied to panel paintings that entered American collections in the early twentieth century.



Figure 2. *Madonna and Child with Saints and the Crucifixion* folded closed showing cradle on all three wood panels. Photo: Author

When the triptych arrived at the Conservation Center in July 2018, its paint surface retained its excellent condition (minus a few areas of discolored retouching) and the cradle was stable (Fig. 2). The three wood panels appeared to retain much of their original thickness and were stable, so the curator inquired about the removal of the cradle.⁷ The aim of this would be aesthetic and would allow for the triptych to be displayed upright in a case with its wings canted, an approximation of its original display and use. Cradle removal proceeded and aided the reconstruction in unanticipated ways.

Technical and instrumental analyses were carried out on the triptych prior to and during treatment.⁸ X-radiography (X-ray) revealed information about the original construction, such as hinges and textile under the gesso layer, as well as later restorations such as wood inserts and lead-containing stucco fills (Fig. 3). Infrared reflectography (IRR) showed some underdrawing especially in the Christ child's drapery and was useful for revealing later restorations. X-ray fluorescence (XRF) provided elemental analysis suggestive of pigments used in the paint layers, which were easily examined under microscopy. Micro-samples were only taken in the blues of each panel to confirm the presence of a red lake

⁷ The cradle did not appear to be imparting stability or damaging the triptych, but it was adding significant weight to the small triptych.

⁸ Holder, unpublished examination report (2019).

glaze in the shadows. Finally, the wood, which appeared to be different species in the X-ray, was identified under microscopy.⁹



Figure 3. X-radiograph of *Madonna and Child with Saints and the Crucifixion* in 2018. Photo: Author

⁹ Wood identification would have been more useful before choosing the wood of the reconstruction. Three sections—radial, tangential and cross-section—are ideal for positively identifying wood, but only radial samples were taken from the small triptych. The central panel of the triptych was identified as coniferous, possibly silver fir or cypress, and the side panels as deciduous, possibly European walnut. Bruce Hoadley, *Identifying Wood* (Newtown, CT: The Taunton Press, 1990) and Giovanni Signorini, Giuseppina Di Giulio, and Marco Fioravanti, *Il legno nei beni culturali* (Florence: Aguaplano, 2014). X-radiography was done with a Carestream HPX-1 digital system.

THE RECONSTRUCTION

Support

I began working on the shaping the support for the triptych before I removed the cradle, and so I was not able to perform wood identification. Working on the assumption that the triptych was most likely poplar (*Populus alba*), probably the most common wood in Italian panel paintings, I chose cottonwood (*Populus tremula*), which is in the same family as poplar.¹⁰ This was important to fully understand the working properties of wood it was important to choose a wood with the same physical characteristics and behavior as the most commonly found wood in the Trecento.

The three pieces of wood were roughly cut to the same dimensions as the three panels of the triptych. They were finished with sole and block planes and grooves were cut into the two side panels with a chisel so that they would overlap when shut.

The frame on the central panel of the triptych was carved out of the panel and is flat with a roughly thirty-degree angle. To create a recess with even depth, a knife was marked with tape and inserted in the wood in a regular pattern (**Fig. 4**). A drawknife was then used to remove the bulk of the material, and the recess and angled edges were finished with a small block plane and chisels (**Fig. 5**).



Figure 4. The panels with the central panel showing the marks to set the depth of the recess (Photo: author)

¹⁰ The term “poplar” is used in the United State to describe tulipwood, or *Liriodendron tulipifera*, which belongs to the family of tulip trees and is harder than Italian poplar, *Populus alba* or *Populus nigra*.



Figure 5. Tools used (left to right): block plane, sole plane, ruler, mallet, flat chisel, straight gouge, curved gouge, awl, rasp, and cabinet scraper

The wood panels were sealed with three solutions of glue size: 1%, 2% and 7%. The panels were first coated with a weak size on the front followed by a strong size, “giving the wood a taste for receiving the coats of size and gesso.”¹¹ The backs were sprayed with 1% glue to reduce warping.¹²

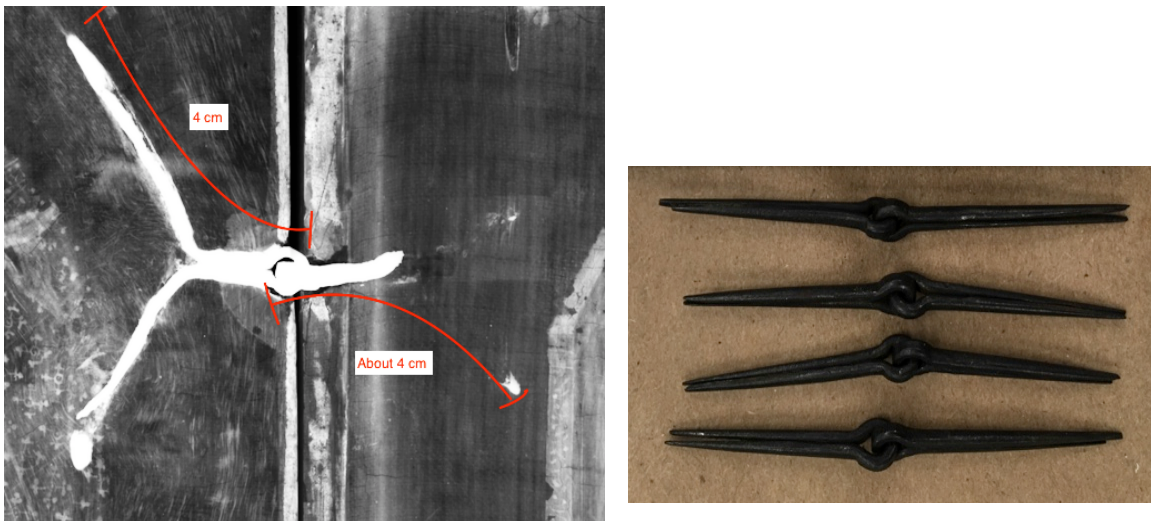
Textile was evident in the X-ray on the flats of all three panels, but it was surprising to see that they were different. The textile in the central and right panels appeared to be the same, while the textile on the left panel was much coarser. For the reconstruction, two types of unbleached Belgian linen, similar to the original (10 and 20 threads per centimeter), were dipped in 7% glue size and applied to the wood. The textiles were spread and smoothed using fingers, removing any bubbles and wrinkles. Unfortunately, the threads in the coarser fabric swelled and curled up and ultimately the fabric had to be removed and replaced with the same fabric on the other panels. This is probably due to the coarse size of the thread size.

¹¹ “And do you know what the first size, with water, accomplishes? Not being so strong, it is just as if you were fasting, and ate a handful of sweetmeats, and drank a glass of good wine, which is an inducement for you to eat your dinner.” Cennino Cennini, *Il libro dell’arte*, trans. Daniel V. Thompson (New York: Dover Publications, 1933) 70.

¹² Before sealing the panels, three test panels were sealed to see how they would react to different treatments on the front and back. All three panels were first coated with a 1% glue size, followed by a 7% size, on the front. The first panel was not sized on the back and warped immediately, the second panel was treated with a spray of water on the back and remained flat, and the third panel was treated with a spray of 1% glue size on the back. Both the second and third panels remained flat, confirming that warping is related to the rate at which moisture is lost.

Hardware

The Kress triptych appeared to have its original ring hinges, not only because they resembled hardware found in other early Italian triptychs, but also because the X-ray showed them in their original configuration in the side panels along with oxidized empty channels in the central panel (**Fig. 6**).¹³ The X-ray did not reveal how the hinges were inserted, but after the cradle was removed, the hinges could be seen coming through the back of the side panels, clinched down into the wood.¹⁴ Email communication with Andrea Santacesaria, Conservator of Wooden Supports at the Opeficie della Pietra Dura, and Roberto Buda, Private Conservator of Wooden Supports, both in Florence, confirmed how this type of hinge would have been inserted.¹⁵



Figures 6 and 7. X-radiograph detail of upper hinge joining panels (left); new *gangherelles*, or ring hinges, purchased from Florence in 2018 (right)

For the reconstruction, hinges were obtained from Il Ferro Battuto di Francesco Signorini in Florence with dimensions close to the original, about five centimeters long (**Fig. 7**). The panels were aligned, the placement of the hinges was marked, and a rasp was used to create an indent. A gimlet was then used to pre-drill holes from the front edge at an angle of about thirty degrees through the wood. The hinges were then inserted and the two ends were splayed and hammered down into the back of the wood. It was unclear how to seal the metal on the back to keep it from rusting. Cennini writes:

¹³ An undated X-ray from the Kress archives showed the panels during the cradling treatment: the two side panels are not cradled but have the hinges intact and the central panel has the glued cradle members but the hinges have been removed.

¹⁴ The hinges on the central panel had been clipped at some point in the past. They were then straightened and inserted into pre-drilled holes in the cradle members. The empty channels are still visible.

¹⁵ Valerio Budaio, an Italian woodworker, can be seen inserting *gangherelle*, or *cerniere di anello*, in this [youtube](#) video. Email communication, August 2018.

“...if there is a bud, or nail, or nail end, sticking through the surface, beat it well down into the board. Then take small pieces of tin foil, like little coins, and some glue, and cover over carefully wherever any iron comes; and this is done so that the rust from the iron may never come to the surface of the gessos.”¹⁶

Instead, the hinges were packed with sawdust and glue, a practice recommended by Ciro Castelli, and then swatches of linen soaked in glue were placed over the metal, but small rust stains could be seen through the gesso layers after they dried.¹⁷ Exposing iron to water and the subsequent deterioration of wood due to the hardware is inevitable and may account for the relatively few number of triptychs and cabinets with original hardware.

Preparatory layers

About two months before beginning the reconstruction, *gesso sottile* was prepared according to Cennini’s instructions: calcium sulphate (gypsum) was soaked in water and stirred every other day. During this slaking, or “rotting,” process calcium sulphate anhydrite is converted to dihydrite, creating much finer particles with a silky feel compared to the gritty starting product. The slurry of *gesso sottile* was then filtered to remove large particles, shaped into cakes, and left to dry (Fig. 8).



Figure 8. Filtering, shaping, and drying cakes of *gesso sottile*

Meanwhile the *gesso grosso* was prepared by combining calcium sulphate hemihydrate and anhydrite along with 5% solution of glue and mixed to the consistency of crepe batter.¹⁸ The first layer of *gesso grosso* was rubbed into the panels with fingers and

¹⁶ Cennino Cennini, *Il libro dell’arte*, 69.

¹⁷ Ciro Castelli writes about finding sawdust and linen over nails and hinges. Ciro Castelli, “Techniques of construction of wooden supports for painting,” in *Structural Conservation of Panel Paintings at the OPD in Florence: Method, Theory, and Practice*, eds. Marco Ciatti and Cecilia Frosinini (Florence: Edifir, 2016) 294, 300, 328.

¹⁸ According to Lara Broecke, artists would use whatever calcium sulphate was at hand when preparing the *gesso grosso*, which might be gypsum from different sources (such as Bologna or Volterra) or different preparations (different locations in the furnace when driving off water). Lara Broecke, *Cennino Cennini’s Il libro dell’arte: A new English translation and commentary with Italian transcription* (London: Archetype, 2015) 151.

hands. After it felt cool to the touch, three more coats were applied with a brush in alternating directions. A cabinet scraper was used to smooth the *gesso grosso*, followed by 220- and 320-grit sand paper.



Figure 9. Panels prepared with gesso grosso and sottile and scraped smooth

Gesso sottile was prepared by placing one of the dried cakes into a small custard dish of water and waiting for all of the air to escape (in pops and fizzles). Using a hand, the soft cake was scooped out of the bowl and onto a slab, where it was mulled with 10% glue until all of the gritty particles were gone. The mixture was then placed on a double boiler and more 10% glue was added until it had the consistency of crepe batter.¹⁹ The *gesso sottile* was applied in a sure manner, first with all of the brush strokes in one direction, then in a perpendicular direction, alternating back and forth, for eight coats (**Fig. 9**). After the gesso dried I scraped it with a cabinet scraper and then sanded it with 600 grit sand paper.

The two side panels were coated on all sides, and remained flat, while the central panel was not coated on the reverse, ultimately developing a curvature related to compression set.²⁰

Underdrawing

For further reading, see I. Zillich, “Der Gipsgrund und seine Verwendung im Bilde,” in *Zeitschrift für Kunsttechnologie und Konservierung* 1: 99–107.

¹⁹ On the double boiler, water evaporated from the gesso mixture, increasing the glue strength so only water was added to thin the mixture.

²⁰ R. Bruce Hoadley, “Chemical and Physical Properties of Wood,” in *The Structural Conservation of Panel Paintings*, eds. Kathleen Dardes and Andrea Rothe (Los Angeles: The Getty Conservation Institute, 1998) 18–20.

Some underdrawing was visible in IRR, in particular the fine lines of the Christ child's drapery and the contour of his leg, which appeared to be drawn in a liquid medium with a fine brush.²¹ Modeling in the Madonna's drapery was executed in larger strokes of wash. The continuous deposition of medium and the tapered 'tips' at the end of the lines suggest a liquid medium.



Figure 10. Infrared reflectographs of the underdrawing of the *Madonna and Child with Saints* (above) and the drawing transferred to the reconstruction (below)

Because little of the overall composition of the triptych was visible in IRR, the drawing was made by carbon-paper transfer. Photographs of the Kress triptych that matched the size of the painting were printed and laid on a thin sheet of paper coated on one side with vine charcoal. These were laid on the prepared gesso panels and a metal stylus was used to inscribe the composition onto the panels. This loose charcoal was fixed by tracing the lines with a fine brush and a few drops of carbon ink in gum Arabic and water (**Fig. 10**).

In preparation for the bole and gilding, lines that demarcated areas to be painted from those to be gilded were metal stylus with a dulled point incised into the gesso. A step was taken to seal the panels of the triptych with 5% glue, which proved to be a setback.

²¹ Infrared reflectography was done with a FLIR SC2500-NIR InGaAs Camera with 0.9–1.7 um range and IR Vista software).

Bole and gilding

Very few gilders currently use glair, or egg white, in the preparation of bole for water gilding, contrary to Cennini's advice, and it is conceivable that somewhere in the process of compiling his writings into a manuscript, the section that recommends glair for bole, a technique used for gilding manuscripts, was accidentally included in the section for painters.²² Nonetheless, for the reconstruction both glair and glue boles were prepared on a test panel to compare the effects of burnishing and incising. Both boles were smoothed with 600 grit washable sandpaper and gilt with double thickness 24-karat gold leaf. After burnishing, the egg white bole had a brighter, smoother finish, but glue bole was chosen for its 'tried and tested' performance.



Figure 11. Removing bole and gilding from Crucifixion panel

Unfortunately, when water was brushed on the glue-bole panels of the reconstruction, the bole immediately swelled with water, delaminating from the gesso. Gold leaf was attempted in a small area, but it showed the swelling bole and would not burnish. All bole

²² *Il libro dell'arte* was assembled from at least three known manuscripts of compilations of Cennini's writings, yet his prescription for glair can also be found in treatises on illuminated manuscripts. *An Anonymous Fourteenth-Century Treatise: De Arte Illuminandi: The Technique of Manuscript Illumination*, trans. Daniel V. Thompson and George H. Hamilton (New Haven: Yale University Press, 1933) 13. Glair is also mentioned for gilding in Theophilus, *On divers arts*, trans. John G. Hawthorne and Cyril Stanley Smith (New York: Dover Publications, 1979) 31.

and gold leaf had to be removed with a sponge, and a 1% gelatin bole was applied instead, unfortunately with the same effect.

“If it doesn’t work now, then it’s probably *not* what the artist did.” The only step that didn’t align with Cennini’s advice and that was not executed on the test panels (which gilded beautifully) was sealing the *gesso sottile* with glue. This layer had to be removed by scraping all of the gesso off with a cabinet scraper and beginning again from the textile (**Fig. 11**). Four layers of *gesso grosso* and six layers of *gesso sottile* were then re-applied, after which bole in 6% glue was applied, sanded with 220-, 320-, and 600-grit sand paper, and a final quick sand with 8000 micromesh.²³

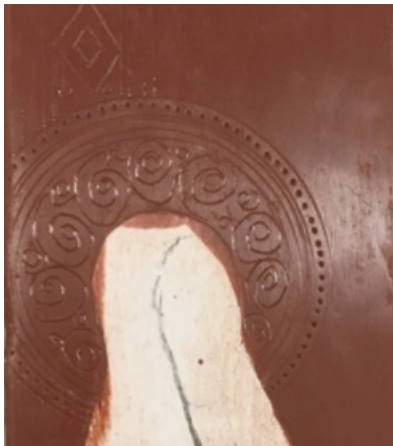


Figure 12. Incised lines in the re-applied bole in the Crucifixion panel

Gold leaf was applied to one panel at a time. In the dry, air-conditioned rooms of the Conservation Center, the gilding was ready to burnish after only 45 minutes, and on the first panel, punches and incisions were done immediately after gilding. The gold was easily scratched through, perhaps due to the dry conditions in the room or the length of time needed to free-hand draw the tracery in the haloes and border. After noting this, punches and incisions were tried out on the test panel *before* gilding and then burnished (**Fig. 12**). Remarkably, this worked very well and extended the working time for incising delicate tracery, making the halos with a compass, and punching decorative borders on the second and third panels (**Fig. 13**).

²³ Cynthia Moyer, Conservator of Frames, and Alan Miller, Associate Conservator of Paintings, both at the Metropolitan Museum of Art, both advised on this mistake and subsequent steps. Cynthia’s expertise in gilding and advice made all of the subsequent steps go smoothly. In conversation, 08/19/2018.



Figure 13. Details of haloes of St. John the Evangelist in the original triptych (left) and reconstruction (right)

Paint layers

Pigments were chosen based on the spectra obtained by x-ray fluorescence (XRF), and the method of application, or layering, was based on observations made under microscopy.²⁴ Azurite was the only blue pigment found in all three panels, although its appearance varies due to differences in particle size, differential degradation of azurite passages, and to significant retouching of the Madonna's mantle. Three red pigments were used—red lead, vermillion, and red lake—sometimes in combination, or just red lake alone, to achieve different and complex colors. Earth pigments, lead white, black and vermillion made up the flesh tones, which were first underpainted in green earth. Yellow and red earth pigments were used for the yellow draperies. An outlier in the composition was the habit of the man kneeling in the lower register of one of the side panels, which is an olive green with red glaze.

Pigments were ground in water with a glass muller, transferred to a small shell, tempered with egg yolk and then painted in thin layers of brush strokes. Landscape, furnishings, and drapery were painted before the faces and hands.²⁵ If gilding was present, it was first sanded slightly with micromesh so that the tempera would adhere well,²⁶ except in the delicately painted scepter and staff held by the figures of St. John the Baptist and the Cardinal-Saint. I first applied delicate lines of pure glair, and then applied tempera. Without the glair layer, the tempera beaded up on the surface. Because of its hydrophobic properties, lead white could only be mulled in pure egg yolk, and then subsequently

²⁴ X-ray fluorescence was performed with a Bruker Tracer III-V+ (Rhodium source, silicon detector, titanium filter) and microphotographs were taken with a Olympus SZX9 and Gryphax software at 16X magnification. Lead was found throughout the painting, copper in the blues and greens, mercury in the reds, and iron in the yellows, flesh tones, and landscape.

²⁵ “When you have done the draperies, trees, buildings, and mountains, and got them painted, you must come to painting the faces...” Cennini, *Il libro dell'arte*, 93.

²⁶ The first layer of tempera on gold appears dark and transparent, but subsequent layers appear opaque.

diluted with water or added to pigments mulled in water. Because it dried very quickly, it was prepared in small amounts.

The logic of Cennini's instructions for painting proved to be a useful guide. For example, when painting an area of color, first the middle tone was applied overall, sometimes in a few layers to achieve good coverage, and then the color was mixed to create two lighter and two darker values, for areas of highlight and shadow. In practice, the Kress triptych seldom exhibited this model, instead the artist tended to use analogous or complementary colors to create areas of shadow. For example in the yellow draperies of Saints Peter and John the Baptist, bright red earth is applied in tiny strokes to describe the area of shadow and also the direction of the folds. And in the green mantle of the Donor, red lake was applied in the shadow. Invisible to the naked eye, but visible in cross-section, red lake glaze was applied on top of azurite blue in all of the blues to create the deep, rich shadows (**Fig. 15**). Light penetrates layers so that colors reflect purely. Mixing them together might create muddy colors.²⁷



Figure 14. A photomicrograph of the Cardinal-Saint shows how the artist achieved deep blue shadows by the application of red lake glaze. The white pattern on his vermilion cloak was layered on before the red lake glaze was applied in the drapery folds. Coarsely ground particles of azurite pigment are visible in the mauve background.

²⁷ Cross-section microscopy on samples of blue from the Cardinal, St. Peter, the Madonna in the central panel, and St. John the Evangelist were performed with a Leica DM400 B microscope and SpotFlex Basic software.

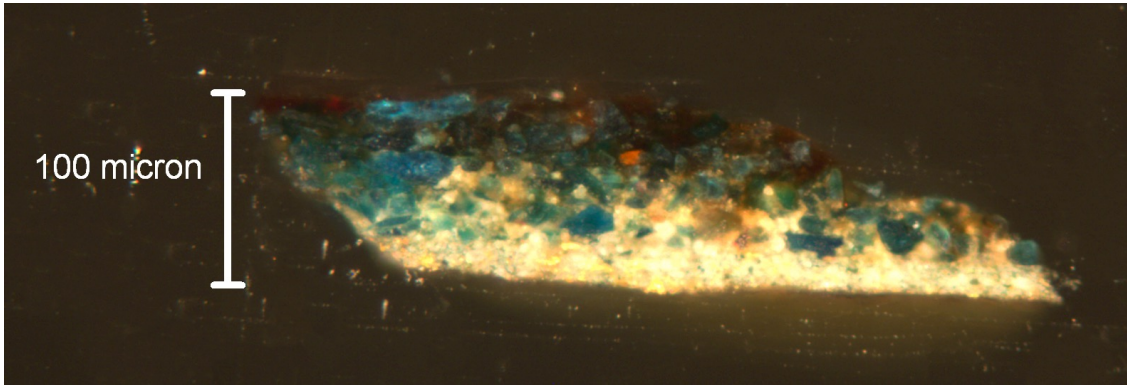


Figure 15. Dark field microscopy (200X) of sample from the Cardinal's blue drapery showing gesso layer, a layer of blue and white pigments, a blue layer, and finally a red glaze layer

In the reconstruction, applying glazes of red lake inspired some experimentation, challenging the common assumption that red lake glazes were ground in oil for gold ground pictures. Instead lac dye was then tempered in egg white, whole egg, and glue. At first red lake pigment was tempered in egg yolk but appeared gritty and turned dark brownish purple, whether it was applied over azurite blue or vermilion. In egg white the lac dye turned clumpy, brown and opaque, and was again hard to apply. Lac dye tempered in glue was a strong, transparent red and easy to apply. Somewhat surprisingly, lac dye in whole egg was smooth, translucent and had a strong red color (see Appendix III, Table 1). These results suggest that alkalinity strongly affects the color, translucency, and texture of lac dye in glazes.²⁸

In the end, red lake glazes were tempered in whole egg and applied over the red lead vermilion and white details of Cardinal's red mantle as well as the blue tunics of all of the figures (Fig. 14). Red lake glazes tempered in glue were painted over the Donor's green earth habit.

CONCLUSION

Reconstructing and treating the Kress triptych brought together many of the different skills sets that should be in a conservator's possession: aesthetics, hand skills, critical thinking, art history and scientific analyses (Fig. 16).

In the search for a better understanding of craftsmanship, the triptych revealed an economical use of time and materials, in the choice of woods, textiles, and even pigments. The author's pitfalls in the gilding or application of glazes demonstrated the high skill levels needed to make such an object also provided insights on the effect of the environment on materials and processes. In some cases actual practice deviated from handbooks, common assumptions, and references. Successes reinforced the fluidity of skills that must have been attained through years of practice and tradition.

²⁸ This variation in results may be due to different pH values of egg yolk, egg white, whole egg, and glue. The pH of egg yolk is about 6.4 and egg white is 7.8 (but can go up to 9.7 if old) and whole egg is about 7.2. The pH of glue is about 6.7 to 7.4.

In his stern advice to young artists, Cennini writes that “even if you study [this book] by day and by night, if you do not see some practice under some master you will never amount to anything,” a reminder that the skills and knowledge necessary for an artist resides in the hands as much as the head.²⁹



Figure 15. Reconstruction (left) and *Madonna and Child with Saints and the Crucifixion* (right).

²⁹ Cennini, *Il libro dell'arte*, CIII.

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REFERENCED BIBLIOGRAPHY

An Anonymous Fourteenth-Century Treatise: De Arte Illuminandi: The Technique of Manuscript Illumination, trans. Daniel V. Thompson and George H. Hamilton (New Haven: Yale University Press, 1933).

British Library <http://www.bl.uk/catalogues/illuminatedmanuscripts/glossg.asp> (Retrieved 08/15/2019).

Baiardo, Valerio. <https://www.youtube.com/watch?v=tKtbkPiqOAM> [Accessed 08/13/2019].

Broecke, Lara. *Cennino Cennini's Il libro dell'arte: A new English translation and commentary with Italian transcription* (London: Archetype, 2015).

Bucklow, Spike. "Housewife Chemistry," in *In Artists' Footsteps*, eds. Lucy Wrapson, Jenny Rose, Rose Miller, and Spike Bucklow (London: Archetype Publications, 2012).

Castelli, Ciro, "Techniques of construction of wooden supports for painting," in *Structural Conservation of Panel Paintings at the OPD in Florence: Method, Theory, and Practice*, eds. Marco Ciatti and Cecilia Frosinini (Florence: Edifir, 2016)

Cennini, Cennino. *Il libro dell'arte*, trans. Daniel V. Thompson (New York: Dover Publications, 1933).

Gordon, Dillian. *National Gallery Catalogues: The Italian Paintings before 1400* (London: The National Gallery, 2011)
https://www.nationalgallery.org.uk/upload/pdf/Gordon_2011_Introduction.pdf
[Accessed August 2018].

Hoadley, R. Bruce. "Chemical and Physical Properties of Wood," in *The Structural Conservation of Panel Paintings*, eds. Kathleen Dardes and Andrea Rothe (Los Angeles: The Getty Conservation Institute, 1998).

Holder, Kristin. Unpublished examination report (2019).

Kirby, Jo and David Bomford. *Italian Painting before 1400* (London: The National Gallery, 1989).

Signorini, Giovanni, Giuseppina Di Giulio, and Marco Fioravanti. *Il legno nei beni culturali* (Florence: Aguaplano, 2014).

Theophilus. *On divers arts*, trans. John G. Hawthorne and Cyril Stanley Smith (New York: Dover Publications, 1979) 31.

Appendix I: Materials and Tools List

Support and hardware

Cottonwood
Japanese dozuki saw
Drawknife
Chisels
Gouges (3-sweep, 10mm and 20 mm)
Block planes
Gimlet
Iron hinges, Il Ferro Battuto di Francesco Signorini, Florence

Preparatory layer

Calcium sulphate (Kremer Alabaster Plaster, Italian, #58340)
Rabbit skin glue (Kremer #63028)

Bole and gilding

Bole (Lefranc & Bourgeois Charbonnel Red Gilder's Clay Base, extra fine)
Gold (Giusto Manetti Deep Double Gold KTS 24)

Drawing

Vine charcoal
Winsor & Newton Calligraphy carbon-based ink
Gum Arabic

Painting

Egg yolk
Leaded oil (Rublev Massicot – Litharge synthetic inorganic, Gamblin Linseed Drying Oil and Kremer Linseed Oil #D-7971)
Vermilion, Kremer #42000
Vermilion, scarlet, Winsor & Newton
Red lead, Kremer
Rose Madder Deep, BLOCKX
Lac dye, Kremer #36020
Cochineal lake from silk (ground in stand oil)
Stack lead white, Rublev
Flake white, Winsor & Newton
Chalk
Mars black, Fezandie & Sperrle, Inc.
Bone black, Kremer #4710
Umber, Kremer #4064

Burnt siena, Kremer #4042
Burnt siena, Kremer #4070
Siena, Kremer #4014
Raw siena, Kremer
Ochre, Kremer #4003
Genuine green earth (Italian), Kremer #4082
Vagone green earth, Kremer #4175
Azurite, Kremer #10201
Azurite blue, natural, Kremer #10200
Azurite, MP Exclusive, Kremer #10208
Verdigris, made from exposing copper strips to vinegar
Verdigris, Kremer #44450
Malachite, natural, Kremer #10300
Copper resinate, Kremer #12200
Verona green, Kremer #11000
Massicot-litharge, Rublev

Appendix II: Recipes

Slaking gesso sottile

1 kg calcium sulphate (Kremer Alabaster Plaster, Italian 58340)
10 gall water

Get two 5-gallon buckets. In each place 500 g of calcium sulphate and 5 gallons of water. Cover loosely with a piece of textile and stir every other day for at least two months. Filter mixture twice with a fine metal mesh. Add the filtered calcium sulphate to the water and using a 500 ml beaker, scoop the liquid into a filter lined with unbleached Belgian linen. Squeeze out the water until only a paste is left. Scrape the past off of the linen and make 2-3 inch cakes and let dry.³⁰

Glue

100 grams of rabbit skin glue
500 ml water

Put rabbit skin glue in a glass jar; pour water over and stir. Leave to soak at room temperature overnight. On the following day, put jar in a double boiler on very low heat and gradually warm until all glue is dissolved. Makes 20% glue size. Keep refrigerated with a lid and dilute with water to desired glue strength for preparing the panel, gesso, bole, and in some cases glazes in painting.

³⁰ The first batch was dried on a scrap of the same linen and the gesso drew up some of the tannins into the white cake. Subsequent batches were dried on an enameled metal pan. All linens should be washed before use.

Bole

To prepare egg white bole

In a glazed ceramic or glass (not metal) bowl, whisk 1 egg white. Pour 1 cup of cold water into the bowl but do not mix it.³¹ Leave at room temperature overnight.

Strain the glair as it will have bits of egg white in it. Grind some bole in egg white with a muller and slab. Add a little of the ground bole to a small bowl of water; sponge on the panel. Add glair and enough ground bole to make a water consistency. Apply with a bole brush. Apply 4-8 layers of bole and with each layer add a little more ground bole and alternate stroke direction 90°. Keep layering until the panel is consistently covered. Watch for ‘breaks’ in the bole (where the wet bole re-dissolves dried bole during application of new layers).

To prepare glue bole

Grind 1 part bole to 2 parts 7% glue. Make sure is very smooth when grinding. Add enough water to make a watery consistency. Keep warm in a double boiler on very low heat. Apply as above.

To prepare glue bole according to Cynthia Moyer

Prepare a 10% hide glue solution. Combine 3 parts of 10% glue with 2 part of water. Rinse the gesso with ethanol before applying bole. Never touch the gesso or bole (grease from hands will prevent gold from attaching). Apply 4-8 layers of bole and assess the timing for burnishing by touch (the bole should feel cool) and sound (a thud to clicking sound). Remember to “rouge the pad” to degrease it. Can burnish the bole first to the gold that is more undertoned in appearance.

To prepare the egg for tempera:

Take 1 egg and separate the egg yolk from the white. With the egg yolk in one hand, puncture the sac and allow the yolk to drip into a glass container. Add a few drops of cold water and stir. Refrigerate when not in use. Spoils after about three days.

Appendix III: Tables

Table 1. Appearance of lac dye pigment in different media

Medium	Color	Transparency	Consistency
Egg white	Brown	Opaque, muddy	Clumpy
Egg yolk	Dark purplish brown	Opaque	Gritty
Whole egg	Red	Translucent	Smooth
5% glue	Red	Translucent	Smooth

³¹ *Mugliuoli* in Cennini’s text (*L. mugiolus* or *muglolus*) the equivalent of about one-third of a liter. Broecke, *Cennino Cennini’s Il libro dell arte*, 38, 165.

Appendix IV: Images

1. Reconstruction with the left wing partially painted



2. Reconstruction with the right wing finished and the central panel partially painted



3. Reconstruction with left and central wings completed



4. Reconstruction of The Madonna and Child with Saints and Crucifixion



