The AIC Painting Specialty Group

POSTPRINTS

VOLUME TWENTY-FOUR 2011

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Papers Presented at the 39th Annual Meeting of the
American Institute for Conservation and Historic Works
Philadelphia, Pennsylvania, May 31–June 3, 2011

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SUE ANN CHUI AND ALAN PHENIX

Giovanni Antonio Boltraffio's *Madonna and Child* in the Context of Leonardo da Vinci's Studio Practice

ABSTRACT

As part of a conservation partnership with the Szépmüvészeti Múzeum, Budapest, Hungary, the *Madonna and Child* attributed to Giovanni Antonio Boltraffio came to the J. Paul Getty Museum in May 2008 for treatment and study. This paper will present aspects of the conservation and restoration treatment of the *Madonna and Child*, and review results obtained from the technical study done in collaboration with the Getty Conservation Institute that includes infrared reflectography, x-radiography, and analysis of paint cross-sections. Some of the notable findings in the *Madonna and Child* are evidence to the direct use of the hand to manipulate preparatory paint layers, the presence of two different styles of underdrawing, and a monochrome underpainting.

INTRODUCTION

As part of a conservation partnership with the Szépmüvészeti Múzeum (Museum of Fine Arts) Budapest, Hungary, the *Madonna and Child* attributed to the late 15th-century Italian painter Giovanni Antonio Boltraffio, came to the J. Paul Getty Museum in May 2008 for treatment and study (figs. 1, 2). It was one of four paintings that were treated either by guest conservators from Budapest or Getty Museum conservators in Los Angeles from 2006 to 2009.

Figure 1. Giovanni Antonio Boltraffio, *Madonna and Child*, 1495-7, oil on panel, 32.4 x 24.9 in. (82.4 x 63.4 cm). Before treatment. Szépmüvészeti Múzeum, Budapest, inv.52. © Szépmüvészeti Múzeum, Budapest.

Since a past structural treatment in which the panel support of the *Madonna and Child* was thinned and cradled, new cracks had developed in the panel and appeared in the painting's surface, necessitating another structural intervention to stabilize the panel. In addition to the structural needs of the panel, the condition of the surface with discolored and darkened natural resin varnish and restoration also called for proper cleaning and restoration. This paper presents a few aspects of the conservation treatment and restoration of the painting, but mainly focuses on some observations made during the technical study. By comparing Giovanni Antonio Boltraffio's technique in the *Madonna and Child* to other paintings by both Boltraffio and his master, Leonardo da Vinci, a complex picture unfolds in which we see much was drawn upon from his teacher's working methods. The first and only published synthetic description of Boltraffio's technique was by Larry Keith and Ashok Roy at the National Gallery London. [1] Our studies offer a complement to that work.

Figure 2. Giovanni Antonio Boltraffio, *Madonna and Child*. Reverse before treatment. © Szépmüvészeti Múzeum, Budapest.

ART HISTORICAL BACKGROUND

Leonardo da Vinci himself notes that Boltraffio was in his Milanese studio in 1491[2], and Vasari describes him as a disciple in his biography of da Vinci where he also mentions one of the few documented works by Boltraffio, the *Casio Altarpiece*, commissioned in 1500 for the Casio family altar in the church of Santa Maria della Misericordia in Bologna, now in the Musée du Louvre. [3] The other documented works are *Saint Barbara*, dated 1502, now in the Gemäldegalerie Berlin, and the *Lodi Altarpiece* of 1508 in the Szépmüvészeti Múzeum, Budapest. [4]

The provenance of the *Madonna and Child* can only be traced back to when it was in the princely collection of Nikolaus Esterhazy where it was attributed to Leonardo da Vinci. From there it was sold to the Szépmüvészeti Múzeum in 1865 where it is one of the gems of collection and is considered by most scholars to be one of Boltraffio's greatest achievements. Besides Leonardo, the painting had been attributed to Bernardo Zenale, but since the late 19th century the attribution to Giovanni Antonio Boltraffio has been widely accepted. [5]

Discussions on Leonardo da Vinci's direct involvement in the painting began because of the high quality of the painting. Several art historians, including Wilhelm von Bode, Wilhelm Suida, and August Mayer have supported the presence of Leonardo's hand in the preparation of the painting.[6] We know from contemporary documentation that Leonardo did do work on his assistants' paintings. For example, in a letter dated 3 April 1501 to Isabella d'Este from her agent the Carmelite monk Fra Pietro Novellara, Leonardo's studio in Florence is described: "…two of his apprentices are making copies and he puts his hand to one of them from time to time. He is hard at work on geometry and has no time for the brush…"[7]

The composition is related to a group identified by David Alan Brown of devotional Madonnas in which the Child reaches towards flowers in a ceramic vase. [8] The dynamic position of the Child's legs, one bent and the other stretched out, is certainly an invention of Leonardo's seen in a related drawing with the figure in reverse. [9] The Child mysteriously reaches out towards an empty vase, perhaps to flowers that were never painted in the end. A flower was fully expressed in Boltraffio's *Madonna and Child* in the Museo Poldi Pezzoli, considered to be the most closely related painting to the Budapest picture, about half the size. [10]

TREATMENT

A brief notice was published in *Kunstblatt* on the last known restoration of the *Madonna and Child* which took place in Vienna, 1845. [11] When the painting arrived at the J. Paul Getty Museum in 2008 for study and treatment, surface deformations and cracks, related to the unfortunate thinning of the panel to about 4-8 mm in thickness and subsequent cradling were immediately noted. Although the painting has a vertical format, the grain of the panel is rather unusually horizontal in this case, so the deformations follow the grain.

The wooden cradle consisted of thirteen fixed horizontal members that aligned with the grain, seven sliding vertical members that were no longer mobile, and two other vertical members on the right and left capping the edges. We know that the cracks developed in the panel after the cradle was applied because they start precisely at the boundary with a fixed member (fig. 3). This is a classic example of how wood is stressed and cracks when it is under restraint during cycles of adsorption and desorption of moisture.

In the x-radiograph taken when the painting first arrived a break in the panel that spanned the entire width of the painting was revealed. This break pre-existed the cradle, since two fixed members, instead of just one, were placed behind the break to reinforce the area.

Figure 3. Overlay of cradle on the front of the *Madonna and Child* with cracks in the wooden support outlined in green. Courtesy of the J. Paul Getty Museum, Los Angeles.

Figure 4. Reverse of the *Madonna and Child* after treatment with perimeter strainer auxiliary support. © Szépmüvészeti Múzeum, Budapest.

The expertise of George Bisacca from the Metropolitan Museum of Art was enlisted to carry out the structural treatment and we used this opportunity as a teaching moment for staff from the Budapest Museum of Fine Arts. Imre Nemcsics, one of their paintings conservators, and Béla Nagy who does structural work on their panel paintings, came for a two-week period to participate in the structural treatment of the *Madonna and Child*.

The cradle which subsequently caused cracks in the wooden support was removed to release the panel from stress. The panel was then disjoined in order to realign the surface deformations, and the joint surfaces were cleaned. Narrow cracks in the panel were consolidated with Araldite AW 106/Hardener HV 953 (formerly Araldite 2011). The cleaned joint surfaces were isolated with two coats of 17% Paraloid B-72 in acetone (w/v), and the two parts of the panel were rejoined with Araldite 1253, a carvable two-part epoxy.[12] After rejoining, the panel quickly adapted to a new natural shape, a convex warp, as it was no longer under the restraint of the cradle.

A temporary auxiliary support was constructed from plywood padded out with polyethylene foam and Volara cut to fit the curvature of the panel. This allowed cleaning, retouching and handling of the painting to continue until it could be fitted with a new auxiliary support to be attached in a second stage of the structural treatment. Near the end of the restoration, George Bisacca returned to construct a perimeter strainer fitted with his newly designed spring mechanisms (fig. 4). The painting was then placed in a climate box that was made to fit into its existing 19th-century frame that will buffer and protect the panel from future shifts in temperature and humidity.

PANEL SUPPORT

Once the cradle was removed, it was made evident that the panel consists of an impressive single board of poplar wood, 82.4 cm wide with respect to the vertical axis of the tree (fig. 5). The quality of the board is very high with some dense, wavy grain and only the remains of one knot discovered in

Figure 5. Reverse of the *Madonna and Child* after removal of the cradle. The dark squares are oxidized areas that were not covered by the cradle. © Szépmüvészeti Múzeum, Budapest.

the course of the structural treatment. During the preparation of the board as a painting support the knot had been at least partially excavated and covered with a square wooden insert that was inlaid into the front of the panel. The insert is visible on the reverse through a hole left by the missing knot; the outline of the insert is visible on the front in the Madonna's sleeve just below the Child's hands because of paint loss around the perimeter of the insert due to differences in movement over time between the insert and the surrounding panel (fig. 6).

The cleaning revealed that a bare wood margin 7-10 mm wide is present on the top, left and right edges of the painting along with a gesso burr. Neither the wood margin nor the gesso burr is present at the bottom edge, but because the painted composition stops about 2 cm from the edge of the panel, it is safe to presume that the present composition has not been cut down, though there is an underpainting visible at the bottom which extends to the very edge of the support suggesting that the initial composition was longer and that the panel had been trimmed. The cleaning also revealed that the

Figure 6. Left, the insert on the front of the support as seen from the reverse through the knothole. Right, the insert visible on front of the *Madonna and Child*. Courtesy of the J. Paul Getty Museum, Los Angeles.

background on the left and right sides, and painted ledge stop short of the burrs by 9-15 mm, but the bowl and the cushion were painted to the edges of the burr. The background was clearly painted on top of the cushion.

The gesso burr would indicate the painting once had an engaged frame, but this subsequent cropping in the painting stage suggests a change in framing which we could imagine to be a traumatic operation if the frame were engaged. The changes in dimensions between the preparation of the panel and the painted composition could be more easily explained if the panel had been in a sort of handling frame which is something Leonardo da Vinci may have described and illustrated in his writings. In the upper left corner of one his manuscript pages he drew a panel seen from the back with butterflies inserted in the join inserted in a type of frame. [13] He advised to put the panel "in a frame in such a manner that it can swell and shrink depending on whether it is humid or dry…" [14] and the gaps represented between the left and right sides of the panel and the frame would have certainly allowed this relative freedom of movement. We postulate that this little drawing could be interpreted as a cross section of a panel with an engaged frame or as a panel held in an independent frame. The latter would explain the presence of the burr and changes in the cropping of the painted composition.

X-RADIOGRAPH

After the cradle was removed from the painting, another x-radiograph was taken. Several pentimenti, previously obscured by the image of the cradle, were more clearly evident in the new x-radiograph (fig. 7). Originally, the orange drapery on the outer edge of the Madonna's proper right sleeve was placed lower or had simpler folds, and the folds of the orange-lined red mantle next to the bowl hanging over the ledge were shifted to the right and were straighter. Her proper right shoulder was slightly higher. The Child's

Figure 7. X-radiograph of the *Madonna and Child* after removal of the cradle. Courtesy of the J. Paul Getty Museum, Los Angeles.

proper right foot was previously shorter and had a bumpier contour, and His proper right cheek was slightly more squashed as well. On the left side of the x-radiograph is an opaque shape emanating from the bowl and going up the left side. Much has been said about the mysterious composition of the *Madonna and Child* seeming to focus on nothing. Unfortunately, the shape in the x-radiograph is too vague to try to define it, so the question of what they are looking at remains unanswered, but there may well have been an object of focus on the left side.

The most astonishing aspect of the new x-radiograph is the use of a bare hand (or hands) to manipulate the preparatory paint layers resulting in areas showing obvious fingerprints all over the painting. These are particularly present in the background, clearly around the figures. Because the pattern of the fingermarks does not correspond to the design in the paint layer, but are also somewhat radio-opaque, it is suggested that these fingermarks are in a lead-containing imprimatura layer. Along the upper left edge is the most obvious set of finger marks that relate to a series of sweeping gestures; these types of gestures are also to the right of the Madonna's head. Some fingermarks were visible in the paint surface, but the x-radiograph shows that they are concentrated in the areas described above. There are remnants perhaps of a palm print in the bottom left corner. More prints are located at the bottom of the cushion. The freedom with which this paint layer was applied is also indicative of oil paint which has a long working time. [15]

Swiss conservator Thomas Brachert published a series of articles in the 1960s and 1970s reporting the direct use of the hand in the preparatory and paint layers in early paintings by Leonardo da Vinci. [16] In Leonardo's unfinished painting of *St. Jerome* in the Vatican Museums one can see the fingermarks in the blue paint which was moved around the rocks in the sky and distant landscape in the upper left corner. [17] The "finger technique", as Brachert described it, can also be seen in the imprimitura layer in the *Virgin of the Rocks* in the National Gallery, London. [18] These prints are visible in the face of the Virgin though the finger- and palm-prints are not in the main paint layers. There are also fingerprints in *Ginevra de' Benci* in the National Gallery, Washington, and in *Lady with the Ermine* in the Czartoryski Museum, Kraków, but in these cases he used his fingers delicately to pounce the flesh paint in the faces. [19]

In his technical preface to his *Lives of the Artists*, Giorgio Vasari recommended applying an oil-based imprimitura on top of a gessoed panel and then pounding it with the palm of the hand until it is evenly spread, but more often the imprimitura layer is found to be brush-applied. [20] The sweeping marks seen in the Budapest x-radiograph differ from Vasari's description of a pounding motion. This technique of hand applying the preparation in the Budapest *Madonna and Child* must also have been learned by Leonardo's students as we find traces of this method in the x-radiographs of other paintings attributed to Giovanni Antonio Boltraffio, Marco d'Oggiono, who collaborated with Boltraffio, and Ambrogio de Predis, also an assistant in Leonardo's Milanese studio.

In Boltraffio's oeuvre there are finger marks all over the x-radiograph of the *Madonna and Child* from the Museo Poldi Pezzoli [21], as well as of the *Portrait of a Girl Crowned with Flowers* from the North Carolina Museum of Art and in the x-radiographs of works by Boltraffio these most closely resemble each other. [22] In the J. Paul Getty Museum's *Chirst Carrying the Cross* attributed to Marco d'Oggiono, whose composition is certainly an invention of Leonardo's [23], the imprimitura has a vertically striated appearance with the presence of a few fingerprints (figs. 8, 9). The imprimitura of a *Girl Holding a Bowl of Cherries*, attributed to Giovanni Antonio de Predis, from the Metropolitan Museum of Art, has

Figure 8. Attributed to Marco d'Oggiono, *Christ Carrying the Cross*, about 1495-1500, oil on panel, 14.4 x 10.7 in. (36.8 x 27.3 cm). The J. Paul Getty Museum, Los Angeles, 85.PB.412. Courtesy of the J. Paul Getty Museum, Los Angeles.

Figure 9. X-radiograph of Christ Carrying the Cross showing vertically striated imprimitura. Courtesy of the J. Paul Getty Museum, Los Angeles.

vertical as well as diagonal striations, with some finger marks at the ends of the strokes that would indicate the imprimatura was hand-applied. [24] The placement of the afore-mentioned fingermarks is different though from the Budapest *Madonna and Child* because they are generally present all over the painting, whereas, in the Budapest painting the pattern of the application of the imprimitura suggests some awareness of the painted composition to follow.

Leonardo was not the only Italian artist in the Renaissance to leave behind fingerprints in their work. In the works of Giovanni Bellini fingerprints can be found almost always in the rosy fleshtones. They are also found in some paintings by Cima da Conegliano, and a few other Northern Italian artists. [25] Fingerprints are found rarely though in Milanese painting. A streaky, hand-applied imprimatura layer appears to be unique to Leonardo da Vinci and his studio at this time.

INFRARED REFLECTOGRAPHY (IRR)

Examination in infrared with an Osiris camera after cleaning shows evidence of a preparatory drawing in two different styles (fig. 10). [26] One consists of some broad, very free strokes made with a brush, visible in the contour of the Child's face flowing from cheek to chin, in his toes of the proper right foot, underneath the folds in the cushion, and in his arm. The other consists of a finer, linear drawing which appears to have been done in a dry media. This is seen as pentimenti in the Child's near hand where the fingers were positioned slightly higher; in the Madonna's proper right fingers which were slightly lower originally; and in her proper left hand where she previously had two fingers placed on the Child's thigh.

Similar underdrawing done in broad strokes can be found in Boltraffio's *Madonna and Child* in the Museo Poldi Pezzoli in Milan, but the finer underdrawing described above was not detected. [27] In another painting by Boltraffio, *Portrait of a Youth with Arrow* from the Timken Museum, some finer underdrawing was found in the proper left eye which appears to be executed with a brush, but none of the broad strokes like in the Budapest painting. [28] The search still continues for a painting by Boltraffio with the two underdrawing styles as found in the Budapest *Madonna and Child*. The use of both dry and liquid media that produce fine and broad marks

Figure 10. Infrared reflectogram of the *Madonna and Child* after cleaning. Courtesy of the J. Paul Getty Museum, Los Angeles.

has been documented in some works by Leonardo da Vinci, including his second version of the *Madonna of the Yarnwinder* in a New York private collection, and the *Virgin of the Rocks* in London. [29]

MONOCHROME UNDERPAINTING

A grisaille underpainting or an underpainting of a very limited palette was executed on top of the imprimatura and underdrawing. The underpainting appears in an unfinished margin at the bottom of the painting uncovered during the cleaning of the painting where the rich burgundy color of the ledge stops abruptly and the warm imprimatura and white and grey paint appears near the lower left corner. In the x-radiograph, a pentimento in the placement of a fold of the orange drapery on the ledge continues into this white and grey paint in the lower margin. The white paint presumably represents the highlight of the fold and the grey paint the area in shadow. One gains an understanding of this continuous drapery in a drawing by Boltraffio in Oxford which is more closely related to the composition of the Poldi Pezzoli *Madonna and Child*. [30]

Figure 11. Cross-section sample from the orange-brown lining of the Madonna's mantle, Photo: Alan Phenix. © 2014 J. Paul Getty Trust.

We have not yet come across other paintings attributed to Boltraffio with a documented grisaille layer or found any grisaille-like paintings in his oeuvre. But in the oeuvre of Leonardo da Vinci there are several examples of monochrome studies: *Head of a Young Girl* on panel from the Museo Nazionale Parma [31], and beautiful studies of draperies on canvas at the Musée du Louvre. [32]

PAINTING TECHNIQUE

All of the cross sections taken seem to indicate that the first pigmented layer above the conventional calcium sulfate gesso ground is an imprimitura layer of a distinctive light cream or beige color, as occurs, for example, in a sample from the orange-brown lining of the Madonna's mantle (fig. 11). Particulates in the imprimitura layer include at least two lead-based pigments (lead white and red lead), plus a little carbon black, and in most cases, a transparent copper-containing green pigment, probably verdigris. At least some of the red lead is the result of remineralization following lead soap formation.[33] The presence of the copper-containing pigment seems unusual, but Leonardo wrote on the same page (as the frame) described earlier a recipe for an imprimitura containing verdigris. "Then, pounce it and lightly outline your design, and over that, lay an imprimitura of 30 parts verdigris to one of verdigris and two of yellow." [34] This is an odd recipe to decipher, and even though what he describes would be a rather dark-colored imprimitura, darker than what one would imagine is present in the Budapest painting, the incorporation of verdigris is a practice described by Leonardo. The existence of this lead-abundant layer across the entire picture plane accords with features of the x-radiograph of the painting that reveal an x-ray-opaque material smeared across the surface seemingly by hand. Imprimitura layers of similar composition were also found in the side panels to the *Virgin of the Rocks* which depict angels, and in a *Portrait of a Lady* attributed to Giovanni Ambrogio de Predis in the National Gallery London. [35] In the 14th and 15th centuries, green pigments such as green earth and copper-green resinate were added to the imprimatura usually found only under the flesh tones. [36] In the *Madonna and Child* from Budapest, a copper-containing green pigment is found in the imprimitura applied over the entire panel, so its inclusion seems quite distinctive to the imprimituras of the studio of Leonardo.

The most striking observation is the occurrence in virtually all the samples from the Budapest *Madonna and Child*, as the first true paint above the imprimatura, of a layer that is essentially a neutral shade of grey, varying in tonality from quite dark, through shades of medium grey, to very pale grey. Generally it can be seen that the tonality of this first neutral, grayish underpainting corresponds quite closely with the final paint appearance of that specific location. The underpainting seen through abrasions in the flesh clearly modulates in tonality with the lightness or darkness of the flesh tones, so that in the shadows the grey underpainting is darker than in the highlighted areas that are lighter. From these observations, it could be put forward quite convincingly that the first the first stage of paint proper, after the application of the imprimatura, was the sketching-in of the composition in relatively neutral tones: a grisaille, if not fully worked up or entirely neutral in color.

A similar grey paint layer above the imprimatura can be found in the *Virgin of the Rocks* in London from a sample in the yellow lining of the Virgin's mantle. [37] It is also interesting to note in both this sample and the one of the orange-brown lining of the Madonna's mantle from the Budapest painting is the presence of a thin, dense, dark layer above the imprimatura layer and below the grisaille layer which presumably represents an underdrawing or other early design stage.

CONCLUSION

Concerning the *Madonna and Child* from Budapest, Maria Teresa Fiorio in her 2000 monograph wrote that Leonardo's participation could not be confirmed. But we do know now of a similar cartoon that must have been used in both the *Madonna and Child* and the *Virgin of the Rocks* in London: a drawing with punched holes that is traditionally related to the head of St. John the Baptist in the first version of the *Virgin of the Rocks* at the Louvre. [38] Luke Syson from the National Gallery London pointed out a pentimento in the Christ Child's head of their *Virgin of the Rocks* visible only in the x-radiograph. The position of this earlier head closely corresponds in scale to the drawing, but in reverse like the head of the Budapest Christ child. At Luke's suggestion, a tracing was made of the child's head in the x-radiograph from the Budapest painting, and when it was laid over the National Gallery x-radiograph, the contours matched almost perfectly.

From a technical point of view, the *Madonna and Child* from Budapest appears to have more in common with paintings by Leonardo da Vinci than with the short survey of paintings attributed to Giovanni Antonio Boltraffio and other artists from Leonardo's circle treated in this paper. An underdrawing with broad, free strokes and fine lines; an imprimatura layer which is hand-applied and shows some awareness of the painted composition; and monochrome underpainting are all characteristic of Leonardo da Vinci's paintings.
A better understanding of the artist's working methods in

Figure 12. Giovanni Antonio Boltraffio, *Madonna and Child* after treatment. © Szépmüvészeti Múzeum, Budapest.

the *Madonna and Child* could be gained through comparison with additional technical information from other paintings by Leonardo's associates. This would give a better scope of how the *Madonna and Child* fits into Leonardo's studio practice.

In October 2009 the *Madonna and Child* returned home in time to be included in the exhibition "Botticelli to Titian" at the Szépmüvészeti Múzeum (fig. 12). In November 2011, the *Madonna and Child* will join many examples of Leonardo's work and that of his studio in the unprecedented exhibition at the National Gallery of Art, London, "Leonardo da Vinci: Painter at the Court of Milan." We expect that the discussion presented here will benefit from the wider context of paintings that will be on view there together. [39]

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ENDNOTES

1. Keith and Roy 1996.
2. "Fu discepolo di Lionardo Giovanantonio Boltraffio milanese, persona molto pratica et intendente, che l'anno 1500 dipinse in nella chiesa della Misericordia fuor di Bologna, in una tavola a olio, con gran diligenza la Nostra Donna col Figliuolo in braccio, S. Giovanni Batista e S. Bastiano ignudo, et il padrone che la fé fare ritratto di naturale ginocchioni, opera veramente bella et in quella scrisse il nome suo e l'esser discepolo di Lionardo." Vasari [1568] 1991, 566. Fiorio 2000, 110-113.
3. Keith and Roy 1996, 13-14. Fiorio 2000, 131-133.
4. Fiorio 2000, 114- 116.
5. Fiorio 2000, 84-86.
6. Fiorio 2000, 86.
7. Leonardo 1989, 273.
8. Brown 2003, 29.
9. School of Leonardo da Vinci, "Corps acéphale d'un enfant se détournant cers la gauche", metal point on blue paper with white highlights, 15th-16th century, 42.6 x 25.5 cm, Paris, Musée du Louvre départment des Arts graphiques, RF 5635.
10. *Madonna and Child*, c. 1485-1490, 45.5 x 35.5 cm, Museo Poldi Pezzoli, Milan, n. inv. 1609/1642.
11. "Erasmus von Engerth has finished the restoration of the picture, which is the only genuine Leonardo to be found in Vienna." No author. Untitled short notice, *Kunstblatt* 26 (1845): 43, translated by A. Vécsey. Fiorio 2000, 86.
12. Paraloid B-72 was found to be a suitable barrier layer for epoxy joins in wood. Ellis 2004.
13. Leonardo 1923-41, folio 1 recto. A drawing after the Leonardo drawing can be found in Leonardo 1970, 319.
14. Leonardo 1999, 5. "e metti i telajo i modo possa cresciere e discresciere secodo l'umido o secco" Leonardo 1970, 319.
15. No media analysis was carried out.
16. Brachert 1969, 1974, 1977.
17. *St. Jerome Praying in the Wilderness*, 1478-1483, oil on panel, 102.8 x 73.5 cm, Monumenti, Musei e Gallerie Pontifiche, Vatican City.
18. Brachert 1977. *Virgin of the Rocks*, c. 1491-1508, oil on wood, 189.5 x 120 cm, National Gallery of Art, London, NG 1093.
19. Bull 1992, 70; 1998, 83, 85; Brachert 1969. *Ginevra de' Benci*, c. 1474/1478, oil on panel, 15 x 14 9/16 in. (38.1 x 37 cm), National Gallery, Washington, DC, 1967.6.1. *Lady with an Ermine*, 1489-90, oil on panel, 55 x 40.5 cm, Muzeum Narodowe, Krackow, Inv. 134.
20. "…impiastrarla su per la tavola e poi batterla con la palma della mano, tanto ch'ella venga egualmente unita e distesa per tutto, il che molti chiamano l'imprimatura." Vasari 1991, 82.
21. Andrea di Lorenzo of the Museo Poldi Pezzoli and Carlotta Beccaria kindly allowed the direct examination of the painting and x-radiograph of the *Madonna and Child*, and shared their technical documentation, including infrared reflectography.
22. *Portrait of a Girl Crowned with Flowers*, c. 1500, 15 ¾ x 11 5/8 in. (40 x 29.5 cm), North Carolina Museum of Art,

Raleigh, GL.60.17.40. Brown 1995. William Brown and Noelle Ocon kindly allowed direct examination of the painting, its x-radiograph and infrared reflectogram.

23. Marani 1987, 37.
24. Giovanni Antonio de Predis (active by 1472-died after 1508) but possibly Giovanni Antonio Boltraffio, *Girl with Cherries*, ca. 1491-95, 48.9 x 37.5 cm, The Metropolitan Museum of Art, New York, 91.26.5. Charlotte Hale kindly allowed direct study of the x-radiograph.
25. Brachert 1969, 93.
26. The Osiris camera made by Opus Instruments, UK has an operational wavelength range of 0.9-1.7 µm, and has an indium gallium arsenide (InGasAs) sensor.
27. Infrared reflectography carried out by l'Istituto Nazionale di Ottica Applicata (INOA) High Resolution Scanner with an operational wavelength rage of 0.8-1.7 µm.
28. Chui 2010, 4-5.
29. Bellucci 2005, 51-52. Syson and Billinge 2005.
30. *Drapery study*, 1485-90, metal point and brown watercolor on paper, 25.1 x 18.7 cm, Christ Church College, Oxford, inv. 23 (0048).
31. *Head of a Young Girl*, c. 1508, oil on panel, 27 x 21 cm, Galleria Nazionale, Parma, inv. n. 362.
32. For example, *Draperie pour une figure agenouillée*, c. 1472-1475, tempera on canvas, 18.1 x 23.4 cm, Musée du Louvre département des Arts graphiques, Paris, Inv. 2256, recto.
33. Phenix 2009. Within the set of cross-section paint samples analyzed in this study there was strong evidence for the occurrence of the various phenomena associated with the soap formation, aggregation and re-mineralization processes described by Boon et al 2002. In several samples, particles of red lead are seen to be associated with amorphous lead soap aggregates and are clearly a result of remineralization processes, but not all red lead particles in the imprimitura layers may be this form of alteration product. The extent to which any of the red lead particles observed in the imprimitura layers are original constituents remains an open question.
34. Leonardo 1999, 5-6. "e poi spoluerezza e proffila il tuo disegnio sottilmete e da di sopra l'imprimatura di 30 parti di verde rame e una di verderame e 2 di giallo." Leonardo 1970, 319.
35. Spring, M. 2011. Personal communication. National Gallery of Art, London. The paintings are Associate of Leonardo da Vinci, *An Angel in Green with a Vielle*, c. 1506, oil on poplar, 116 x 61 cm, NG1661; *An Angel in Red with a Lute*, c. 1490-9, oil on poplar, 118.8 x 61 cm, NG1662; attributed to Giovanni Ambrigio de Predis, *Profile Portrait of a Lady*, c. 1500, oil on walnut, 52.1 x 36.8 cm, NG 5752. Spring had also pointed out that in a study of 16th-century Italian preparatory layers, slightly later than the period discussed in this paper, at the National Gallery, of the nearly 140 paintings examined, none contained any copper-containing pigment in the preparatory layers. Dunkerton 1998.
36. Matteini 1989, 59.
37. Keith 2011, 75.
38. *Tête d'enfant de trios quarts à droite*, fourth quarter of the 15th century – first quarter of the 16th century, metalpoint with white highlights on paper, 13.4 x 11.9 cm, Musée du Louvre département des Arts graphiques, Paris, Inv. 2347, recto.
39. In conjunction with the exhibition, a version of this paper will be presented at the CHARISMA Leonardo Technical Conference January 2012. The proceedings of the conference will be published in a future issue of *Technè.*

SUPPLIERS

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AUTHORS

Sue Ann Chui
Associate Conservator
J. Paul Getty Museum
1200 Getty Center Drive, Suite 1000
Los Angeles, CA, 90049
E-mail: schui@getty.edu

Alan Phenix
Scientist
Getty Conservation Institute
1200 Getty Center Drive, Suite 700
Los Angeles, CA 90049
E-mail: aphenix@getty.edu

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KRISTIN DEGHETALDI AND KATHRYN MORALES

A Neoclassical Mystery: The Technical Study and Treatment of an Iconic French Portrait

ABSTRACT

For over four decades *Portrait of a Woman in White* was proudly displayed on the walls of the National Gallery of Art in Washington, DC as a masterpiece by none other than Jacques-Louis David. Initially thought to be an image of the famous Madame Hamelin, its attribution and title were reassigned in 1972, as scholars and art historians began questioning the provenance of the painting. While nearly all of David's works are well documented, the Gallery's portrait has not been found in any of the literature relating to his Salon entries or private commissions. There are no published technical studies of David's materials and painting techniques, let alone the techniques employed by his students, leaving conservators and art historians to look towards his unfinished pictures for answers. Nearly 400 students are documented as participating in David's studio between the years 1780 and 1825. David is also known to have recruited talented pupils to assist him with large-scale commissions. Since David had such a successful workshop, art historians are faced with enormous challenges when tackling questions related to attribution. Treatment of *Portrait of a Woman in White* was carried out in 2009 allowing the conservation staff to closely examine the painting and perform a full technical study that provided some information about the practices of this anonymous painter in the circle of David. Pigment identification was performed using XRF and polarized light microscopy, while cross-sectional analysis provided insight into the artist's layering. Key pigments such as Scheele's Green helped to confirm the date of the portrait as no earlier than 1775. The information gathered in this study makes the case for assigning attribution of this painting to a different artist than those that have previously been suggested.

AUTHORS

Kristin deGhetaldi
Painting Conservation Fellow
National Gallery of Art

Kathryn Morales
Conservation Scientist
National Gallery of Art

NARAYAN KHANDEKAR, SARAH KIANOVSKY, AND KATHERINE EREMIN

A Comparison of the Pigments Mentioned in Delacroix's Diary with Those Found in the Oil Sketch and Final Version of *Bacchus and Ariadne*

ABSTRACT

After complaining about a dinner with Mme de Forget, Delacroix's diary entry for 8 May 1856 makes specific mention of pigments he used in certain passages of a painting containing the figure of Ariadne. This is the painting of *Autumn* from a seasonal series depicting Bacchus finding Ariadne on Naxos. The oil sketch belongs to the Fogg Art Museum, Cambridge Massachusetts and the final version belongs to Museu de Arte de São Paulo (MASP), Brazil. Guided by the description in the diary, samples were taken from similar locations in both versions and pigments were compared with the written entry.

Initially, an X-ray fluorescence (XRF) survey was carried out of the Fogg oil sketch to determine which pigments could be identified. Spectra were collected from twelve locations. The results prompted a more detailed analysis. Also, a sketch of the Fogg painting by Pierre Andrieu from the Museum of Fine Arts Boston was examined by XRF spectroscopy.

Five samples each from the Fogg oil sketch and the MASP painting were collected according to descriptions in the diary:

Sample 1 *Charmant ton demi-teinte de fond de terrain, roches*

Sample 2 *Dans le rocher, derrière l'Ariadne, le ton de terre d'ombre naturelle et blanc avec laque jaune*

Sample 3 *Le ton local chaud pour la chair à côté de laque et vermillon*

Sample 4 *jaune de zinc, vert de zinc, cadmium, un peu de terre d'ombre, vermillon, bleu de Prusse, ocre de ru, vert neutre*

Sample 5 *Ce ton, avec vermillon laque, donne un ton de demi-teinte charmant pour chair fraîche.*

The samples were mounted and prepared as cross-sections and photographed under visible and ultraviolet light. They were examined by Scanning Electron Microscope-Energy Dispersive Spectroscopy (SEM-EDS) to identify the pigments.

Microscopic Raman spectroscopy was attempted; however, the fluorescence of the oil medium prevented any useful data from being collected, except in one particle.

In the diary, Delacroix mentions chromium pigments several times: e.g. "*chrome clair, ocre jaune, vert émeraude. - le chrome clair fair mieux que tout cela, mais il est dangereux alors, il faut supprimer les zincs.*"

Chromium containing pigments were found in the Fogg Sketch both by XRF and SEM-EDS analyses, but none were found in the MASP painting. The results suggest that the diary refers to the Fogg sketch. The copy by Andrieu has a similar palette to the Fogg painting.

Pigment analysis of the two versions of *Bacchus and Ariadne* by Delacroix revealed that the Fogg's sketch contains chromium-based pigments which were absent in the MASP version of the painting. This strongly suggests that the entry in Delacroix's diary for 8 May 1856 refers to the sketch rather than the final painting.

AUTHORS

Narayan Khandekar
Harvard Art Museums
Cambridge, Massachusetts. USA
narayan_khandekar@harvard.edu

Sarah Kianovsky
Harvard Art Museums
Cambridge, Massachusetts. USA
sarah_kianovsky@harvard.edu

Katherine Eremin
Harvard Art Museums
Cambridge, Massachusetts. USA
katherine_eremin@harvard.edu

KATRINA A. BARTLETT

Attributed to Henri Rousseau: The Technical Examination of *La Sainte Famille*

ABSTRACT

The provenance of *La Sainte Famille* was revisited alongside a close scrutiny of the material aspects of the work. This painting and a selection of works by Henri Rousseau were examined with a range of techniques during a yearlong inquiry. As a result, insights into the painting and into the materials and working methods of the French artist were made, culminating in a symposium at the Menil Collection in October 2010. During the two-day symposium conservators, curators, and art historians convened to discuss the work of Henri Rousseau while laying groundwork for future research.

This paper presents the examination of *La Sainte Famille* and, drawing from collaboration with other institutions, as well as topics considered at the symposium, discusses some of the painting practices of Henri Rousseau.

INTRODUCTION

In 1963 John and Dominique de Menil purchased the painting titled *La Sainte Famille* or *The Holy Family* (1905) through Sotheby's auction house in London, as a painting by Henri Rousseau (1844–1910) (figs. 1, 2). Despite his persistent efforts and correspondence with institutions and galleries worldwide, John de Menil was only able to build a partial record of the painting's past ownership. It is suspected that this inability to establish a complete provenance, coupled with the doubt of some, including Dora Vallier, author of one of the catalogs raisonnés on Henri Rousseau, and the oddity of the subject matter for the artist may have had a ripple effect on subsequent appraisers and the curatorial staff at the Menil Collection. Consequently by 2000, Menil Collection curators listed this painting as "attributed" to Henri Rousseau, instead of labeling the painting as a work by the artist (Vallier 1981; Cavanaugh 2000; Davidson, 2000). While this was a reasonable decision with the information available at the time, as with many things, it warranted another look.

Figure 1. *La Sainte Famille*, 1905; oil on canvas. 44 1/8 x 29 1/2 in. (112 x 75 cm), The Menil Collection, Houston, X 3127

Correspondence between the Menil Collection and Dora Vallier in 1981, ironically establishes that Vallier neither saw the painting in question in person nor had accessed a complete exhibition history of the work in the course of evaluating it. The painting was exhibited as a work by Rousseau a number of times before being sold to the de Menil's, including at the Reinhardt Galleries, New York, 1929;

Figure 2. Auxiliary support of *La Sainte Famille*, 1905; oil on canvas. 44 1/8 x 29 1/2 in. (112 x 75 cm), The Menil Collection, Houston, X 3127

Marie Harriman Gallery, New York, 1931; the Renaissance Society, Chicago, 1931; Tooth's Gallery, London, 1934; Dayton Art Institute, Ohio, 1942; The Wisconsin Union Gallery, Wisconsin, 1942; Venice Biennale (in a tribute to Henri Rousseau), 1950; and at Wildenstein & Company, New York, 1950 (Reinhardt Galleries 1929; Marie Harriman Gallery 1931; the Renaissance Society 1931; Arthur Tooth's Gallery 1934; Dayton Art Institute 1942; McCloy 1942; Pallucchini 1950; Wildenstein 1963). However, despite working with a limited exhibition history, which included only the latter two venues listed above, Vallier did leave room for debate in her conclusion about the dubious nature of the work. In her letter to the Menil Collection Vallier stated:

> *…To know if this painting, which does not have an equivalent in the work of Rousseau, is well by his hand, it should be carefully studied and submitted to very strong technical analyses…*
> (Vallier, 1981, n.p.)

Fast-forwarding nearly 3 decades from the date of this letter, in 2009 a research project focused on this painting was initiated. By studying *The Holy Family,* and a number of works painted by Henri Rousseau, through in-depth examination, analysis of the artist's materials, and by developing an understanding of the manner in which the works were painted, it was hoped that some of the ambiguity of the painting, and the working methods of Rousseau, would be clarified.

PROVENANCE AND HISTORICAL EVIDENCE

At the time of his search in 1964-65 John de Menil discovered that a previous owner of *The Holy Family*, Mr. Paul Hyde Bonner, had purchased the painting from Wildenstein & Co. in October of 1927 (Bonner 1965). In a letter to Mr. de Menil, Louis Goldenberg, the then vice-president of the company, disclosed that many of the records kept in Paris pertaining to sale of paintings in the 1920's were lost, and he had no further information on the work in question (Goldenberg 1965). Unfortunately, Mr. de Menil was unable to overcome this impediment and therefore unable to expand the provenance of the painting.

The research project initiated in 2009 included a renewed pursuit of a complete provenance for the painting. However, this time the historical significance of the physical evidence associated with the painting was also brought to the table in hopes of moving the stalled research forward.

Figure 2 shows the auxiliary support of *The Holy Family*, a heavily worn five member wooden stretcher that carries clues to the painting's history and known provenance. Written in pencil on the top of the stretcher is the word "Roma", which is made clearer in a detail of an infrared image of the stretcher (fig. 3). This writing likely corresponds to a paper label (fig. 4), which was applied when a prior owner of the painting, Mr. Paul Hyde Bonner, lived in Rome for a short time. The label is from a forwarding or shipping company in Rome and has a typed passage in Italian that translates to: "*Painting by Rousseau,*

Figure 3. Infrared image (detail) of the auxiliary support of *La Sainte Famille*; The Menil Collection, Houston, X 3127

Figure 4. Detail of paper label on the auxiliary support of *La Sainte Famille*; The Menil Collection, Houston, X 3127

Figure 5. Detail of Paris customs stamp on the auxiliary support of *La Sainte Famille*; The Menil Collection, Houston, X 3127

property of: Mr. Mrs. Bonner," followed by the address of a palazzo in Rome. The stretcher also displays two paper labels from *The Holy Family*'s exhibition at the 1950 Venice Biennale and two partial customs stamps from Paris of unknown date (fig.5). The final label of interest is a small piece of paper tape, with the number 4221 (fig.6). Although, it is still unknown precisely who applied this label or when, thanks to the help of Elaine Rosenberg, who discovered and deciphered a card from her father-in-law, Paul Rosenberg's gallery archives, it appears that the label relates to a cataloging number (sk.4221) and was applied either prior to, or at the time of the acquisition of the painting by the art dealer, between 1925 and October of 1927 when the work was sold to Paul Hyde Bonner [1] (Haskell 2010). This is a significant step in the research on the history of this painting which helped to solidly place the painting in the Paul Rosenberg's hands, while adding up to an additional two years to the painting's known history.

HISTORY OF RESTORATION

The condition of *The Holy Family* is stable overall, although it has not remained untouched by the hands of time or restorers. The painting has been lined to a fine, plain weave canvas. It is likely that the lining was added to support two mended tears present in the canvas. Historical and physical evidence associated with the painting indicate that the lining may have occurred prior to Paul Hyde Bonner's acquisition of the painting from Felix Wildenstein (and Paul Rosenberg) in 1927.[2] This theory is supported by research into the painting's location(s) while in the Bonnor family's possession, and by the fact that during Mr. Bonnor's ownership of the work, there is record of only one treatment of the painting, which occurred in London in 1963 when Sotheby's had the painting cleaned (Bonner 1964; Haskell 2010). Additionally, before it's sale in October of 1927 the painting was believed to be in Paris [3] –and close examination of a newspaper interleaf between the original canvas and the lining support is written in French.

While seemingly mundane, this information may be helpful in understanding this artwork. In the absence of a complete provenance of the work, establishing a timeline of the restoration and the condition of the painting may lend additional credibility to the authorship of the work. In this case, 1925 and 1926 were critical years for paintings by Rousseau. In late 1925 it was announced that the Louvre

Figure 6. Detail of paper tape label on the auxiliary support of *La Sainte Famille*; The Menil Collection, Houston, X 3127

Figure 7. Ultraviolet induced visible fluorescence image (detail) of *La Sainte Famille*; The Menil Collection, Houston, X 3127

Figure 8. Raking light image (detail) of *La Sainte Famille*; The Menil Collection, Houston, X 3127

would accept Jaques Doucet's bequest of Rousseau's painting *The Snake Charmer* (Shattuck et al. 1985, 182). Then, in the October of the following year Rousseau's *The Sleeping Gypsy* fetched a sum of 520,000 francs at a Paris auction, an unheard of amount for the sale of a piece of modern art at that time (Zilczer 1979). In the subsequent years Rousseau grew in popularity and consequently paintings by Rousseau, both authentic and not, began to flood the market. That the evidence shows *The Holy Family* was in the hands of a well-respected art dealer and possibly even undergoing restoration treatment during the flood of the art market is encouraging.

Furthermore, establishing the condition and restoration history of this painting is crucial to understanding how the painting has changed since it left the artist's studio, and how many other hands have been involved with it. In this case, close examination of the paint layer reveals a network of cracks throughout the painting and there are at least two different campaigns of retouching present visible under examination with ultraviolet (UV) radiation. Presumably one of these campaigns arose from the 1963 treatment of the painting, and the other, likely took place following the lining. Examination of Joseph's robe beneath the microscope also reveals a distinct variation in texture in the paint layer, which was also apparent during the UV examination of the painting as fluorescence variations (fig. 7). This evidence suggests that sensitive red paint in Joseph's robe may have been damaged during cleaning, resulting in a modified surface uncharacteristic of the original artist's work.

TECHNICAL EXAMINATION OF *THE HOLY FAMILY* AND OTHER WORKS BY HENRI ROUSSEAU

In addition to these microscopic and UV examinations, illumination of the painting with raking light was employed to examine the artwork. Raking light revealed striations in the paint layer (fig. 8), attributed to the scraping down of a painting beneath *The Holy Family* rather than a product of the restorations. In 1964 conservator Sheldon Keck made a similar observation when he examined the painting as a favor to Mr. de Menil. Although Keck postulated that the painting beneath

The Holy Family was not "in Rousseau's style" the desire to qualify this statement necessitated a closer look (Rabin 1964). Infrared reflectography (IRR) revealed horizontal linear elements in the center of the artwork as well as dark and light areas of partial arcs associated with a painting beneath *The Holy Family* (fig. 9). The x-radiograph of the painting was consulted to clarify this evidence (fig. 10). Although it was originally hypothesized that the painting beneath *The Holy Family* could be architectural in nature, as estimated in Figure 11, continued study of the x-ray, including examination of the variation in the density of the paint (causing the dark and light bands), encouraged rotation of the canvas to a different orientation. In the new orientation, the linear elements could easily be seen as the trunks of a line of trees (fig. 12), an image that is found in a number of different paintings by Henri Rousseau. This theory would not however explain the arc that is also seen in the x-ray and further analysis was warranted.

Attempting to clarify what is beneath the visible paint layer of *The Holy Family*, two cross sections were taken from pre-existing losses in the paint layer. One sample (fig. 13) taken from a loss at the lower edge of the painting in Mary's dress reveals at least five different layers of paint beneath *The Holy Family* and the possibility that two or more paintings, partial or completed, exist beneath the one on the surface. An image with a line of trees, similar to those in Rousseau's painting *The Flamingo's* (c. 1907) or his 1906 work *Liberty Inviting Artists to Take Part in The Twenty-second Exhibition of the Société des Artistes Indépendants,* could certainly be a possibility for one of the paintings beneath the surface (Shattuck et al. 1985, 170-171, 184-184).

At the Menil Collection symposium "Henri Rousseau: Paint + Process" conservator Patricia Favero from the Phillip's Collection presented a similar finding regarding the Phillip's Collection painting *The Pink Candle* (1908). Favero found that transmitted infrared revealed evidence of a completely different painting, a portrait, beneath the surface of the current still life (Favero 2010). Likewise, Allison Langley from the Art Institute of Chicago reported that x-radiography of the Art Institutes portrait *Dahlia and Daisies in a Vase*, (c. 1904) revealed that a painting beneath the current one had been scraped down using a jagged tool (Langley 2010). In light of the fact that Rousseau was regularly in debt to his art material suppliers (Gauthier 1949), it would not be surprising if he often reused canvases in this way, either due to lack of new canvases or as a way of exploring new ideas, such as a religious scene, without wasting valuable resources. Additional research into the frequency with which Rousseau scraped down and reworked canvases is necessary, however to establish this as a standard working practice for the artist.

Figure 9. Infrared image of *La Sainte Famille* showing linear elements (red) and arch (blue); The Menil Collection, Houston, X 3127

Figure 10. X-radiograph of *La Sainte Famille*; The Menil Collection, Houston, X 3127

Figure 11. X-radiograph of *La Sainte Famille*, rotated 90 degrees counter clockwise and highlighted; The Menil Collection, Houston, X 3127

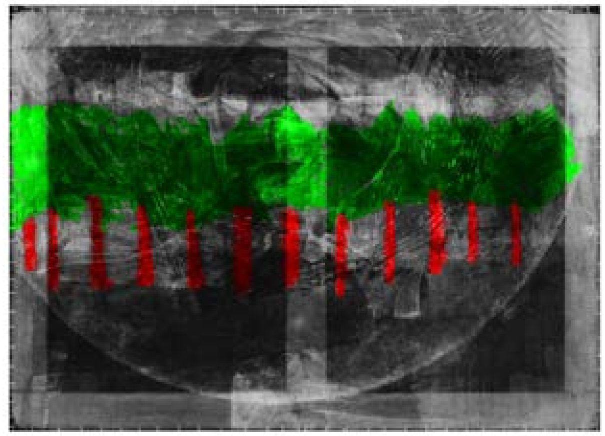

Figure 12. X-radiograph of *La Sainte Famille*, rotated 90 degrees clockwise and highlighted; The Menil Collection, Houston, X 3127

LAYOUT OF COMPOSITION

Next, on top of the partially scraped down canvas, a yellowish cream-colored ground layer was applied over the surface, and the composition for *The Holy Family* was mapped out. Observed with microscopic examination, there are instances near Mary's robe where small gaps between the blue sky and the purple robe reveal the ground color (fig. 14). This is also true of Joseph's headdress. As shown in the photomicrograph (fig.15), the blue sky is only visible beneath the top portion of the red headdress, whereas further down the yellowish cream ground layer is visible beneath the red. Both of these examples indicate that the background of the image was painted while leaving voids for the figures, which were then painted later.

Based on photo documentation, it is known that Rousseau painted in this way. In a well known photograph of Rousseau in front of the *Portrait of Joseph Brummer* (1909) and the second, then unfinished, version of *The Muse Inspiring the Poet* (1909), it is clearly visible that Rousseau had left voids for the figures in the latter painting, filling in the background first and planning to paint the figures in afterwards (Shattuck et al. 1985, 230).

CHANGES IN COMPOSITION

Returning to the IRR image of *The Holy Family*, it can be seen that the artist places importance on the relationship between the figures of Mary and Joseph. It is clear in the image that Joseph's robe was planned and then moved slightly in such a way to create a small triangle of space between the two figures (figs. 16, 17). Similar importance seems to be

Figure 13. Cross section of paint sample from *La Sainte Famille*; The Menil Collection, Houston, X 3127

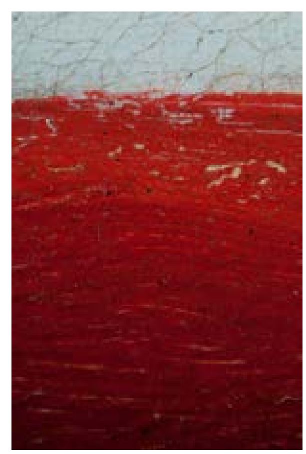

Figure 14. Detail of Mary's robe (left), *La Sainte Famille*; The Menil Collection, Houston, X 3127

Figure 15. Detail of Joseph's headdress (right), *La Sainte Famille*; The Menil Collection, Houston, X 3127

Figure 16. Infrared image of *La Sainte Famille*, highlighted to show initial placement of Joseph's robe; The Menil Collection, Houston, X 3127

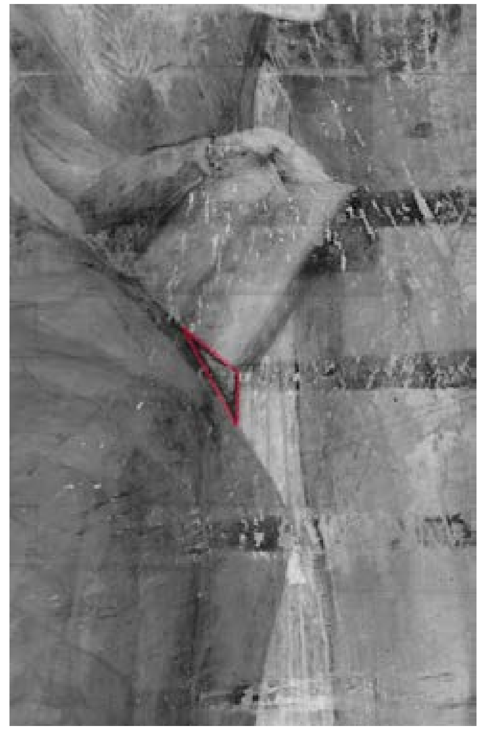

Figure 17. Infrared image of *La Sainte Famille* (detail), highlighted to show triangle of space constructed between the figures of Mary and Joseph; The Menil Collection, Houston, X 3127

placed on the relationship between the figures in a number of Rousseau's paintings, including the PMA's 1886 painting *A Carnival Evening* (Shattuck et al. 1985, 99), where Rousseau paid careful attention to how the two figures' elbows and costumes alternate in plane with one another.

Additionally, a closer look at the X-radiograph of *The Holy Family* focusing on Mary's proper right arm reveals evidence that this appendage may have been moved from its initial location. The dark area on the proper right of Mary, which is similar in density to Mary's arm holding the book, appears to have been the initial placement of the arm (fig. 18). Also, when comparing the IRR image to the actual artwork, it is clear that the stem of leaves behind Mary originally continued slightly lower, before being covered by Mary's robe. It is likely that the covering of the foliage occurred when the figure's shoulder was adjusted.

Similar instances of reworking or change are visible in several paintings by Rousseau. In Rousseau's *The Past and the Present, or Philosophical Thoughts,* a Barnes Foundation work dated 1891, there is visible reworking around the figures' heads where they have been adjusted or reworked. In The Museum of Fine Arts, Houston (MFAH) painting *The Eiffel Tower* (c. 1898), the conservators at the MFAH discovered that Rousseau had completely painted out a boat from the water. In normal light there is nothing visible in the area, but while examining the artwork with infrared reflectography a boat becomes visible (Bezur and deBango 2010). In addition to this, Yvonne Szafran, Head of Paintings Conservation at the J. Paul Getty Museum described in her talk at the 2010 Menil Collection Symposium, how examination of the *Centennial of Independence* (1892) with x-radiography and cross sectional analysis revealed a number of both minor and major changes, some of which were completed after the varnish had been applied by the artist (Szafran 2010). An interesting discovery which not only reinforces Rousseau's tendency to make changes in paintings, but highlights how at times he would do this even after varnishing a painting.

THE PAINTING PROCESS: WORKING IN LAYERS

Examination of *The Holy Family* beneath the microscope revealed that the artist worked in multiple layers of paint. After the creamy ground layer was applied all over, the upper portion of the canvas was blocked in by a single color blue sky. Once the sky was essentially dry the overlying foliage was developed, initially roughly sketched with dark green and

Figure 18. X-radiograph of *La Sainte Famille*, highlighted to show a estimated initial placement of Mary's arm (red), current placement of Mary's arm (blue) and position of baby Jesus (orange); The Menil Collection, Houston, X 3127

brown, followed by the building up of the leaves "wet into wet" with dark then light green strokes. Finally additional strokes of blue were added (figs. 19 and 20). Meanwhile, in the smaller leafed foliage on the proper left of the painting, a majority of the leaves appear to be painted on top of the blue background, built up by applying the darker green paint followed by thicker daubs of light green paint while the dark green paint was semi-dry (fig. 21). Also in this area, the artist then applied rough strokes of blue paint to define the foliage.

To compare this painting technique to that of a work firmly attributed to Rousseau, the Menil Collection painting titled *Bonne fête* (fig. 22) was also carefully studied beneath a microscope. The paint on *Bonne fête* was likewise applied in layers. But, unlike in *The Holy Family* the paint was applied in remarkably distinct layers, one shade of green painted carefully after the last (figs. 23-25). Comparing the two paintings side by side, *The Holy Family* seemed rather coarsely rendered (Bartlett 2009). The inconsistency between the applications of paint in the two works is more consistent within the oeuvre of Rousseau than one might expect, however. Suzanne Penn, Conservator of Paintings at the Philadelphia Museum of Art (PMA) shared her opinion on this in November 2009. Penn, having had experience examining multiple paintings by Rousseau with a technical eye, felt that Rousseau's paintings often lack a thread of consistency between them, such as the difference between the precision in *Bonne fête* and coarseness of *The Holy Family* (Penn 2009).

With that said, while examining works by Rousseau set within jungle scenes, a different conclusion was formed as small consistencies between the works became apparent. Close examination of *The Merry Jesters* (1906) at the PMA revealed evidence that sky color paint was added after the application of the foliage, in instances on top of leaves, to define them and create space between them. There are also sections of this artwork where the leaves are crisscrossed in a manner that creates small squares of space between leaves, which Rousseau then roughly defined with the sky colored paint. Likewise, in the Barnes Foundation painting, *Scouts Attacked by A Tiger* (1904), Rousseau painted in larger areas of the background sky after painting in sections of leaves. In this case the manner of painting creates interplay between the background and foreground of the image (McIntyre 2010). Finally, in *The Repast of the Lion (c. 1907),* a painting owned by the Metropolitan Museum of Art, New York, Rousseau

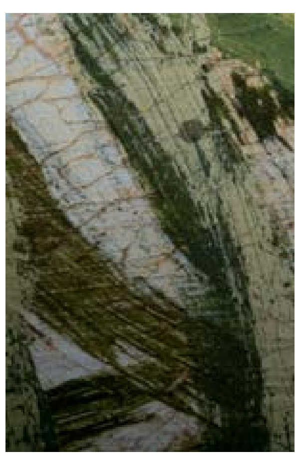

Figure 19. *La Sainte Famille* (detail); The Menil Collection, Houston, X 3127

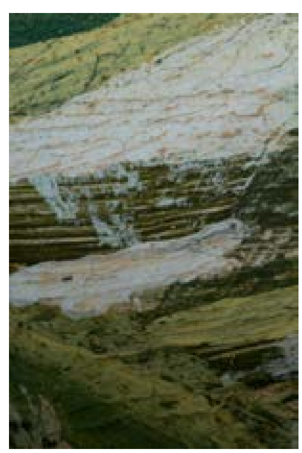

Figure 20. *La Sainte Famille* (detail); The Menil Collection, Houston, X 3127

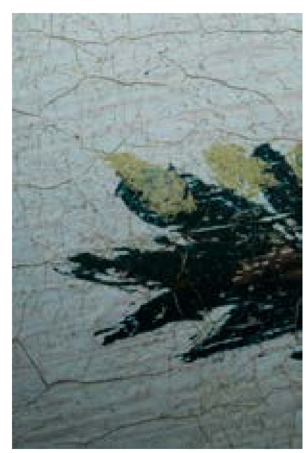

Figure 21. *La Sainte Famille* (detail); The Menil Collection, Houston, X 3127

Figure 22. Henri Rousseau, *Bonne fête*, 1892; Oil on paperboard, mounted on panel. 11-3/4 x 8-3/4 in. (31.5 x 22.1 cm), The Menil Collection, Houston, 80-16 DJ

Figure 23. Henri Rousseau, *Bonne fête* (detail); The Menil Collection, Houston, 80-16 DJ

Figure 24. Henri Rousseau, *Bonne fête* (detail); The Menil Collection, Houston, 80-16 DJ

Figure 25. Henri Rousseau, *Bonne fête* (detail); The Menil Collection, Houston, 80-16 DJ

again handled the paint in this manner. The author from a 1984 catalog of an exhibition of works on Henri Rousseau, writes to describe the painting, *"It would appear that Rousseau first painted the green trunks dark green and then filled in the spaces between them with a grey green"* (Shattuck et al. 1985, 210).

Further examination of, and research on, works by Rousseau, reveal this manner of painting in leaves and then defining them with strokes of sky or background colored paint to be quite common,[4] thus making the roughly rendered strokes defining the space between the leaves in *The Holy Family* markedly similar to works painted by Rousseau, and revealing a consistency within Rousseau's work when focusing on a single genre of painting.

The leaves are not the only areas of painting in *The Holy Family* handled in a similar manner as paintings by Rousseau, however. It can be seen that throughout *The Holy Family* the artist uses the direction of the brushstroke to define form and contour. This is particularly evident in the face of Mary (fig. 26). Although quite thinly painted over a darker base color, the direction of the brushstroke of the uppermost layer in the face of Mary is what is used to create the form as it follows the contour of Mary's face and neck. In her examination of the painting *Scouts Attacked by a Tiger,* Barnes Foundation Painting Conservation Intern, Christine McIntyre (2010), made a similar observation. Describing the Barnes Foundation painting in her examination report she writes, *"The oil paint was applied in thick layers and textured brushwork follows the contours of the forms, emphasizing shapes."*

PIGMENT ANALYSIS

Analysis of pigments (and consideration of how the colors were used) was also employed to develop a better understanding of the materials that Rousseau used and those present in *The Holy Family*. Under the guidance of the Menil Collection Conservation Scientist Aniko Bezur, X-ray fluorescence spectroscopy (XRF) was used to examine *The Holy Family* and a number of paintings by Henri Rousseau at the Menil Collection, the Museum of Fine Arts, Houston, and The Barnes Foundation in Merion, Pennsylvania. These results combined with information on pigment analysis from other institutions, literature research, and observation with

Figure 26. Detail of Mary's face, *La Sainte Famille*; The Menil Collection, Houston, X 3127

magnification, resulted in a number of observations about *The Holy Family* and Rousseau's use of pigments and paints within particular works of art.

1. *Bonne fête* (1892)

Dated 1892, Rousseau completed the Menil Collection work titled *Bonne fête* (fig. 22) with a fairly limited palette. Observation under the microscope revealed that the velvety grey background was applied by brush to a paper substrate (Bartlett 2009). The abundant presence of lead and significant amount of barium, calcium, and phosphorus as indicated by the XRF spectra of this area, informs the hypothesis that this color is largely composed of the pigment lead white, possibly with barium sulphate filler, (a commonly used additive to lead white since the 19th century (Eastaugh et al. 2008)) mixed with ivory or bone black paint.[5] This relatively smooth, dark layer is visible beneath the craquelure throughout the painting, indicating that the background extends beneath the image of the bouquet and the hand, having been painted solidly first before anything else was added. The additional paint layers in *Bonne fête* are fairly thin and flat in application with no impasto or roughly rendered strokes present. Based on XRF analysis, Rousseau used a mixture of Prussian blue [6] and chrome containing yellow paint (possibly chrome yellow) to create a medium toned green color. Mixing this green paint with varying amounts of bone black, lead white, and (possibly) occasional additional Prussian blue or yellow paint, it appears from this he achieved a range of greens, which were applied to the canvas in smooth layers, at times one stroke applied precisely next to the previous with very little mixing (as described in section 2.1). These colors were also used in the leaves. Lying in of the hand was then completed with a flesh colored mixture composed of lead white, small amounts of vermillion, and likely an earth pigment, possibly ochre, as indicated by analysis with XRF and the detection of ochre color particles visible in the paint matrix at 50 times magnification. Finally, the white flower in the top left corner of the painting is comprised of mostly lead white paint, while varying amounts of vermilion (and possibly another red lake pigment) were added to lead white paint in the pink flowers to give them a their reddish hue.

This basic palette of lead white, ivory black, Prussian blue, chrome (or chrome containing) yellow, and vermillion fits into the list of pigments in an account of a record of debt that Rousseau owed to Lefebvre-Foinet (Gauthier 1949). In addition to this, thus far, the pigments mentioned coincide with those present in the National Gallery of Art, London's 1891 painting *Surprise!* and the Fondation Beyeler's painting, *Le lion, ayant faim, se jette sur l'antilope* (1898/1905), which is potentially dated 1898, as was discussed by Fondation Beyeler head of conservation, Markus Gross at the symposium Henri Rousseau: Paint + Process (Gross and Steckling 2010).

2. *The Past and the Present, or Philosophical Thought* (1891)

Examination of the Barnes Foundation's 1891 painting, *The Past and the Present, or Philosophical Thought* (fig. 27), reveals that an off white ground was evenly applied to the canvas,

Figure 27. Henri Rousseau, *The Past and the Present, or Philosophical Thought (Le Passé et le présent, ou Pensée philosophique)*, 1891. Oil on canvas, 33 1/4 x 18 1/2 in. (84.5 x 47 cm), BF528. The Barnes Foundation, Philadelphia, Pennsylvania. Image ©2014 The Barnes Foundation.

extending onto the edges of the tacking margins. The ground, which appears commercially applied, was determined to be lead containing based on the appearance of lead in the XRF spectra from all points analyzed on the painting. Over this ground, Rousseau applied oil paint in thick layers with low-relief brushwork. The average width of the brushstrokes is ¼ inch wide, suggesting that he painted much of this composition with a fairly small brush. During analysis with XRF it was found that the blue sky was likely composed of a mixture of Prussian blue and lead white or another blue not easily detected by XRF alone, such as ultramarine (although confirmation would need to be done with a different type of analysis). White clouds were then painted over the blue sky with a slightly dry brush of lead white paint, possibly with barium sulphate filler.

It is likely these initial elements were in place prior to planning the rest of the composition. Graphite pencil lines just under some of the upper layers of painting are visible in normal light, and where visible, these lines may represent some of Rousseau's initially planned elements that were later decided against. For instance, visible in the sky is graphite cross, possibly defining the center of the composition, and below the male face in the sky, there is evidence that a shirt collar was planned.

The coarsely rendered leaves are built up from dark to light, but the strokes are less precise and the shading from light to dark is not as seamless as in the previously described *Bonne fête*. Despite this difference, there were similarities in composition of mixtures of this paint. Analytical results support that the dark green leaves of the background foliage are composed of a mixture of Prussian blue and chrome containing yellow paint. In *Bonne fête,* however, the darkness of the paint is most likely caused by the addition of bone or ivory black pigment. In *The Past and the Present,* XRF analysis detected the presence of mercury, indicating that the dark green paint contains particles of vermillion, a feature that is also present in The Fondation Beyeler's painting *Le lion, ayant faim, se jette sur l'antilope* (1898/1905) (Gross and Steckling, 2010), but is not present in the earlier artwork, *Bonne fête*. Unfortunately, it is impossible to know from this type of analysis alone whether the presence of these pigments was due to Rousseau mixing paint colors or whether he bought the paints already mixed by his suppliers. It was not unheard of for paint manufacturers to add small amounts of vermillion to their green mixtures to achieve a darker color. On the other hand, in areas of lighter green leaves and grass in *The Past and The Present*, there was compelling evidence that Rousseau was adding chrome yellow to the paint to vary the color of the green.[7] In this case the mixing of the colors (addition of yellow to green) is visible under close examination and supported by the increase in intensity of chrome peaks in the XRF spectra.

Lastly, close examination of the figures in this artwork reveals visible reworking around the outer edge of the man's proper right arm, where it appears as though the arm was shifted or reduced, and in the background around the tops of the figures' heads. In analysis of this area of paint, small amounts of the element zinc were detected. The male figure's white shirt was determined to be composed of lead white and a small amount of a zinc containing pigment, likely zinc white, as there was no barium present to suggest the use of lithopone. Analysis of the figure's cheek reveals evidence of lead white and vermillion. These were likely mixed with either earth pigments or lake pigments, and a small amount of a zinc containing pigment. Finally, analysis of the figure's black suit indicates the presence of bone or ivory black mixed with an iron containing pigment and either mixed with or applied over a small amount of a zinc containing pigment.

Even though the presence of zinc in this painting is very small and relatively confined to the figures and the surrounding area, it should be noted. Towards the latter part of the 19th century, when this painted is dated, it would not have been unheard of for lead white paint to have been adulterated with other pigments (Schur 1985). It is possible that when Rousseau reworked the canvas at a later date, he was using a tube of paint with a slightly different composition to the one he started with.

3. *Unpleasant Surprise* (1901)

The next Barnes Foundation canvas analyzed was the 1901 painting, *Unpleasant Surprise* (fig. 28). In this painting, the element zinc also makes an appearance, this time in more significant amounts. In the water area, where the brightest white paint is found, there are approximately equal amounts of zinc and lead in the volume of paint analyzed. Since XRF results are not limited to the surface of the of the painting it is possible that the zinc containing pigment is in the top layer of paint while the lead detected is in a lower paint layer or the ground. Consequently, the white paint could just as easily be a mixture of lead white and zinc white. It is difficult to tell without confirming with another type of analysis. It is also interesting to note that lead and zinc were detected in similar (substantial) amounts in the large white incisors of the bear's mouth, which consequently are thought to be a later addition to the painting. Under careful examination with raking light, small ridges detected along the bear's gums indicate that smaller teeth, filling the whole mouth of the bear, were painted out after the paint was dry.

Figure 28. Henri Rousseau, *Unpleasant Surprise (Mauvaise surprise)*, 1901. Oil on canvas, 76 5/8 x 51 1/8 in. (194.6 x 129.9 cm), BF281. The Barnes Foundation, Philadelphia, Pennsylvania. Image ©2014 The Barnes Foundation.

Further analysis with XRF indicated that in the water and sky Rousseau added streaks of Prussian blue, vermillion, and likely some earth colors to the whites. In these cases however, the zinc containing pigment was much less prominent in the mixture. In regards to Rousseau's greens in this painting, they correspond with the greens in the last two paintings analyzed, as does his use of black. Additionally, the dark cloaked figure was painted solidly with a mixture of bone or ivory black and Prussian blue, to create a deep blue color. The palette used to paint this work also expands beyond the addition of zinc; the yellow cloak in this artwork was brush applied with an earth pigment, most likely yellow ochre, and a number of the browns appear to be earth pigments darkened with bone black.

Of note is the fact that the artworks *Unpleasant Surprise* and *The Past and the Present*, or *Philosophical Thought* remained in the artist's studio for a time after each was painted. *Unpleasant Surprise* was painted and exhibited in 1901, is visible in a 1907 photograph of the artist in his studio, and wasn't purchased until 1909 by Ambroise Vollard (Rousseau 1909; Shattuck et al. 1985; May 2006). Likewise, *The Past and the Present, or Philosophical Thought,* a much more personal painting to Rousseau, was known to have remained in the artist's studio until his death in 1910. While one cannot be sure when these artworks were reworked, it is certain that Rousseau would have had plenty of opportunity to rework them many times throughout the years in which they remained in his possession, and likely with slightly different materials than he had used initially.

4. *Scouts Attacked by a Tiger* (1904)

The final Barnes Foundation painting that was analyzed is *Scouts Attacked by a Tiger* (1904) (fig. 29). This large canvas was prepared with an off-white oil ground. The ground, which is visible beneath cracks and losses throughout the canvas, does not extend past the paint edges to the tacking margins, suggesting that the canvas support was not commercially prepared. Analysis of ten points in the composition and the primed lining canvas used to support this painting was used to determine that the lining canvas was prepared with a lead white priming with a small amount of calcium, while the original ground layer was most likely prepared with a zinc white containing ground. A different ground material than had been found in the other paintings analyzed. Additionally, each of the pure white spots analyzed on the painting contained significant amounts of zinc. This includes the Scout's white robe and the bright white moon in the sky.

It appears that Rousseau painted this canvas in thick layers of medium rich paint. Using fairly small brushes, as evidenced

Figure 29. Henri Rousseau, *Scouts Attacked by a Tiger (Éclaireurs attaqués par un tigre)*, 1904. Oil on canvas, 47 7/8 x 63 3/4 in. (121.6 x 161.9 cm), BF584. The Barnes Foundation, Philadelphia, Pennsylvania. Image ©2014 The Barnes Foundation

by the width of strokes (average brushstrokes between 3/16 and 7/16 inches) in the painting. Based on XRF analysis it is estimated that the dark green leaves were painted in with a mixture of bone black, Prussian blue, and a small amount of chrome containing yellow paint. The blue sky, which is composed largely of zinc white and an unknown blue pigment, was then painted. In the figure of the scout on horseback, Rousseau then used small daubs of chrome containing yellow paint for the shoe and a mixture that appears to be predominantly a red lake pigment for the belt, which wraps around the figure's zinc white robe. It seems that Rousseau used a yellow earth pigment instead of a chrome containing pigment to achieve a pale yellow-green hue in the thick grass, however. Analysis with XRF supports that the more intense greens located in the stalks were completed using a mixture likely comprised of zinc white, Prussian blue, and chrome containing yellow pigment. Noticeably absent from this composition is the mercury containing pigment vermillion.

5. *La Sainte Famille (The Holy Family)* (1905)

The paint layers of *The Holy Family* vary between slightly thick and thin in application and are fairly flat with little impasto present. There are brushstrokes visible throughout the painting, particularly in application of the multiple shades of green paint of the foliage on the proper right of the canvas, in some instances in the figure of Mary's robe and in her headscarf, and in various areas of the figure of Joseph's robe. There are also several colors of paint that extend onto the tacking margins of the painting. This is partially a continuation of paint from *The Holy Family*, but in some instances appears to be from the painting beneath.

Analysis of *The Holy Family* with XRF revealed elemental spectra that implied use of a chrome containing yellow in each of the pure yellow spots analyzed, Prussian blue in the blue and in mixtures to create green, vermillion in the red of Joseph's robe and as an additive to dark green paint,[8] cobalt violet in Mary's drapery, and varying amounts of lead white and the element zinc (likely corresponding to zinc white) throughout the painting. While cobalt violet has not been observed in any of the paintings described above, the uses of the other pigments listed correspond closely with those used by Rousseau, particularly for those paintings reworked or painted around 1900 and after.

3.6 PIGMENT SUMMARY

While it is impossible to make definitive assumptions based on only a handful of paintings, given the analysis of the works above a trend involving the use of zinc white paint in Rousseau's later works is observed. It appears as if either Rousseau, or possibly his paint sellers unbeknownst to Rousseau, added a zinc containing pigment to his palette sometime around the year 1900. While this does not indicate that all paintings by Rousseau painted after 1900 use a zinc containing pigment, as is evidenced by recent findings at the National Gallery of Art in Washington, DC[9] (Krueger 2010), thus far any paintings painted by Rousseau prior to 1899 do not contain zinc-containing pigments. As further information becomes available a definite statement about Rousseau's use of zinc containing white paint, may be able to help researchers better date some of his artworks and help to further clarify those with ambiguous attributions.

CONCLUDING REMARKS

This body of research was initiated as a simple inquiry into one painting, but out of necessity became something much broader. Throughout the coarse of examining *The Holy Family* it was realized that the type of examination and analysis of paintings by Rousseau that was sought for comparison, simply wasn't available because it had not ever been conducted. This was unfortunately the case, more often than not. Perhaps it was because this type of close looking at materials and technique might challenge how people think of Rousseau, or perhaps it is because for so many years people have focused on the imagery in his paintings? Regardless, it was encouraging that many seemed willing and even excited to contribute to a body of research focused on how Rousseau painted, as witnessed by the collaborative efforts that supported this paper and the fall 2010 symposium at the Menil Collection.

So, is *The Holy Family* a work painted by the hand of Henri Rousseau? While it cannot yet be unequivocally stated that *The Holy Family* is by Rousseau, it is the belief of this author that there is evidence supporting the attribution. But the message in this paper is hopefully much broader than that. Generally speaking, there is movement towards a different understanding of Rousseau. From his process of working in layers, defining foliage, and defining shapes with the contour of his brushstroke, to making significant changes, at times even on top of varnish, through examination, scientific analysis, critical thinking, and close looking, much has been learned on the broader topic since 2009. And perhaps, as in the case of *The Holy Family,* as well as that of Henri Rousseau, much has also been reinforced regarding the merit of looking at things from a slightly different perspective.

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ENDNOTES

1. "sk.4221" is written on the inventory card for *The Holy Family* contained in the Rosenberg Gallery archives. Elaine Rosenberg stated that this type card likely indicates the painting entered Rosenberg's inventory no earlier than 1925.
2. Although the nature of their partnership is not clear, evidence suggests that Rosenberg and Wildenstein were working together during the sale of *The Holy Family* to Paul Hyde Bonner.
3. 21 rue de la Boétie, Paris is the address most associated with Paul Rosenberg between 1908-1940.
   Close examination of jungle paintings in the 2010 Exhibition "Henri Rousseau" at the Fondation Beyeler, Basel, Switzerland revealed numerous examples of this painting technique.
4. The XRF spectra revealed a significant amount of calcium (Ca) in the presence of trace amounts of phosphorus (P) in areas mixed with black pigment.
5. Estimated based on the detection of significant amounts of iron (Fe) present with trace amounts of potassium (K). No barium was detected in the spectrum to indicate barium chromate.
   Under examination with a stereomicroscope, scattered red pigment particles are visible in areas of dark green paint.
6. XRF detected only minor amount of zinc in The National Gallery of Art's paintings *Equatorial Jungle* (1909) and *Tropical Forest with Monkeys* (1910).
7. No barium was detected in the spectrum to indicate barium chromate.
8. Under examination with a stereomicroscope, scattered red pigment particles are visible in areas of dark green paint.
9. XRF detected only minor amount of zinc in The National Gallery of Art's paintings *Equatorial Jungle* (1909) and *Tropical Forest with Monkeys* (1910).

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PHOTOGRAPHIC CREDITS

All the photographs of Menil Collection paintings contained in this article were taken by the author and are property of the Menil Collection, Houston, TX.

AUTHOR

Katrina A. Bartlett
Andrew W. Mellon Fellow in Painting Conservation
The Menil Collection
1511 Branard St
Houston, TX 77018

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PER KNUTÅS

When You Come to a Fork in the Road, Take It: Two Directions for the Conservation of an Anselm Kiefer

ABSTRACT

An Anselm Kiefer was damaged during transportation in 2004. The damage included a loss of a 25 by 15 in. lead component, found crumbled in the bottom of the crate. The reattachment of the lead sheet relied on a series of images from two different exhibition catalogs. The discrepancy between two previously recorded states of the painting, neither of which was the original presentation appearance, presented the major conservation challenge. Within the context of Kiefer's broad acceptance of physical evolution of his art, the conservation challenge was how to decide which of the three states to present; the two documented or the undocumented original, and to build a framework of treatment around this.

The paper will discuss the treatment and the considerations leading to the final outcome of a comprehensive treatment of a severely damaged and compromised Anselm Kiefer diptych painting. The treatment concluded in 2004 at the Intermuseum Conservation Association (ICA) in Cleveland, Ohio. The project appeared seemingly straightforward until the history of the painting unraveled itself and logistical circumstances imposed by the owner further complicated the conservation treatment decision-making process.

The owner was adamant about not being involved; nor did he want the ICA to contact the artist. For conservators working with contemporary/modern art, contacting the living artist is often among the first steps, especially when the artwork is as severely damaged as this painting was. The owner asked us to leave his name as well as the title of the painting out of the discussion. So during the paper neither will be revealed.

The painting, completed in 1986, is comprised of two large canvas panels hung side by side and together measuring approximately 12 feet tall by 18 feet wide. The painting is attached to a seven-member wooden strainer with one vertical and two horizontal crossbars. The strainer is custom made for the artist with each of the seven strainer members being fabricated out of two strips of fortified dimensional lumber glued together to create stock that measures 1 ½ by 3 ½ in. There are cleats attached to the lower horizontal crossbar as well as the upper member to support the weight of the artwork when being mounted on the wall. A plywood panel, measuring approximately 1/2 in. thick by 14 in. wide, was inserted between the reverse of the canvas and the strainer to support the attachment of steel objects that are screwed through the face of the canvas and into the wooden framework below. The materials are acrylic paint, emulsion, shellac, gold leaf, asphaltum, ash, straw and lead as well as two large steel objects mounted on the painting by cleats.

The painting is from a period in Kiefer's life when esoteric allusions, German post-WWII guilt, the Holocaust and alchemy were embedded in his work. The transmutation of the artist's material is a central component of his work. Materials are chosen to give off energy, either by being changed from hot to cold and from liquid to solid. By burning straw, melting lead, charring the surface and paint with hot torches, the transformation of the material creates a surface embodying the spirit of alchemy, a keen interest of the artist.

The working methodology and the process were not immediate. Albert Albano, the executive director of the ICA, was instrumental to the understanding of the creation of Kiefer's work from the mid-1980s to early 1990s producing a comprehensive study of Kiefer's working methodology and preservation concerns. In it he writes "He worked only on the paintings he felt intuitively drawn to at the moment" and that at the time of Albano's visit some "paintings had been with him for as many as 12 years" (Albano, 1998). In this process the painting is intentionally scarred by his reduction of material by physically altering the surface with heat, or simply tearing and scraping material from the canvas.

Art historian Mark Rosenthal, who had mounted the first comprehensive four-venue Anselm Kiefer retrospective exhibition in the United States in 1987-1988, discussed this particular work with Kiefer and reported that, "He first created a landscape painting, then covered large areas with hot lead and more paint. Several months later, he peeled off a good deal of the lead taking color away and leaving patches and partly pulled up other sections of lead revealing colors on the underside as seen in the upper right. The effect is of skin that has been violently torn away in a fetishistic or even maniacal activity." (Rosenthal, 1987)

The painting was sold at an auction in 2004 to a private collector. The painting was then transported to the Artex Storage facility by a non-art specialized moving company. It was damaged during transit as a result of poor packing and shipping. Upon arrival conservators at Artex examined the piece. They notified the owner that the piece had been damaged. The owners insurance company contacted the ICA in 2004 upon recommendation by Mark Rosenthal. His recommendation was based not only on Albert Albano's intimate knowledge of Kiefer's working methodology but the fact that Albano was the last conservator to condition check this piece prior to it's sale.

Prior to the auction, the piece had been found to be in an excellent state of preservation. After the damage it was Mr. Albano's assessment that given the degree of intervention necessary to properly conserve/restore the painting, it would be necessary to transport the artwork to the ICA's center for treatment. Only the severely damaged panel, the right hand panel, was transported.

Albert Albano and Per Knutås traveled to Artex to prepare the painting for safe transportation to Cleveland. Upon arrival, we found fragments of asphaltum, lead, and pigment at the bottom of both crates. Even more disturbing was the discovery of a large detached crumpled section of lead approximately 25 inches long and 15 inches wide, at the bottom of the crate of the right hand panel. This piece of lead had torn away from a large form in the center of this panel and had been severely distorted by the impact of the fall.
After assessing the travel frame used for the transportation of the painting to Artex it was necessary to alter and improve it to create a more appropriate and substantial structure to avoid any additional stress to the precariously attached components on the painting.

The previous shipping method, by riding the painting on its side without any support for the lead, created tremendous stress on the paint layers and on the attached lead elements. The lead sheeting had minimal points of structural adhesion, therefore we designed an additional support system for the lead components by adding three extra wood cross braces where the need for support was most critical. Mr. Albano and Mr. Knutås cut pieces of medium density Ethafoam, with exact fits and attached them to the braces to support the weight of the lead. An additional concern was the sagging and compression of the lead. To prevent the lead from collapsing on itself, the conservators added slings of soft cotton fabric, cotton twill tape and Tyvek for additional support. The cotton slings were attached to the front of the cross braces with staples. Extensive photo-documentation was also taken to be able to gage any movement of the lead elements after transportation to the ICA.

To further reduce the impact of the weight of the lead an A-frame was employed to support the travel frame in the truck while being transported. The large section of lead that was torn from the canvas during the transportation to the Artex facility was attached to a custom mount made by Artex conservation staff to prevent further damaging distortions from occurring. Upon arrival in Cleveland the condition of the painting had not changed significantly during travel. Minor local compression of the lead was noted by comparing the photographic documentation but nothing that compromised its condition.

At the ICA the painting was placed flat and face up to be able to work on the lead and the lifting paint. Large squares of ethafoam were placed in between the strainer/crossbar members to prevent drooping and permanent distortions of the support. To examine and work on the painting the conservation support staff at the ICA constructed a bridge on wheels over the painting to allow the conservator to lay on the bridge while working on the painting.

Given Kiefer's working method of scarring and peeling back areas of the media, there were many areas of lifting materials.

The initial conservation focus and task was to assure that the painted surface components were stabilized without compromising Kiefer's acceptance of scarred surface layers. Intentional lifting paint and lead pieces not at risk were not set down. A consolidation was performed with Jade 403, undiluted with a fuller body, to consolidate and secure loose paint without having to alter the paint layer. The adhesive acted, in this case, as filler for the space between the loose paint/ asphaltum/ lead layer and the support, as well as a consolidant.

Where shape and texture acted as clear indicators of location, detached fragments were returned to their exact location. In other areas, the reattachment of displaced larger lead fragments could not be determined by the typography of the surface but rather had to depend on tonal value, texture and shape for reference. These fragments were only returned to the surface when the result presented a visually balanced appearance.

After the complete consolidation and reattachment of small lead fragments, the focus was on the positioning and flattening of the larger lead component.

After a thorough search it was concluded that there was not any photographic documentation of the painting immediately prior to the damage. Two photographs of the painting were found in the exhibition catalogue published in 1987. This book included two pictures of the painting, one overall, that proved to be from the time the painting was completed and a close-up detail, fortunately, of the damaged area.

The detailed area proved to have a vastly different in appearance from the overall photo and therefore is presumed to document an alteration. Instead of a softly folded-over lead component, the detail presents three lead elements, a gentle fold, a completely detached and reattached section, and a folded lead tube in the center. The presence of these two images within the same catalogue, gives support to Kiefer's acceptance of change within his work.

Furthermore, it is known that the painting was included in the four-venue, cross-country exhibition arranged by The Art Institute of Chicago and Philadelphia Museum of Art. It is also known that change kept on happening during the course of the exhibition. At each venue of the exhibition, Kiefer traveled with his assistants, helping with complex installations as well as "repairing" or reattaching disfigured or dislodged pieces. Evidence of this process can be seen on this painting. Five different staples was found on the surface (copper staples and stainless steel) and three different kinds of silicone adhesives (grey, glossy black and red) most likely attesting to the attention of Kiefer's assistants during this period.
A project that appeared straightforward had suddenly taken a sharp turn. The conservator was now confronted with the dilemma of three options, each with a different set of ethical considerations.

The first option would be to bring back the painting to the 1986 appearance, arguing that this would be the appearance of the painting when it left the studio. Second option would be to create the appearance of the detail appearing in the exhibition catalogue, since this is the best documentation available and at this point in the discussion proved to be the last state of appearance of the torn off lead section.

At this point, it was not clear to what degree the torn off lead component could be reshaped to pursue any of these options. The large detached lead sheet was severely altered when it was torn off the canvas. Small areas were tested with heat, complemented with mechanical modeling in an attempt to determine how feasible it would be to return them to earlier appearances. A larger area was tested for the safest way of reshaping the lead without creating ruptures and cracks. In the areas of oxidized lead the most effective method of remodeling was to work in small areas and bend the warmed lead in increments, working over the surface, bending the lead sheeting little by little until the lead was sufficiently flattened.

Continuing this investigation, the reshaped lead was positioned on the painting to aid the decision making process of what path to follow. The lead fit perfectly on the canvas; however there were two areas of lead that had been attached to the canvas by Kiefer or his assistants at some point to accommodate the large lead sheet when it had already moved from its original configuration. One of the areas was attached with a red silicone adhesive slightly to the right of the larger lead section and the second area was a ball of disfigured lead, crumbled up and adhered to the surface with grey silicon adhesive. This ball of lead was not visible on either of the available photographic documentation and did not correspond to the two previous versions of the lead positioning. Questions and further research into photographic material proved fruitless. Consequently, this implied the existence of a third undocumented positioning placement of the lead, possibly the appearance of the painting prior to the current damage. The treatment options had to be reviewed, but now with an additional third option.

The first option was to recreate the appearance of 1986 which would entail the rejoing the fragments to one piece of folded over lead. With this option the treatment would be slightly more invasive, including patching or soldering the lead back to one sheet. At this point we had a large sheet of lead and two smaller 4 by 5 in. fragments that would have to be assembled into one piece.

The second option would be to follow the appearance of the detail illustrated in the catalogue from 1987. This option would be less invasive, however, the detail included a tube shaped component, which was no longer present.

The third option would be to attach the flattened lead component on top of the newly found, crumbled up ball shaped lead component and create an estimated appearance, based on the knowledge of Kiefer's interest in transformation and change approval.

So what would be the best practice and the most informed path forward? After collecting as much information available, and with Mr. Albano's intimate knowledge and expertise in Kiefer's preservation philosophies the last option was ruled out. The intervention would be too great and the outcome would in comparison to the other available options, include a freer interpretation of the appearance, resulting in a less true outcome.

The first and the second option was discussed, and the further the issues was discussed the clearer the answer appeared to be. The first option would be too invasive creating an unsupported fold and at this point there were still question marks whether the lead would be structurally sound enough to withstand future travel. Weeks could be spent recreating a section that could potentially fail on the return to the owner.

The second option presented itself as the best and most viable option based on the structural integrity of the lead component. This option also provided the best documentation of a previous appearance with massive blow up of the detail and an alteration previously approved by Kiefer. This would also be the image that curators, registrars, conservators and other related professionals would revisit. By recreating this area, it was felt less confusion and questions would be raised.

The lead was shaped to resemble the lead-sheeting configuration in the 1987 illustrated photograph and placed on the painting. In order to correctly fit the larger lead component the ball-like shaped lead had to be removed and repositioned. This ball shaped section was adhered to the surface with a grey silicon adhesive. The ball shaped lead was removed from the surface by gently peeling away the silicon from the surface. Only a minimal amount of pinpoint paint fragments were adhered to the silicone. In addition, the silicon glue was removed from the lead piece and the piece was flattened. The removal allowed a more precise fit of the larger lead component and when the second smaller lead component was positioned about four inches above and away from the larger sheet it became evident that this was a piece originally attached to the larger lead component.

Meanwhile, the tube shaped element identified in the 1987 detail photograph, was thought to be lost or discarded. Upon closer examination it was discovered that the unraveled ball shaped lead was indeed this missing piece. Mr. Knutås reshaped the lead to resemble a tube according to the existing photographic documentation and positioned it on the canvas in its proper place. The result was very successful. After selecting the positioning of the larger lead component, Mr. Knutås decided to move the second smaller piece adjacent to the larger lead piece where it originally had been attached. After laying out all three pieces and finding the result astonishingly resembling the detailed photograph, a variety of different approaches were discussed to determine a way to safely re-adhere the large and heavy lead components.

All the usual conservation adhesives presented shortcomings and after much deliberation Kiefer himself presented the answer. Kiefer's preferred adhesive to attach lead is silicone. California has Silicon Valley, Ohio has Polymer Valley, a half an hour south of Cleveland. A silicone adhesive specialist, David M. Brassard, with Silicon Solutions was contacted to develop a silicon adhesive that would have the desired properties for the restoration. In discussions with Mr. Brassard, viscosity was a concern. The desired consistency of the silicon was to have a body that would flow appropriately, and readily conform, yet have a sufficiently firm structure when dry. The working time was also of concern, a quick setting, less than an hour, was not desired. The tensile strength had to be high, well over the actual weight of the lead. The lead weight was calculated, and the tensile strength was set at least 60% above the actual weight of the lead. A custom order of six tubes of silicone adhesive was ordered, three tubes with a color matched to the dark grey in the painting and three tubes to match the ochre colored areas of the painting. The two could be mixed to achieve a closer match if needed. Even though the silicone adhesive was not going to be visible, some areas of lifting lead had perforations showing the ground below. If the adhesive were to be applied in an area with these features, the adhesive would blend with the surrounding paint/lead/asphaltum.

The silicon adhesive was applied with a spatula and brush onto the canvas and along the perimeter of the lead sheet after positioning it in its location. The folded lead, still attached to the painting had a large crack that severely compromised the structural stability of the piece. The metal conservator at the ICA, Mark Erdmann, worked on the crack in the lead and also examined the full piece to ensure that there were no other structural failures. The area was soldered with minimum flow and left a thin shiny surface in the area of the crack. The shiny surface was inpainted with Gamblin Conservation Colors to blend with the surrounding lead.

The first viewing of its condition was an immense shock, given that the last condition evaluation of the painting was at the auction house, before any damage had occurred, and at that time it was in an excellent state of preservation.

The nature of the damage to the lead sheeting was of special concern, specifically the degree to which the large section of folded lead sheeting had dislodged and separated from its canvas support.

This terribly contorted, quite large component of lead, offered the gravest uncertainty for determining its degree of remaining structural integrity, and the degree of residual pliability it retained, given the varying and precariously thin sections throughout its structure. This severe condition was compounded by the incurred stress it had sustained from the fall, and thus its ability to be safely reconfigured to a semblance of its original conformation, let alone an exact duplication of that conformation.

In conclusion, the most significant issue about the painting's physical state was resolved through long conversations and research into Kiefer's intent and preservation philosophies. As stated in previous research, Kiefer is not opposed to his work changing, in fact, he welcomes the transformation of his work, very much in keeping with the desired transformation his choice of materials are taking during his working process. However, the complete loss of the lead was determined to be too drastic a transformation, and with the information in hand, the need to proceed seemed too obvious to ignore. The extensive conservation/restoration campaign conducted on the painting was an overriding success, and has exceeded all initial expectations given the assessed condition of the painting upon initial evaluation.

Often we don't know the full path forward when we embark on a treatment. The process is more organic and adaptive, responding to the information the object reveals to us in the course of treatment. It is of utmost importance to constantly seek alternative paths to our treatments. Sometimes the hardest issues facing us can be to decide the path forward.

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SUPPLIERS

Silicone Solutions.
1670 Enterprise Pkwy # C.
Twinsburg, OH 44087-2270

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AUTHOR

Per Knutås, studied Arts & Crafts studies in Malmö, Sweden, Anthropology at the University of Lund, Sweden followed by Conservation & Cultural Heritage at the University of Gothenburg, Sweden. This led to advanced studies in conservation in Denmark. He graduated with a degree in Paintings Conservation from the Royal Danish Academy of Art, Copenhagen. In 1998, he moved to New York to work in the conservation laboratories at the Guggenheim Museum and the Museum of Modern Art. After four years in New York, Mr. Knutås moved to Ohio to work for the Intermuseum Conservation Association in Cleveland, followed by contract work at the Cleveland Museum of Art, and Chief Conservator at the Cincinnati Museum of Art. Prior to moving to the United States, Mr. Knutås worked at the Moderna Museet, and the Swedish National Heritage Board, both of which are in Stockholm. He is currently the Chief Conservator at the Cleveland Museum of Art.

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MARY GRIDLEY

Choices Post-Mortem in Joan Mitchell's Work: Cropping Paintings

ABSTRACT

When cropping a previously un-stretched painting after an artist's death, factors such as the artist's signature elements, extant examples and informed critical judgment must be factored into the decision-making. The American abstract painter Joan Mitchell (1926-1992) painted on canvas stapled to the wall early in her career. Upon her death a trove of these early works, which had never been stretched up, were divided between two main beneficiaries. The gradual conservation and presentation of these works over the last twenty years, and the necessity of establishing methodologies for their cropping, provides an opportunity to examine some of the criteria used in deciding where the edges of a given painting should be. Cropping paintings after an artist's death is not a unique situation, and this paper postulates a methodology, discusses approaches taken by the beneficiaries, and offers the reader a chance to visually compare and ponder the similarities or differences resulting from different approaches.

INTRODUCTION

As conservators, we make decisions all the time: not only about the overall course a treatment will take, but minute by minute as we adjust swab pressure or add a little red to the retouch mixture. And while all these small decisions can add up to one very changed painting, as we travel through the treatment, the choices seem organic, even intuitive. But sometimes our profession requires us to make or participate in making some big decisions right up front. This paper is an exploration of one such situation.

The issue at question is: absent the artist, how does one crop, frame or impose a composition on paintings that have never been stretched before? This has been the challenge presented by a cache of Joan Mitchell's early paintings, and its resolution has been an on-going process since her death 20 years ago. Mitchell (1926-1992) was an American artist working in the style commonly referred to as Abstract Expressionism, although she herself disliked that shorthand appellation. However, the term is well enough understood to give the reader a fairly general idea of her style of painting. Like her contemporaries, Mitchell's early painting life took place in the gritty, impoverished, but artistically fruitful post-war period. Occupying a series of temporary studios, Mitchell's technical practice at the time was to paint on canvas stapled to the wall (a practice that ceased when she acquired a permanent studio in 1968), and since many of these paintings were never stretched up, the need to make compositional editorial decisions forms part of the treatment of these early works as they have emerged from her estate over the last 20 years.

This requirement to crop post-mortem is not unique to these Mitchell works. It has occurred and continues to do so as part of the estate management of several of her contemporaries; abstract expressionists or color field painters for whom the physical process of painting involved non-traditional approaches and large swathes of un-stretched canvas.

A well documented example of stepping in after an artist's death to make cropping decisions involves the color field painter Morris Louis. His staunchest supporter, the art critic Clement Greenberg, was named as advisor to the painter's estate and in that capacity for 10 years or more made all the decisions about how these previously unseen paintings should be cropped (figs. 1, 2). Greenberg was criticized from all sides for this, but no one else seemed willing or able to take on the responsibility. One memorable anecdote describes Greenberg standing on the ramp at the Guggenheim Museum, New York, as works were unrolled below him, deciding where to make the edges of the paintings in preparation for the Memorial Exhibition of Louis's works at that museum in 1964.

Figure 1. Morris Louis, *Untitled*, 1958, Magna acrylic resin on canvas, 8 ft 5 in x 11 ft 6 in. (265.5 x 350.5 cm.), Collection Mr. and Mrs. David Mirvish, Toronto. ©1958 Morris Louis

Figure 2. Marcella Louis (left), James Lebron (far right) and others choosing paintings for Morris Louis exhibition, c.1970

Similarly, the recent founding of a museum dedicated to the works of Clyfford Still in Denver, Colorado, has meant that the conservators responsible for the artist's estate are unrolling paintings which have spent twenty years in storage and trying to decide which of multiple previous stretching marks should be honored and, where none existed, devising a methodology of selecting fold lines that would present a composition that expresses Still's aesthetic (fig. 3).

When an artist's estate is divided between multiple heirs, different approaches can be formulated by each group, in which case different ethical aspects can take precedence. For example, opposite but equally viable approaches have been taken by The Mark Rothko Foundation directors and Rothko's heirs when determining how to treat his late works

Figure 3. Unrolling a Clyfford Still painting, 2009. Courtesy of ARTEX Conservation

on paper. The former opted to keep the white margins, with all their evidence of process (fig. 4), whereas Rothko's children opted to treat those works as Rothko himself had done in his lifetime, cropping them so that the color fields would float in colored space, referencing the signature borderless aesthetic of the majority of his work (fig. 5).

Whether done by an individual or by consensus, whether by heirs, foundations, critics, dealers, fellow artists, studio assistants, conservators, or art handlers, decisions that fundamentally inform how we look at and intuitively experience an artist's work sometimes have to be made post-mortem.

This paper is an attempt to tease out the threads of how such decisions are made. Joan Mitchell's working method, critical and commercial success, as well as her death and the subsequent dispersal of her artworks has brought us to a place where the 'artist's intention' is parsed and filtered through various sensibilities.

Joan Mitchell in the 1950s and 1960s

STUDIO LIFE

Joan Mitchell moved to New York City in 1947. In her first 10 years in the city, she occupied several small studios in Brooklyn and in Manhattan below 14th Street. She also spent time in Paris, and from 1956 to 1968, had successive studios there, one of which she kept as late as 1974 (figs. 6, 7). Her peripatetic life during those years had a direct bearing on her painting technique at the time.

In 1968, her mother died, leaving her a small legacy, which she used to buy a house and studio in Vétheuil, south of Paris. This would be her permanent home until her death in 1992 (figs. 8, 9).

Figure 4. White border showing process. Mark Rothko, *Untitled*, acrylic on paper, 1969, 72 x 46 in. image (182.2 x 116.8 cm), 74 5/16 x 48 5/16 in. sheet (188.7 x 122.7 cm), (1 ARC. 69). © 2003 Kate Rothko Prizel & Christopher Rothko / Artists Rights Society (ARS), New York

Figure 5. Trimmed border reflecting artist's painterly aesthetic. Mark Rothko, *Untitled*, 1968, acrylic on paper mounted to Masonite, 24 1/16 x 18 1/16 in. (60.9 x 45.7cm) (1295.68). © 2003 Kate Rothko Prizel & Christopher Rothko / Artists Rights Society (ARS), New York

Figure 6. Joan Mitchell and George, c. 1952-53. Photo by Walt Silver

Figure 7. Joan Mitchell and her Skye terriers, Rue Frémicourt studio, Paris, c.1958-60

Figure 8. Joan Mitchell's studio at Vétheuil. Photo Jean Fournier Gallery Archives, courtesy Lennon, Weinberg Inc., New York

Figure 9. Joan Mitchell's studio at Vétheuil, 1991

Figure 10. Joan Mitchell at work, St. Mark's Place studio, 1956. ©2011 Estate of Rudy Burckhardt / Artists Rights Society (ARS), New York

The studio in Vétheuil allowed her to paint on a larger scale. But more importantly, it enabled a fundamental change in her working technique. While in her early years Mitchell always painted first and stretched the canvas up later, after 1968, she ordered her supports pre-stretched and primed from Lucien Lefebvre Foinet in Paris, and had them delivered in batches.

The un-stretched paintings that remained after her death can therefore all be dated to the early years—the 1950s and 1960s—years when Mitchell's working method was to buy rolls or large pieces of pre-primed canvas, cut them up, staple them to the walls and paint. Photographs taken at the time give a vivid image of Mitchell's studio life where she is vigorously at work painting against the wall, or surrounded by canvases of all sizes, some stretched up and others not (figs. 10, 11).

CRITICAL AND COMMERCIAL SUCCESS

Mitchell was successful from early on, showing and selling regularly from 1950 onwards, and she maintained relationships with dealers and museums throughout her life (figs. 12, 13, 14). But the number of works she painted during this period was far greater than the number ever shown or sold. It is known that she rolled up early, unsold paintings, hauling them from studio to studio and storing some with various dealers. She refers to this in a letter of 1974 to her then New York dealer, Xavier Fourcade. Written just before the demolition

Figure 11. Joan Mitchell portrayed in Life Magazine, Rue Daguerre studio, Paris, 1956. Photo by Loomis Dean

Figure 12. Installation view, Joan Mitchell's first solo show, The New Gallery, New York, 1952

Figure 13. Installation view, Joan Mitchell's mid-career retrospective, The Whitney Museum of American Art, New York, 1974

of the last studio she had in Paris, which she had kept as a Paris base while in Vétheuil. Mitchell wrote: "The fucking demolition of Frémicourt, moving moving, trying to find a place to put rolls of paintings, books, poems, letters, dogs in heat have kept me from painting the way I would like to Paint."[1]

After her death in 1992, the majority of Mitchell's own artworks, including these early works, passed either to the foundation that bears her name, or jointly to two heirs who had been with her acting as general assistants and companions in her last years. It was at this point that the unsold paintings from the early years were brought out from the basement where they had been stored (referred to as the dungeon or cistern) tightly rolled face in, in bunches of three to eight and shoved into long narrow cardboard boxes. After the rituals

Figure 14. Installation view, Joan Mitchell's Grand Vallée show, Galerie Jean Fournier, Paris, 1984. Photo Jacqueline Hyde

of probate had been worked through, the gradual sorting, conservation, showing, and sales of these works commenced. It was left to her beneficiaries and the galleries she had long relied upon to establish a protocol for the conservation and formatting of these paintings. (Although there are often other condition issues with these works, they are not relevant to the current discussion).

Framework for a Decision

It is helpful to break down the process of how and where to establish a painting's edges into some manageable points for discussion. Broadly, one can consider three areas of contributory knowledge: 'look,' 'evidence,' and 'judgment.' The categories are somewhat arbitrary, but serve as a convenient way to frame a discussion.

'LOOK'

To start with the first of the three touchstones: what is the 'look' of a Joan Mitchell painting? What should be our benchmarks? Are there recurring themes or colors or formats? Was her work consistent from 1948 to 1968 or did it change? If so, how did it change, dramatically or subtly?

Mitchell was a landscape painter in the sense that she was inspired by and brought to the canvas the colors and shapes around her. What she observed in nature was filtered through her mind and arm, and she developed a highly personal and gestural vocabulary of brushstrokes, sometimes with heavy, wet and dense paint and sometimes with dry and airy marks (figs. 15,16). Her artistic concerns, aside from color and gesture, were often with the figure/ground relationship. The relationship between center and edges shifted from work to work and it shifted across time. Consequently, there are points

Figure 15. Joan Mitchell, *Grand Vallée XIII*, 1983, oil on canvas, 100 x 79 in. (254 x 200.7 cm). ©Estate of Joan Mitchell

Figure 16. Joan Mitchell, *Calvi*, 1964, oil on canvas, 96 x 64 in. (243 x 163 cm). ©Estate of Joan Mitchell

in the trajectory of her painting life when she pushed the paint out to the edge of the canvas, and periods when she pulled it in.

The very early works, those from 1951–2, have an affinity with the work of Arshile Gorky and Willem de Kooning at that time, and are painted in shapes right out to the margins (figs. 17, 18). But this did not last long: for the next two decades, she experimented with the figure/ground dichotomy.

Towards the middle of the 1950s, Mitchell began to use white or light colored paint to create space at the edges of her paintings by whiting out earlier, darker brushstrokes (figs. 19, 20). By the end of the decade, she was both whiting out strokes and using bare canvas at the edges (fig. 21). And as the 1960s progressed, she became more confident, and the bare canvas increased while the use of light-colored paint as erasure decreased (figs. 22, 23).

However, she was anything but consistent. She could and did revert to density, sometimes pushing paint right out to the edges. But in other works she displayed an economy of gesture, laying the paint on with a lighter touch (figs. 24, 25). This changeable relationship between the edge and the center is where the tension of the composition is held, so it is important to have a comprehensive knowledge of her work from these decades and to acknowledge that tension when choosing where to make the edges. From a practical standpoint, this means that unpainted margins of previously un-stretched works can be interpreted as planned or as unplanned.

Because of Mitchell's working process, however, there are a few signature items, such as the 'arced' gesture or gestures that generally appear at the top center, and which act as a starting point for reading the painting. There are also drip trails at the bottom and often splatter marks and fingerprints at the edges, which are evidence of process (figs. 26, 27). Should they be considered as desirable parts of the painterly design; or do they detract from its coherence? They are certainly pentimenti

Figure 17. Joan Mitchell, *Untitled*, 1951, oil on canvas, 65 x 69 in. (165.1 x 175.3 cm) MI.14829. Collection of The Joan Mitchell Foundation. ©Estate of Joan Mitchell

Figure 18. Joan Mitchell, *Cross Section of a Bridge*, 1951, oil on canvas, 80 x 120 in. (203.2 x 304.8 cm). Osaka City Museum of Modern Art, Osaka, Japan. ©Estate of Joan Mitchell

Figure 19. Joan Mitchell, *City Landscape*, 1955, oil on linen, 80 x 80 in. (203.2 x 203.2 cm), unframed, Gift of Society for Contemporary American Art, 1958.193, The Art Institute of Chicago. Photography ©The Art Institute of Chicago. ©Estate of Joan Mitchell

Figure 20. Joan Mitchell, *Hemlock*, 1956, oil on canvas, 91 x 80 in. (231.1 x 203.2 cm). Whitney Museum of American Art, New York; purchase, with funds from the Friends of the Whitney Museum of American Art 58.20. ©Estate of Joan Mitchell

Figure 21. Joan Mitchell, *George Went Swimming at Barnes Hole But it Got Too Cold*, 1957, oil on canvas, 85 x 78 in. (215.9 x 200.7 cm). Albright-Knox Art Gallery, Buffalo, New York. ©Estate of Joan Mitchell

Figure 22. Joan Mitchell, American, 1926-1992, *Blue Tree*, about 1964, oil on canvas, 245.4 x 198.1 cm (96 5/8 x 78 in.). Worcester Art Museum, Worcester, Massachusetts, Museum purchase. ©Estate of Joan Mitchell

Figure 23. Joan Mitchell, *Untitled (Cheim Some Bells)*, 1964, oil on canvas, 84 x 78 ¼ in. (213.4 x 198.8 cm), CR# MI.5352. Collection of John Cheim. ©Estate of Joan Mitchell

Figure 24. Joan Mitchell, *August, Rue Daguerre*, 1957, oil on canvas, 82 x 69 in. (208.28 x 175.26 cm). Acquired 1958 The Phillips Collection, Washington, DC ©Estate of Joan Mitchell

Figure 25. Joan Mitchell, *King of Spades*, 1956, oil on canvas, 90 x 78 in. (228.6 x 200.7 cm). ©Estate of Joan Mitchell

Figure 26. Joan Mitchell, *Untitled*, 1958, oil on canvas, 97 ¼ x 86 3/8 in. (247 x 219.4 cm), CR#MI.7740. ©Estate of Joan Mitchell

Figure 27. Joan Mitchell, *Untitled*, 1960, oil on canvas, 98 x 80 ¼ in. (248.9 x 203.8 cm), CR# MI.10921. ©Estate of Joan Mitchell

of process and can conjure a vivid image of the painter at work, a small but valuable reminder of how active 'action painting' really was. However, they could also be considered as awkward elements that distract from the emphatic painterly marks.

'EVIDENCE'

Given the inconsistent relationship in Mitchell's works between the painted forms and the edges, can we look to existing works for guidance? There are many paintings from this period that have been out in the world, stretched up, for a long time. They are signed or are listed in show catalogues or were photographed.

Mitchell, with one known exception, signed and titled her paintings only at the request of friends or dealers. So it is safe to assume that if one is looking at a signed or titled painting from this period, it was cropped at least nominally under Mitchell's instruction or with her tacit approval. Other extant examples that can be used as references are paintings that have been illustrated in a catalogue or book published before 1992, or were accessioned by an institution or a collector prior to the artist's death in that year.

Anecdotal evidence points to the conclusion that Mitchell was not very invested in the cropping of her own paintings. She may have done it herself (she never employed studio assistants), or have left it to others: friends, gallery assistants, art handlers, framers, museum staff or conservators. It is possible she used Lefebvre Fointin in Paris (who is known to have provided mounting services for other artists, including Matisse), or James Lebron, who was the go-to person in New York for rolling, storing, stretching, and installing paintings for many of Mitchell's contemporaries. There is also the fact that some paintings, destined for a particular show, have suspiciously regular measurements, indicating that the stretchers were bought retail for convenience rather than special ordered for a specific composition. So when looking at existing paintings for guidance, it is worth remembering that the old examples we have may *themselves* have been cropped for convenience, without necessarily involving a rigid vetting process by the artist.

Evidence of a third kind comes from print sources. But to rely on published photos means to run up against the possibility of additional cropping done during the photographic and publishing process. As an example of this, figures 28a-d show the fictional progression of a (real) painting—from un-stretched to printed page—demonstrating how information vital for comparative purposes in a new cropping decision may have been excised from the versions printed in the catalogues and books we use as sources.

Having established that the stretching up of extant early paintings was done at least nominally under Mitchell's supervision, we also have to take into consideration that this was not an area in which she needed absolute control, or about which she held inviolable opinions. This leaves a fair amount of latitude for those who have inherited this task. So, how to make a judgment?

'JUDGMENT'

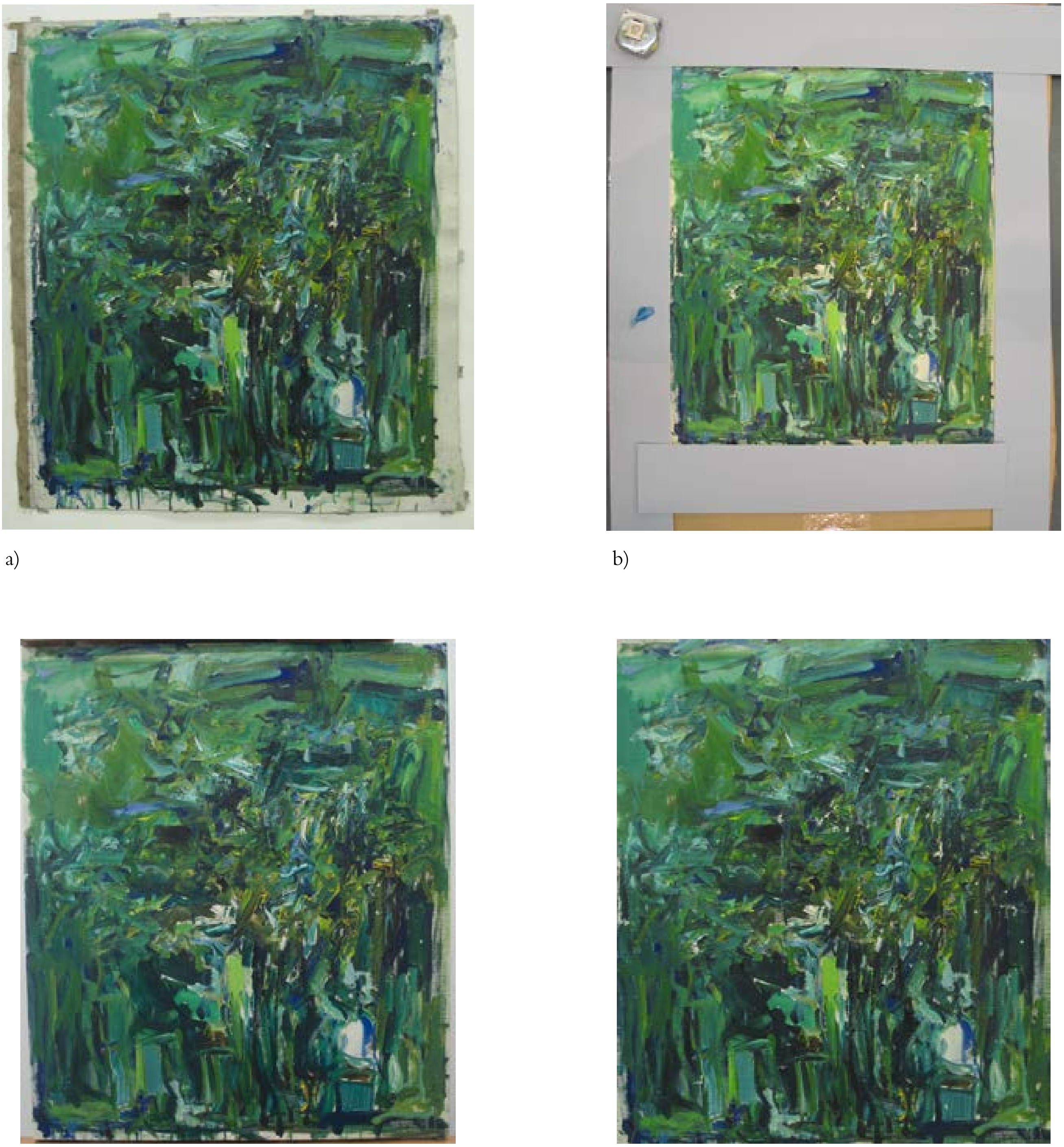
Looking at this last factor in deciding where a painting ends, judgment, we come up against the same lack of clarity that has plagued the previous two categories. The approach taken during the artist's lifetime, which might best be described as loosely articulated or random, will not be very satisfactory going forward.

Some kind of framework within which judgment can be rendered is needed. Some of the factors contributing to a decision will be the physical parameters of the work (how much spare canvas exists at the margins), a detailed knowledge of the artist's shifts and priorities, an aesthetic or ethical framework, and a little old-fashioned connoisseurship. Because of the dual nature of Mitchell's legacy, in which the majority of her estate went to the foundation which bears her name and a lesser number of works were left jointly to two beneficiaries, we have an opportunity to see how the application of these factors by thoughtful and sensitive people can be utilized to solve the problem in different ways, subtly weighting one or another of the criteria in each case.

Cropping A Painting

The paintings belonging to The Joan Mitchell Foundation, based in New York, were handled first by Robert Miller Gallery, and now by Cheim & Read Gallery, both in New York. Jill Weinberg, of Lennon, Weinberg, Inc. in New York, on the other hand, has always represented the heirs. In each case there is a continuity of involvement with Mitchell. John Cheim, before starting his own gallery, was the director of the Robert Miller Gallery, where one of his primary responsibilities was the organization of Mitchell's biennial shows. Similarly, Jill Weinberg entered Mitchell's orbit early on, when she began her art world career as an assistant to Xavier Fourcade, Mitchell's longtime New York dealer.

These personal relationships with the artist and her work, dating back twenty years or more, mean both Cheim and Weinberg have unique repositories of knowledge. In the sensibilities of these two people the categories of look, evidence and judgment cease to exist separately and instead meld to form that elusive gift of connoisseurship.



a) b)

c) d)

Figure 28. Joan Mitchell, *Untitled*, 1954, oil on canvas, 31.8 x 27 in. (80.7 x 68.6 cm). Private Collection, courtesy of Lennon, Weinberg, Inc. ©Estate of Joan Mitchell

a) Painting before stretching
b) Marking out the desired margins
c) Final stretching (note human error at bottom, where margin is wider than planned)
d) Cropped for publication

Both approach an un-cropped painting armed with a long memory of extant examples and both work with other experts to arrive at a consensus, but the slight differences in approach provide templates that can be illuminating for those of us trying to grapple with the issue. While the distinction between approaches is subtle, it hopefully provokes a re-examination of priorities for conservators, whose role in these matters is intellectually collaborative and supportive as well as actively hands-on.

Cheim and his colleagues, where appropriate, opt for what could be termed an 'inclusive' cropping, starting with signature elements like the characteristic arched brushstroke(s) at the top and retaining as much surface area of the canvas as possible while still maintaining a rectangle. The advantages of this approach include a clear set of guiding principles that favor the inclusion of marks, drip trails and other evidence of the act of making the painting, capturing some of the vigor and movement of the artist in action. This approach also allows for easier editing of the composition in the future, should it be deemed necessary (making a painting smaller is always easier than making it larger, from the conservator's perspective).

Jill Weinberg comes at the decision-making process from a different direction, which might be termed 'focused.' Her approach starts with the figure/ground relationship and moves outward to establish edges which frame that relationship in a way comparable to existing examples. More intuitive than structured, this approach aims at arriving at a suitable level of tension between the fore and backgrounds. Marks of process and areas of unpainted canvas at the edges are sacrificed if she and her colleagues feel that they detract from this tension/vision. The advantage of this approach is that is prioritizes the formal qualities of the painting as a composition, and what the process lacks in replicable standards it makes up for in internal integrity.

One could say that Cheim starts thinking at the edges and moves to the center, while Weinberg starts at the center and moves to the edges. It is a subtle distinction, and is perhaps rooted in personality and proclivity more than anything else. But in short, both approaches work. What is more, in deciding what to include and what to exclude, approaching the problem from either direction may lead to the same place in the end.

Working Examples

Three paintings that were treated at Cranmer Art Group have been selected for this paper to provide an exercise for the reader in looking at what each approach to cropping might mean for the painting. Although the paintings are real, some of the illustrations are only fictional examples of how the application of each set of criteria/guiding parameters might work in practice, and are meant to provide a set of images for contemplation of the issues and their possible resolutions. Each of the following three examples shows a painting before any cropping has been done (a), followed by two photo-shopped examples of the way the painting could look (b and c), and finally a photo of the actual cropping of the completed work (d).

The first example, *Untitled*, c. 1955, approx. 38 x 28 in. (figs. 29a-d), is a small painting which has a selvage edge at the top from the commercial priming process and is unevenly cut at the sides and bottom. There are several sets of staple holes in all four corners that tell us it is not a fragment. This and the number of fingerprints at the edges and on the reverse indicate that, typically for Mitchell, it was worked on over a period of time.

Figure 29b enables us to see what the painting would look like using an 'inclusive' approach, incorporating the arced gesture at the top, fingerprints and splatter marks at the edges as well as unpainted margins and as much canvas as possible. Figure 29c is a closer cropping of the work. This is the 'focused' approach. While it makes for a more charged and dynamic image, it eliminates some of the subtle marks of process and puts constraints on rethinking the dimensions in the future. Figure 29d shows the painting in its final, real incarnation.

Figures 30a-d provide another example on a larger scale. In this painting, *Untitled*, c. 1957–8, approx. 82 x 72 in., there are also staple holes, drip marks and the like, but because of the scale of the painting, they compete less with the overall design. Also, the airy nature of the brushwork and the expanses of white ground between the colored strokes will subtly affect the viewer's perception of the figure/ground relationship.

Figures 31a-d, *Untitled*, c. 1956–7, approx. 35 x 25 in., illustrate a denser, more heavily worked canvas on a medium scale, but one in which, because of the scale, density of paint, and rectilinear forms at the edges, the decision of where to make the edges will dictate whether the gestures are experienced as a form in space or a continuous expanse of color and shapes.

CONCLUSION

The very word we use to describe ourselves and our profession—Conservation—carries several meanings. Not only does it describe what we do for the art objects, but it also describes our natural and professional bias towards conservatism and caution in treatments and in approach.

a)

b)

c)

d)

Figure 29. Joan Mitchell, *Untitled*, c. 1956-7, approximately 15 x 28 in. (38.1 x 71.1 cm). Private Collection, courtesy of Lennon, Weinberg, Inc. ©Estate of Joan Mitchell

a) Painting before stretching
b) Wide cropping
c) Close cropping
d) Final cropping, 14 ¼ x 21 7/8 in. (36.5 x 55.6 cm)

a)

b)

c)

d)

Figure 30. Joan Mitchell, *Untitled,* c. 1957-58, approximately 82 x 72 in. (208.3 x 182.9 cm). Private Collection, Courtesy of Lennon, Weinberg, Inc. ©Estate of Joan Mitchell

a) Painting before stretching
b) Wide cropping
c) Close cropping
d) Final cropping, 77 7/8 x 68 1/4 in. (197.5 x 173.4 cm)

a)

b)

c)

d)

Figure 31. Joan Mitchell, *Untitled,* c. 1955, approximately 35 x 25 in. (88.9 x 62.2 cm). Private Collection, courtesy of Lennon, Weinberg, Inc. ©Estate of Joan Mitchell

a) Painting before stretching
b) Wide cropping
c) Close cropping
d) Final cropping, 34 3/8 x 24 ½ in (87.3 x 64.8 cm)

This is both our greatest strength and our greatest weakness, as it can feel uncomfortable to make big, bold, irreversible decisions up front. Yet we are also highly visually attuned, and should embrace the opportunity to bring our unique skill set to collaborations involving the historic and aesthetic qualities of the objects in our care.

ACKNOWLEDGEMENTS

My sincere thanks to Jill Weinberg and John Cheim, both of whom were extraordinarily generous with their time and insights; to my colleagues at Cranmer Art Group: Dana Cranmer, Christine Frohnert, Steve Norton and Michele Cramer; to our interns Kristin Robinson and Sophie Scully; and to Jen Dohne at The Joan Mitchell Foundation and Ellen Robinson at Cheim & Read Gallery for all their archival assistance.

ENDNOTES

1. Mitchell, Joan, letter to Xavier Fourcade, March 27, 1975. Xavier Fourcade Archives, courtesy of Lennon, Weinberg, Inc., New York

FURTHER READING

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Livingston, J. 2002. *The Paintings of Joan Mitchell*, New York, Berkeley, Los Angeles

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AUTHOR

Mary Gridley
Contemporary Paintings Conservator
Cranmer Art Group, LLC
45 Crosby Street
New York, New York 10012
E-mail: mary@cagsoho.com

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LANCE MAYER AND GAY MYERS

A Soluble Problem: Morse's *The Gallery of The Louvre*, Glazing, and Toning

ABSTRACT

Samuel F. B. Morse's painting *The Gallery of the Louvre,* is quite yellow, but much of the yellowing lies in thick, soluble glazes having a high ratio of medium to pigment rather than in a discolored overall coating. Previous attempts at cleaning resulted in damage and unevenness; the authors' treatment consisted of restoring damaged glazes and toning back areas that appeared too clean. The treatment serves as a springboard for the discussion of larger issues such glazing, toning, and how American painters wanted their paintings to look in the second quarter of the nineteenth century.

Figure 1. Samuel F. B. Morse, *The Gallery of the Louvre*, 1831-33, oil on canvas, 73 3/4 x 108 in. (187.3 x 274.3 cm), Terra Foundation for American Art, Daniel J. Terra Collection, 1992.51. Before conservation treatment.

Samuel F. B. Morse's large composition *The Gallery of the Louvre* (1831-33, Terra Foundation for American Art) has been considered, since its inception, among the most important paintings in the history of American art (fig. 1). Morse was President of the National Academy of Design at the time, and he believed that this painting would play a significant role in bringing European culture to America. Morse did not copy an actual arrangement of paintings in the Louvre, but rather selected and rearranged pictures that hung in different parts of the museum. Morse himself appears at the center of his composition, giving instruction to a student, just as he thought his painting would instruct Americans about European art. Art historians have debated and written about aspects of this painting for many years, including why Morse selected these particular paintings and arranged them as he did, and also why the painting was not as enthusiastically received in America as Morse had hoped. [1]

One can put the painting and its conservation treatment into context in several different ways. The authors have treated a number of portraits by Morse that were all much more conventional in terms of their construction. But Morse studied under Washington Allston, who was famous for his experimental techniques, and there is documentation that Morse himself experimented with unusual painting materials like milk and beer on some occasions. [2] Daniel Huntington, who became Morse's pupil several years after *The Gallery of the Louvre* was painted, connected Morse's technological inventions, such as the telegraph, with his inventiveness in art techniques. (Of course, the telegraph would eventually make Morse much more famous than his paintings ever had.) Huntington said: "[Morse's] fondness for experiment in natural philosophy manifested itself also in the domain of art. He was always trying different textures, vehicles, and methods.... When I knew him, he had his wires strung around his studio, and his chemical apparatus side by side with his easel." [3] This is only one of many connections between science and innovative American painting techniques in the second quarter of the nineteenth century; in the 1830s Morse was also involved in bringing to American the new art of photography, the most "scientific" branch of picture-making. [4]

In many cases a conservator can carefully thin a varnish and achieve a balanced appearance, even if the paint is soluble in the same solvent that would dissolve the varnish. [5] The authors initially thought this might be the case with *The Gallery of the Louvre*. However, when the painting was examined closely in the studio, and solvents tests were carried out under a binocular microscope, it turned out that much of the discoloration lies in the glazes that Morse used to carry out his modeling rather than in an overall varnish layer. The modeling of many of the dark shadows was done with glazes that are quite thick; these glazes are rich in medium and are very soluble. Analysis of the medium done by Professor Henry DePhillips of the Department of Chemistry at Trinity College, Hartford, Connecticut, showed a great deal of mastic resin in addition to some oil in the glazes. It is possible that the mastic was added directly to oil paint, but it is also possible that mastic was used in the form of megilp (megilp is mastic varnish mixed with drying oil beforehand to make a gel, which would then be added to oil paint). [6] Mastic may also be present as an intermediate varnish layer; a few years after painting *The Gallery of the Louvre*, Morse described to Thomas Sully his process of painting a copy after Rembrandt, which included an intermediate layer of mastic varnish followed by oil paint. [7]

The authors attempted to take cross-sectional samples, but the brittleness of the layers made sampling very difficult. Moreover, simply studying the surface with a binocular microscope and carrying out small solvent tests demonstrated very clearly what the situation was.

Unfortunately, there was just enough oil in the old varnish that remained on *The Gallery of the Louvre* to make the varnish difficult to thin easily. In small cleaning tests, at first nothing would happen, then more of the surface coating would dissolve than one might desire, and the glazes would start to dissolve as well. There was absolutely no discrimination in solubility between varnish and glazes.

Of all of the paintings that Morse copied in the Louvre, only one painted study has survived, a small painting on wood panel after the *Portrait of François I* by Titian (10 x 8 in. [20.3 x 25.4 cm], Terra Foundation for American Art). The authors had this study in the studio for reference when treating *The Gallery of the Louvre*. The study is not nearly as discolored as the larger painting, and it does not have glazes that are as thick, but the paint is very soluble, indicating that the study also has a great deal of resin mixed into its paint.

There was abundant evidence that conservators had gotten into trouble trying to clean different parts of *The Gallery of the Louvre* in the past. In fact, close examination showed that much more work had been done on its surface, in subtle and not so subtle ways, than the authors initially thought. This further complicated the treatment, because the old surface coating (or coatings) had been commingled with the glazes in many areas.

Morse copied the individual paintings using techniques that varied somewhat from one painting to another. The Rembrandt *Head of an Old Man*, for instance, shows the extensive use of translucent, brown glazes. Perhaps because this painting looked like it might be difficult to clean, conservators in the past had done very little to it. On the other hand, the painting by Guido Reni, *Dejanira and the Centaur Nessus*, immediately to the right of the Rembrandt *Head of an Old Man*, was a very different case (fig. 2). Morse appears to have painted the Guido Reni more opaquely to begin with, with fewer glazes than the Rembrandt, which may have led a previous conservator to focus on cleaning it, with unfortunate results. Even some of the opaque colors in this painting had been abraded during cleaning. The glazes that defined the shadows on the picture frames also had suffered badly in this area, as had the picture frames in many other parts of the painting. It is clear that Morse was not employing glazes

Figure 2. Detail before treatment, showing abrasion from previous cleaning.

Figure 3. Detail before treatment, showing uneven varnish removal and damage from previous cleaning.

Figure 4. Detail before treatment, showing how different paintings have been cleaned to different degrees.

Figure 5. Detail before inpainting.

simply to imitate the techniques of the old masters whose paintings he was copying; in addition to the picture frames, he defined the architecture of the walls, floors, and ceilings of the galleries of the Louvre using glazes as well.

Examination revealed that other individual paintings showed different kinds of damage. Many paintings, to varying degrees, have a spotty, uneven appearance caused by the varnish having been thinned unevenly (fig. 3). The lack of discrimination between varnish and glazes led to glazes being damaged as well. Equally disturbing was the fact that some paintings had been cleaned much more than others, throwing the relationship between these and neighboring paintings out of balance (fig. 4). In fact, the paintings that looked best were those like the Rembrandt *Head of an Old Man* and *Beggar Boys* by Murillo, which had been cleaned very little or not at all.

One of most important parts of the design is the long, central view down the Grande Galerie (fig. 5). This area has suffered in several ways. First, it is more yellow than other areas; it also has a great deal of badly discolored retouching from various periods. This is an area where the authors initially hoped that some thinning of the varnish might improve the appearance. But there were cautionary tales in previous attempts at cleaning that did not look encouraging. Especially in the right-hand side of the view into the Grande Galerie, some areas that had been locally cleaned looked very uneven, and there had been some damage to glazes and opaque areas of paint in this area as well. There was a great deal of very obvious darkened retouching in the floor, as well as unnaturally light areas in the floor that looked too clean, which also interfered with the recession of space.

One might ask why Morse used glazes that contained so much resin on this painting. Many painters at this time believed that the old masters had added varnish to their paint. Some Americans – Rembrandt Peale was one, for instance – actually believed that adding resin to oil paint would keep it from discoloration, and that this was one of the secrets of the old masters. [8]

Another motive for Morse might have been speed. Paint that has a great deal of varnish added to it dries much faster than pure oil paint, and artists recognized this. On some occasions, nineteenth-century painters referred to varnish as a "drier." [9] Thomas Sully once wrote about being in a hurry and adding so much varnish to his paint that the paint actually dried faster than he wanted it to. [10]

Morse was clearly in a hurry while he was painting *The Gallery of the Louvre*. This is documented in a letter in which he wrote: "From nine o'clock until four daily I paint uninterruptedly" out of fear that he would not finish before the Louvre closed for its August recess. [11] Morse then shipped his painting back to New York and completed it there. Numerous large flake losses – that look very different from the way flake losses normally occur – may have been caused by the canvas being rolled up for transport before it was completely dry, and then sticking to itself or to a release sheet (fig. 6). Some of the losses were retouched in a rudimentary way, probably by Morse. Other areas were repainted more completely; for instance, it appears that Morse repainted most of the lower part of the wall below the lowest row of pictures. He did not match the color exactly (the repainted part is more yellow than the other parts of the wall) and he skipped some spots. He also neglected to paint the decorative pattern that is so prominent in the rest of the wall (fig. 7).

Figure 6. Detail before treatment, showing paint losses, possibly from paint having been pulled off.

Figure 7. Detail before treatment, showing repainting of the damaged wall without the decorative design.

A number of places in the left-hand part of the design had been repainted because they developed noticeable drying crackle. In these areas, particularly in the black coat of the artist near the lower left corner, parts of his easel, and the adjacent wall, paint that looks exactly like artist's paint goes over and into lines of drying crackle (fig. 8). In a few places, areas where the paint had pulled up into islands were glazed over after the crackle occurred, but the paint continued to move, exposing new areas of white ground as the islands continued to contract.

In some other areas, such as the Raphael *Madonna with Christ Child and St. John*, old retouching was done so poorly that it seems very unlikely that it was done by Morse. In Leonardo's *Mona Lisa*, badly darkened retouching that covers up some of the losses (the ones that were probably caused by rolling) makes a dark cloud next to the sitter's head that neither Leonardo nor Morse would have intended.

The most important goals of the present conservation treatment were to make the different parts of the design relate better to one another and to try to make the space work more convincingly. The authors removed a very thin layer of grime and applied a thin brush coating of MS2A over the existing layer of high-molecular-weight synthetic resin varnish. This appeared to make only a subtle improvement, but several people who had seen the painting previously saw it immediately after varnishing and—without any prompting—said that they did notice an improvement in being able to read the darker parts of the design.

The part of the treatment that made the greatest improvement in the painting's appearance was the application of a great many strokes of inpainting. Individual paintings, like the Claude *Sunset at the Harbor*, that looked brighter than their neighbors because they had been cleaned more, were glazed

Figure 8. *The Gallery of the Louvre*, detail before treatment, showing man's coat repainted after drying crackle had occurred.

Figure 9. *The Gallery of the Louvre*, detail after treatment.

back. A great deal of glazing also needed to be done on a small scale to correct areas that appeared spotty because discolored varnish had been thinned unevenly. Abraded areas, such as the shadows of the picture frames that had been damaged in a previous cleaning, were also inpainted.

Of special concern was the view down the long hallway of the Grande Galerie, which leads the viewer's eye back into space. A great deal of badly darkened old retouching needed to be inpainted, in addition to toning back areas on the right side that had been overcleaned (fig. 9). Before treatment, it was very difficult to discern the pattern of coffering that defines the geometry of the ceiling, and which Morse painted using faint reddish lines. However, scumbling over the spots of darkened retouching and toning the spots that were too light allowed the pattern of coffering to gradually emerge. Glazing and scumbling to correct the visual clutter caused by darkened retouching and uneven cleaning also revealed the small figures in the hallway more clearly, and allows the viewer to see the rows of picture frames more distinctly, which also helps lead the eye back. To a lesser degree, inpainting the many areas of darkened retouching in the floor helped make the floor recede, in part by reestablishing the pattern of converging lines on the floor that makes the perspective work.

Some of the widest lines of traction crackle were toned back a little, especially in the darker, shadowed part of the room on the left side of the painting. All of the retouching was done as far as possible with a light hand, because some of the old retouching might have been done by Morse. For this same reason, the large losses that were probably caused by rolling when the painting was still sticky were not filled before inpainting.

After treatment, the space works better, and the different parts relate better to one another, although the painting is still quite yellow, certainly much more yellow than it was originally (fig. 10). During the course of treatment, the authors investigated to see whether written evidence could provide hints about what the painting might have looked like when it was new.

Figure 10. *The Gallery of the Louvre*, after treatment.

An obvious question is whether Morse might have shared in the taste for paintings that looked "old." The only piece of documentary evidence that the authors could find is not about this painting, but is a comment by Sully about one of Morse's earlier paintings, in which Sully said that Morse was "too fond of process in his colouring – loading – glazing &c. &c. until the work looks soiled." [16] In Sully's jargon, "process" means preparing for glazing, then glazing as a separate step. The word "soiled" is intriguing, and implies that at least some of Morse's paintings might have had a little of the look of old paintings even when they were new.

Morse was clearly very much influenced by his teacher, Washington Allston, and remained close to him until Allston's death. Allston's paintings, even when they were new, had – to some degree – the look of old paintings. In 1831 (at about the time Morse was beginning *The Gallery of the Louvre*), Allston told Thomas Sully to put a thin, overall toning layer of asphaltum over every painting. [12] Sully had mixed feelings about this practice of overall toning. He believed that the Old Masters did it, but he was sometimes critical of the practice, and he seems to have only occasionally applied an overall toning layer to his own paintings. [13] But clearly, it was part of the taste of the 1830s, for some artists, to have their paintings somewhat low in tone. There is even evidence that in the 1830s marble sculptures were toned to take away the cold color of the white marble. [14] When Thomas Cole heard about Allston's death in 1843, he wrote:

> *I feel confident that [Allston's] great admiration for the Old Masters led him somewhat astray, for in some of his pictures he imitated the effects of time, and they have often put me in mind of what Fuseli has said "Those pictures which anticipate the beauties of time are pregnant with the seeds of decay."* [15]

(This would turn out to be prophetic; there are many comments from the second half of the nineteenth century about how Allston's paintings had, in general, lasted poorly.)

It is impossible to know if there was an overall toning layer of asphaltum on this picture because the old surface coatings have been so mixed up with the glazes. Samples of the glazes were analyzed to look for asphaltum, which is difficult to identify because it dissolves in a medium rather than showing solid pigment particles, but Henry DePhillips feels that asphaltum is probably present in the glazes. Another piece of information in connection with asphaltum is that a letter survives from Allston to Morse, telling him how to use asphaltum. Allston told Morse not to mix any oil with his asphaltum, but simply to add turpentine. [17] If a painter had mixed asphaltum with oil (as many painters did)[18], glazes by Allston – and possibly by Morse – that contained asphaltum might have survived better.

To put the technique of *The Gallery of the Louvre* into context in yet another way, in the decades leading up to the middle of the nineteenth century, a trend was beginning to develop in which at least some American painters became more cautious about glazing and/or adding large amounts of medium to their paint. For instance, Laughton Osborn's *Handbook of Young Artists and Amateurs in Oilpainting*, first published in 1845, which would become the most popular and most reprinted nineteenth-century American book on technique, contains a long discussion of glazing. Osborn wrote that glazing was not used nearly so much at that time as it had been in the past, and gave two reasons for this: glazes will turn brown because of the high proportion of medium they contain, and glazes can be accidentally removed by picture-cleaners. [19] Obviously, both of these concerns would apply to *The Gallery of the Louvre*. Osborn based his book in part on an earlier book by the Swiss artist Pierre Louis Bouvier; however, these negative opinions about glazing do not appear in Bouvier's book, but rather seem to be Osborn's own.

By the 1850s, some Americans were saying that painters should use no added medium at all. [20] Even Thomas Sully, who had experimented with all kinds of different media in the first half of the nineteenth century, sometimes adding medium copiously to his paint, changed his technique at some time after 1851. Sully switched from adding megilp "freely" to his paint to using only drying oil and spirits of turpentine mixed 1:1, which Sully said should be added "sparingly." [21] One cannot help but wonder whether by mid-century artists might have noticed the yellowing of some American paintings that had been painted with medium-rich glazes, and this could have led them to be more cautious about adding medium. Of course, modern conservators now know that the old masters did not normally add large amounts of resin to their paint. Ironically, the actual sixteenth- and seventeenth-century paintings in the Louvre have lasted much better than Morse's nineteenth-century copies of them.

In retrospect, the conservator's adage that "all paintings change" is emphatically true about this painting, although it clearly looks better now than it has for many years. And both Morse's close connection with Allston and Sully's quotation about Morse's paintings looking "soiled" hint that Morse himself would probably not be *too* unhappy if he saw that his painting is more yellow than it once was.

ACKNOWLEDGMENTS

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ENDNOTES

1. On the history of *The Gallery of the Louvre*, see Staiti 1989, 175-206.
2. Mayer and Myers 2011, 67.
3. Sheldon 1881, 105, cited in Mayer and Myers 2011, 92.
4. On connections between science and technical experimentation and innovation by American artists, see Mayer and Myers 2011, 89-95; on Morse and photography see Staiti 1989, 226-8.
5. See Mayer and Myers 1996, for the example of a soluble painting by Rembrandt Peale.
6. On megilp see Carlyle 2001, 101-5; Mayer and Myers 2011, 11, 49, 102, 121, 134.
7. Sully "Hints," AAA, microfilm roll N18, frame 140 (June 22, 1836).
8. Mayer and Myers 2011,135.
9. Thomas Cole and Thomas Sully referred to adding varnish as a "drier" in 1837 and 1862 respectively (Mayer and Myers 2011, 156).
10. Mayer and Myers 2011, 156.
11. Prime 1875, 227.
12. Sully "Hints," AAA, microfilm roll N18, frame 128 (June 30, 1831); Sully "Memoirs," 31; Mayer and Myers 2011, 78-79. Allston also used a mixture of megilp tinted with asphaltum, red, and blue for modeling shadows that he called "Titian's dirt" (Flagg 1892, 182-87).
13. Mayer and Myers 2011, 81.
14. Mayer and Myers 2011, 76-77.
15. Cole Journals [July-August 1843].
16. Sully Journal, AAA, microfilm roll N18, frame 290 (July 21, 1825).
17. Allston to Morse, February 18, 1812, in Allston 1993, 60. (Note that the letter was written nineteen years before Morse began *The Gallery of the Louvre*.)
18. Carlyle 2001, 403-7.
19. [Osborn] 1845, 137-39; 148
20. Chapman 1857, 213
21. Mayer and Myers 2011, 104-5.

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AUTHORS

Lance Mayer and Gay Myers are both graduates of the Intermuseum Laboratory training program in Oberlin, Ohio. They work as conservators at the Lyman Allyn Art Museum and as independent conservators.

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JOHN K. DELANEY, DAMON CONOVER, MATHIEU THOURYA, KEN FLEISHER, E. RENÉ DE LA RIE, M. PICOLLO, ANDREA CASINI, LIONEL SIMONOT, AND MURIEL VERVAT

An Experimental Study on the Merits of Virtual Cleaning of Paintings

ABSTRACT

Image processing to improve color accuracy of images of paintings has expanded with the advent of multispectral and, more recently, high spatial hyperspectral imaging cameras. The increased color accuracy results from a more accurate measurement of the spectral reflectance. Various groups have attempted to restore the color appearance of Old Master paintings by compensating for faded pigments and discolored varnishes using such reflectance information in their models. The latter has been called "virtual cleaning" of paintings. In these models the varnish is often treated as a transmission filter and color is restored to the painting by removing the discolored varnish's absorbance. The absorbance of the aged varnish is determined by either a heuristic process or altering the reflectance spectra by using reflectance or transmittance spectra of artificially aged varnish.

In this paper, the results of experiments designed to test the accuracy of such "virtual cleaning," using several paintings covered with aged varnishes, is presented. The experimental method consists of collecting reflectance spectra before varnish removal and then after application of new varnish. Also, the absorbance properties of removed varnish are measured. Two types of experimental studies are performed; the first using a fiber optic reflectance spectrometer (350 to 2500 nm) at selected sites and the second a color accurate imaging hyperspectral mechanical scanning camera system (400 to 900 nm) to collect reflectance spectra of an entire painting. The first set allows determining the degree to which a transmission model can be used to predict the final reflectance spectra of the cleaned and varnished area. The second set allows for a visual comparison of results of virtual cleaning versus actual on a painting. The obtained results will be used to demonstrate whether "virtual cleaning" does or does not account for the scattering inherent in naturally aged varnishes or variation in varnish thickness.

AUTHORS

John. K. Delaney
Damon Conover
Mathieu Thourya
Ken Fleisher
E. René de la Rie
National Gallery of Art

M. Picollo
Andrea Casini
CNR-IFAC

Lionel Simonot
Université de Poitiers-CNRS

Muriel Vervat
Vervat Conservation Laboratory

JUDY DION

The Construction and Reconstruction of a Spanish Retable

ABSTRACT

This paper contains an overview of research done on the construction of retables, or *retablos*, in 15th-century Spain. Concentrating on panel paintings made in the regions of València, Catalonia, and inland Aragón, the author presents observations on characteristics of the construction, assembly, and framing of altarpieces in these regions. A case study applies the research and the results of a technical investigation of *The Birth of the Virgin,* by Jaume Mateu (John G. Johnson Collection, Philadelphia Museum of Art), in assembling a hypothetical reconstruction that places the painting within the compound work from which it originated.

INTRODUCTION

Though created in the same period and with the exchanged influences of Northern European and Italian Renaissance paintings, Spanish paintings of the 15th century have not received a similar depth of research from a historical or technical standpoint. Several recent publications originating in Spain, the United States, and the United Kingdom have begun to fill this gap, however the body of published technical literature is still relatively sparse.

The research presented in this paper was carried out over a span of five years through Mellon Fellowships served at the Balboa Art Conservation Center and the Philadelphia Museum of Art (PMA). The research included firsthand non-invasive examination of intact altarpieces in Spain, the United States, and the United Kingdom, as well as in-depth collaborative study of paintings in the collections of the San Diego Museum of Art and the PMA (Court 2004, Dion 2008). In November 2006, the author traveled to Spain with colleagues from the PMA. In ten days of travel, numerous intact altarpieces were studied; observations from this time became the foundation upon which continued research was built.

Figure 1. Regions and major historic centers of northeast Spain.

The portion of the research presented in this paper includes a review of the format and vocabulary of Spanish altarpieces from the regions of Catalonia, València, and Aragón (fig. 1), with a description of stages of construction and a particular emphasis on assembly. A case study using the technical analysis of *The Birth of the Virgin*, c. 1430-1435, by Jaume Mateu (documented 1403-1452), in the Johnson Collection of the PMA (fig. 2), demonstrates how evidence remaining on a surviving panel combined with a basic knowledge of the construction of altarpieces can be combined to form a hypothetical reconstruction of the altarpiece from which a painting came.

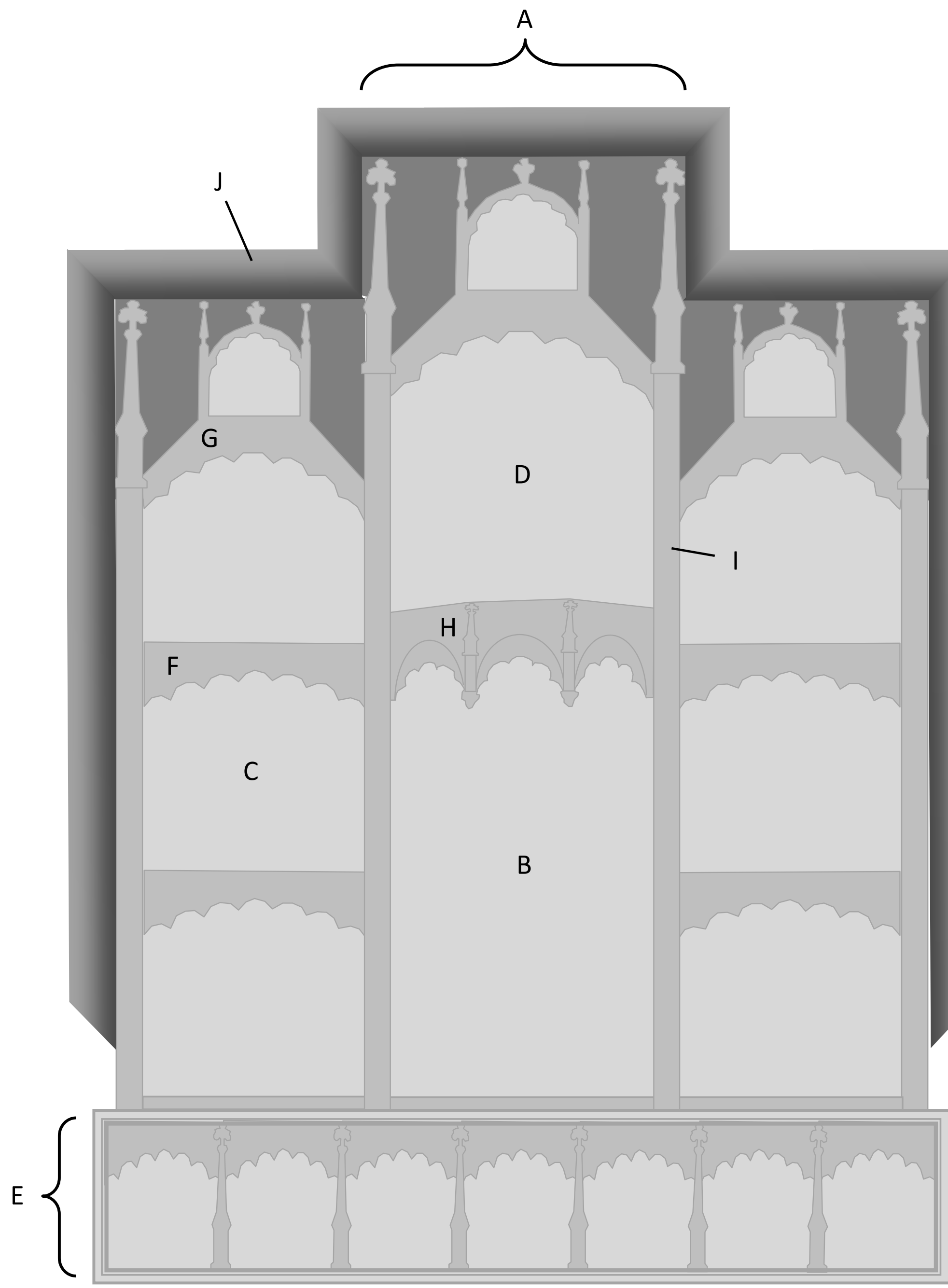
FORMAT

The main body of the altarpiece follows a strict bilateral symmetry with vertically imposed scenes laid out in *calles* (figs. 3, 4; diagram 1). The Spanish word for "lane," *calle* used in the context of altarpieces does not have a direct English translation; however, a two-dimensional visual comparison

Figure 2. Jaume Mateu, *The Birth of the Virgin*, c. 1430-35, tempera and tooled gold on wood panel, 31 1/4 x 22 3/4 x 13/16 in. (79.4 x 57.9 x 2.0 cm). Philadelphia Museum of Art, Johnson Collection, Inv. 2493. © Philadelphia Museum of Art, Conservation Department, Joe Mikuliak.

Figure 3. A small but representative example of a 15th-century Spanish altarpiece, intact except for its guardapolvos. *Retable of the Eucharist*, attributed to the Villahermosa Master, tempera and tooled gold on wood panels, approximately 8 1/2 x 7 ft. (2.6 m x 2.1 m). Parochial church of Villahermosa del Rio, region of València. Photo: Author.

Figure 4. Photomontage view from reverse of the main body of the altarpiece in Figure 3, installed with a modern steel support. *Retable of the Eucharist*, attributed to the Villahermosa Master, tempera and tooled gold on wood panels, approximately 8 1/2 x 7 ft. (2.6 x 2.1 m). Parochial church of Villahermosa del Rio, region of València. Photo: Author.



A – Center *calle*
B – Saint's effigy
C – Narrative episode
D – Crucifixion
E – *Banco*

F – Cusped arch
G – Pinnacled arch with vignette
H – Canopy
I – Pilaster

Diagram 1. The layout, main parts, and general proportions of a 15th-century altarpiece from the regions of Catalonia, València, and Aragón, in Spain.

might also be made with the columns of a data table. Two or more registers of scenes occupy each *calle*. A near life-size depiction of the saint to whom the altarpiece is dedicated occupies the lowest register of the center *calle*, which is taller and wider than the lateral *calles*. An equal number of lateral *calles* situated on each side of the center *calle* contains smaller narrative episodes from the life of the saint, told in chronological order. The size of a narrative episode is relatively consistent throughout the genre; altarpieces were enlarged by the addition of episodes rather than by the enlargement of individual scenes. A crucifixion or related scene sits above the central panel; on altarpieces containing more than two registers, the space between the saint's effigy and the crucifixion may be occupied by a narrative episode of particular significance in the life of the saint. The uppermost reaches of the most elaborate altarpieces might contain smaller-scaled vignettes or lunettes depicting an annunciation, saints, or the prophets.

A *banco* sits below the main body of the altarpiece and is the equivalent of the Italian predella. It contains small scenes unrelated to the narrative above, and often instead shows scenes from the life of Christ.

The scenes are divided by carved and gilded applied framing elements. The decorative scheme in the carving repeats across the work, changing in shape and scale according to the size and location of the scene. Each scene is topped with a horizontal framing element–usually a low, cusped arch–that ends in the flat ledge that is the lower edge of the scene above it. The upper scenes terminate in pinnacled arches. The arches are almost always applied to rectangular panels, which are responsible for the distinctive inverted T shape of the altarpiece. The non-design background areas outside the arches are painted matte, dark blue, and are often not further decorated. However, some backgrounds bear simple, monochromatic brocade patterns, while others are overlaid with full vignettes akin to the marginalia of medieval manuscripts. Gilded pilasters extending the full height of the main body of the altarpiece are present on the outside edges and between *calles*. Surrounding the entire assembly and visually reinforcing the inverted T shape is a *guardapolvos*, or dust guard, constructed of several gilded and painted boards canted forward, much like a picture frame.

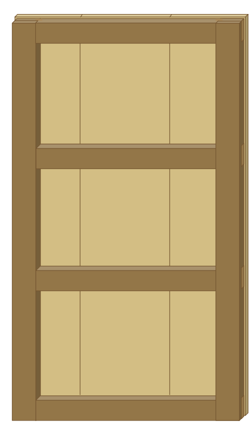
An altarpiece sits in a fixed position above a rear-facing altar on the back wall of a church or side chapel, and with few exceptions, it is finished on only one side. Depending on the number of scenes present and the importance of the altarpiece, it can range in size from two to seven meters tall, however four meters is about average. All but the smallest altarpieces are made up of several panels that usually contain multiple vertically imposed scenes.

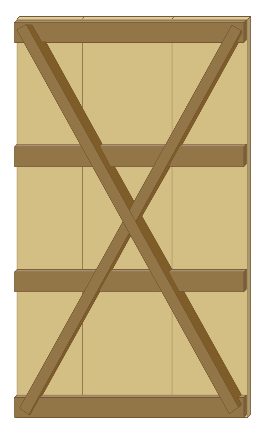
CONSTRUCTION

Though stylistically distinct, Spanish altarpieces share many similarities with Italian altarpieces of the period in basic construction, preparation, and painting technique. The descriptions below address characteristic or unique qualities of Spanish panel construction and are based on the assumption that the reader will already have a basic knowledge of the construction of Italian panels. [1]

Panels were constructed of boards face-nailed to battens. Poplar and pine were the most commonly used woods, however durable hardwoods such as oak and walnut occur as well. [2] With the exception of most *banco* panels, altarpiece panels are higher than they are wide, and consequently boards and the wood grain are oriented vertically in relation to the image. All panels have transverse battens running perpendicular to the orientation of the boards. An upper and lower batten are aligned with the upper and lower edges of the panel, and all but the smallest panels have one or two more transverse battens spaced evenly along their heights.

In addition to this, vertical or diagonal battens could be present (diagrams 2-3). They were applied after the transverse battens, and lap joints were used to fit them over the transverse battens. Vertical and diagonal battens serve the same purpose of giving greater stability to a panel, and they do not occur together on the same panel. Vertical battens were always placed flush with the edges of the panel, and never down the center. [3] Diagonal battens form an X-shape typically extending between opposite corners of the panel, however a few rare





Diagrams 2-3. The reverse of a panel with four transverse and two vertical battens; the reverse of a panel with four transverse and two diagonal battens.

variations in this configuration occur. All of the panels produced in the region of València examined by the author had diagonal battens as part of their original construction; the use of vertical versus diagonal battens was more variable in the regions of Catalonia and Aragón.

Butt joints were universally present in the panels examined by the author, and dowels were frequently used (fig. 5). In the region of València, metal dowels were common, and are easily identified in x-radiographs due to their density relative to the wood (fig. 6). The approximately 10 cm long lozenge-shaped dowels have the appearance of double-ended nails, narrowing to a point at each end from an approximate one centimeter diameter at the center.

Figure 5. A wood dowel is visible in the gap between two boards on the reverse of a banco panel. Lluìs Borrassà, *St. Catherine and St. John the Baptist*, c. 1411-1413. Tempera on panel, 34 7/16 x 35 3/8 x 3 1/4 in. (87.4 x 89.8 x 8.2 cm). Harvard Art Museums/Fogg Museum, 1933.153. Photo: Carl Strehlke

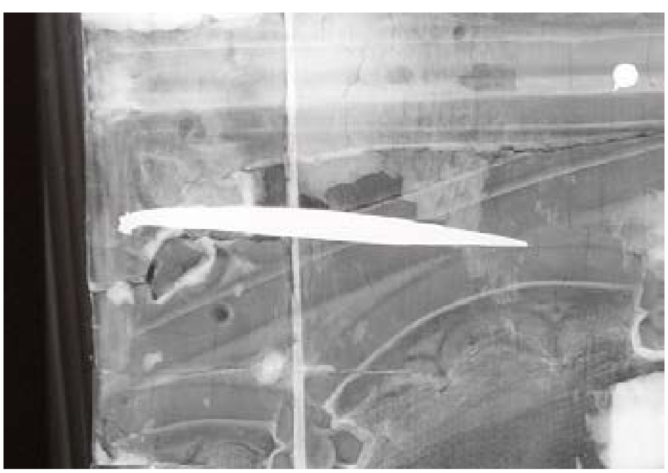


Figure 6. X-radiograph detail of a metal dowel. Jaume Mateu, *The Birth of the Virgin,* c. 1430-35, tempera and tooled gold on wood panel, 31 1/4 x 22 3/4 x 13/16 in. (79.4 x 57.9 x 2.0 cm). Philadelphia Museum of Art, Johnson Collection, Inv. 2493. © Philadelphia Museum of Art, Conservation Department, Joe Mikuliak.

Preparation for painting included addressing cracks, checks, and knots in the boards, as well as filling gaps between boards. Gaps could be up to one centimeter wide and were filled with wood shims and coarse gesso; the contrast in density of the gesso and shims, with the gesso being denser than the wood, makes the fills and the gaps visible in x-radiographs (figs. 7, 8). One theory that panels were assembled before the wood was fully seasoned offers an explanation for the common occurrence of gaps between joints, as well as minor flaws, such as cracks and checks (Marchant 2000). On the back of the panel, the joints, cracks, and checks were covered with a thick application of coarse gesso and either fabric strips or matted fibers. On the face of the panel, the area to be painted was covered with an overall application of fabric. Secondary design areas, such as the dark blue background, were prepared with fabric strips applied only over the joints. Non-woven plant fibers could be used in place of or in conjunction with fabric in the preparation layers (fig. 9). In x-radiographs, fibers may be visible as dark, randomly oriented lines (fig. 10). Though not a focus of this research, further preparation for painting included application of multiple gesso layers, as in typical Italian construction. The species of wood did not influence how a panel was prepared; an oak panel would be covered with fabric just like a poplar or pine panel, though it would likely be thinner than the 2-4 cm thickness of panels constructed from softer species (Dion 2008).

ASSEMBLY

The final step in the carpentry of the panels, and a step that anticipated the eventual assembly of the altarpiece, was the attachment of applied framing elements. Affixed with glue, nails, or wood pegs, all but the most ornate framing elements were in place before the panel was prepared for painting. Framing elements served as both pictorial and functional transitions between scenes and panels, allowing the viewer to perceive many pieces as a cohesive whole.

A vertical framing element such as a pilaster provided the lateral transition between *calles*, extending beyond the edge of the panel to which it is attached and overlapping onto the face of the adjacent one (diagram 4). Consequently, when taken out of context, lateral panels appear asymmetrical because they have vertical framing elements attached to only one edge of the panel. The overlapping of the framing elements originated from a symmetrically constructed central panel (with a vertical framing element attached to both edges), so a lateral panel typically has a vertical framing element attached to only its outside edge (diagram 5). Because of this, when examining a lateral panel from a disassembled altarpiece, it should be possible to identify the side of the altarpiece from which it was removed as long as sufficient evidence of the placement of the original vertical framing element remains.

Figure 7. Damage along the joint has exposed the shim. Guerau Gener, Lluìs Borrassà, and Pere Serra, panel from the *Retable of the Virgin*, c. 1410, tempera and tooled gold on wood panel. Originally from the Monastery of Santes Creus. Diocesan Museum, Tarragona, region of Catalonia. Photo: Author.

Figure 9. Non-woven fibers are visible on the face of a painting in areas of loss. Pere Garcia de Benebarre, *Retable of the Virgin, St Sebastian, and St. Anthony Abbott*, c. 1470, tempera on wood panel. Museu de Lleida Diocesà i Comarcal, region of Catalonia. Photo: Author.

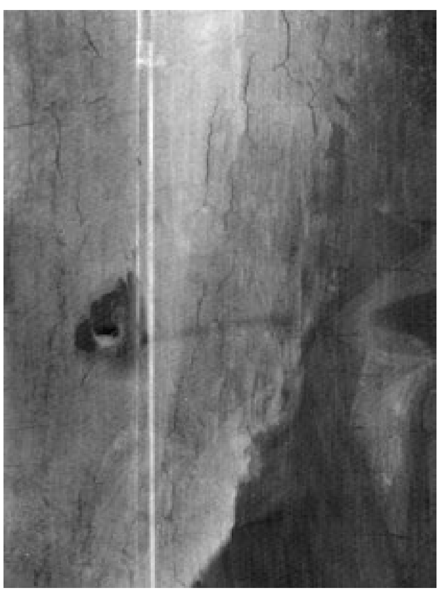


Figure 8. Shims in the joint of a panel are visible in an x-radiograph Jaume Mateu, *The Birth of the Virgin*, c. 1430-35, tempera and tooled gold on wood panel, 31 1/4 x 22 3/4 x 13/16 in. (79.4 x 57.9 x 2.0 cm). Philadelphia Museum of Art, Johnson Collection, Inv. 2493. © Philadelphia Museum of Art, Conservation Department, Joe Mikuliak.

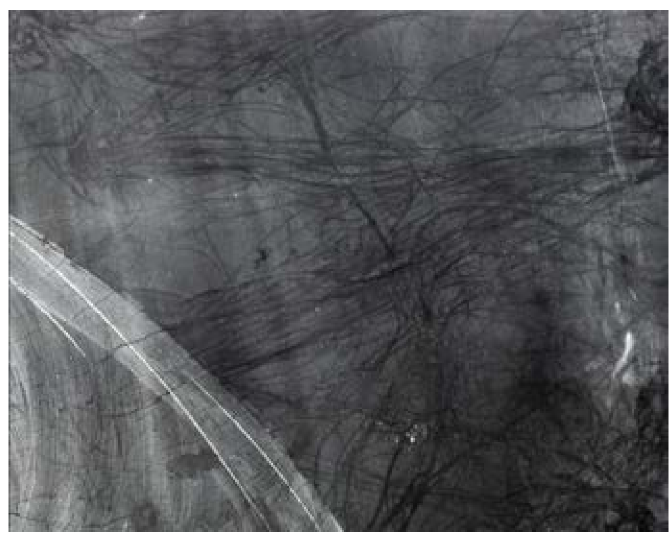


Figure 10. X-radiograph detail enhanced to show fibers beneath the ground layer. Oslo Master (attributed), *The Resurrection,* c. 1480. Oil, silver, and tooled gold on panel, 67 3/4 x 35 1/2 in. (172.1 x 90.2 cm). Philadelphia Museum of Art, Kienbusch Bequest, 1977-167-1041. © Philadelphia Museum of Art, Conservation Department, Joe Mikuliak.

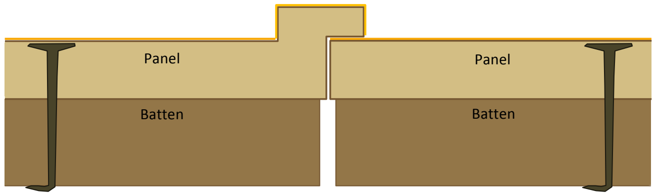


Diagram 4. A horizontal cross-section view of overlapping panels and the function of the vertical framing element.

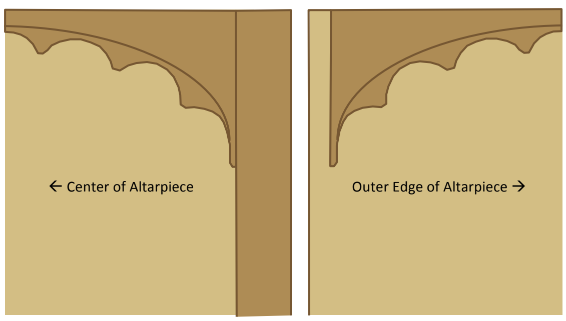


Diagram 5. The faces of adjacent panels that are meant to overlap.

Figure 11. A modern spacer interferes with the correct fit of the upper to the lower panel. Gerardo Starnina and Marçal de Sas, Retable of the Virgin, c. 1400, tempera and tooled gold on wood panels. Parochial church of El Collado Alpuente, region of València. Photo: Author.

The same technique was used in completing vertical transitions, where a ledge attached to the upper edge of a lower panel overlapped onto the face of an upper panel (fig. 11).

In order to make both the vertical and horizontal transitions more effective, the panel receiving the overlapping framing element was painted all the way to its edge, meaning that a small amount of design was covered once the altarpiece was assembled (fig. 12).

Because the central *calle* is almost always taller than the lateral *calles*, in the area of height difference the upper central panel was widened slightly to better accommodate the vertical framing elements. Where the central *calle* rose above the lateral *calles*, the vertical framing elements extending beyond the edge of the upper central panel would have been unsupported and would have interfered with the attachment of the *guardapolvos*. To avoid this, the top of the upper central panel was made slightly wider–no more than 2 cm on each edge–than the rest of the panel. The increased width is barely noticeable due to the presence of the framing elements, however identifying this minor detail on a panel can help confirm its location in an altarpiece. (fig. 13, diagram 6)

Figure 12. The vertical framing element has been removed from the panel on the right, revealing the small gap between the panels, and the paint that extends all the way to the edge of the adjacent panel. Joan Mates, Retable of Santiago el Mayor, c. 1400, tempera and tooled gold on wood panels. Diocesan Museum, Tarragona, region of Catalonia. Photo: Author.

Figure 13. The extra width of the center panel is just visible on the inside corner of the altarpiece. Jaume Mateu, Retable of San Valero, ca. 1437, tempera and tooled gold on wood panels. Originally in the parochial church of Vall de Almonacid. Now in the Museo de Bellas Artes, Castellón de la Plana, both in the region of València. Photo: Author.

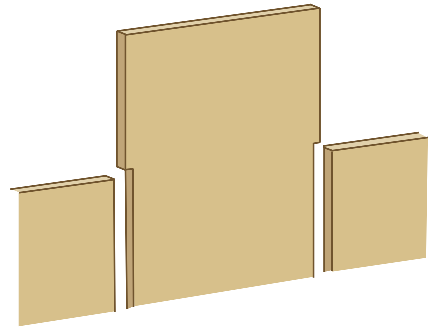


Diagram 6. The profile of the upper center panel of an altarpiece, shown without framing elements attached.

Figure 14. Wedges connecting an upper to a lower panel; a modern support of wood and steel is also in place. Joan Antigó, *Retable of the Virgin*, 1437-39, tempera and tooled gold on wood panels. Monestir de Sant Esteve, Banyoles, region of Catalonia. Photo: Author

Once painted and transported to their destination, the separate panels were assembled into an altarpiece. Overlapping framing elements helped keep the panels in place, but more secure attachment of vertically imposed panels was accomplished with wood wedges inserted through dadoes cut in the upper and lower transverse battens (fig. 14, diagram 7). The dadoes would have been cut into the battens before assembly of the panel, indicating that, from the start of construction, the layout of the altarpiece would have been well established. Though this attachment method was not always employed, finding evidence of this on a panel can help determine the original vertical placement of a panel in an altarpiece.

Raised framing elements, such as canopies and the (guardapolvos) boards (fig. 16), were installed in the final stages of assembly. The inherent fragility of construction and the semi-permanent attachment of these framing elements make them particularly vulnerable to loss and damage.

CASE STUDY

Changes to altarpieces may result from a combination of evolving styles and tastes, accidental or intentional damage, or

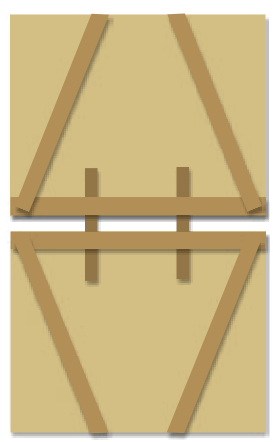


Diagram 7: An exploded view of the transition between an upper and lower panel, with wedges, shown from the reverse.

Figure 15. View from above of the dado in a batten. Guerau Gener, Lluìs Borrassà, and Pere Serra, panel from the *Retable of the Virgin*, c. 1410. Tempera and tooled gold on wood panel. Originally from the Monastery of Santes Creus. Diocesan Museum, Tarragona, region of Catalonia. Photo: Author.

dismantling to exploit an opportunity for profit. When altarpieces were moved or disassembled, modifications were made to make them fit into new spaces or appear as stand-alone works of art. The bilateral symmetry so essential to the aesthetic of the altarpiece worked only in relation to the whole; once disassembled, panels were divided into individual scenes, and framing elements were removed, altered, or added (fig. 17).

The construction of *The Birth of the Virgin,* by Jaume Mateu (fig. 2), has been altered, but technical analysis provides sufficient evidence to propose a hypothetical reconstruction of the complete work from which it came. *The Birth of the Virgin* is thought to come from an altarpiece painted for the Convent of the Trinity, in València (Strehlke, n.d.). Only two other scenes have been located: a like-sized narrative episode, *The Annunciation of the Death of the Virgin* (fig. 18), is in a private collection, and the large central panel, *The Virgin and Child Enthroned* (fig. 19), is at the Museum of Fine Arts, Boston.

Figure 16. An intact guardapolvos on a small altarpiece. Artist unknown, *Retable of St Peter*, 15th century. Diocesan Museum, Tarragona, region of Catalonia. Photo: Author

Figure 17. Alterations to an altarpiece include substituting a later sculpture for a lost central panel and replacing lost lateral panels with unpainted reconstructions. Gerardo Starnina and Marçal de Sas, *Retable of the Virgin*, c. 1400, tempera and tooled gold on wood panels. Parochial church of El Collado Alpuente, region of València. Photo: Author.

The PMA's panel is constructed from one very wide board butt-joined to a very narrow board (51.6 cm W and 5.8 cm W, respectively). The joint is aligned and internally reinforced with two metal dowels (located 21.0 cm W and 74.0 cm H from the bottom), which are visible in the x-radiograph (figs. 6, 20). Also visible in the x-radiograph are the wood shims used to fill the half centimeter wide gap between the two boards and the heads of the nails once used to attach the boards to the battens (fig. 8). The placement of the nails indicates that two transverse and two diagonal battens were once present. The transverse battens were located at the bottom of the panel and close to its top (centered at 68.5 cm H). The diagonal battens begin in the lower corners of the panel; they are angled on convergent paths moving upward, but they do not intersect on the part of the panel that remains intact.

Though the battens have been removed and a crack down the center of the panel has been repaired with wood blocks, much of the reverse of the panel remains intact (fig. 21). Coarse gesso still covers the joint except where the presence of battens prevented its application. As a result, the dimensions of the battens can be ascertained by measuring the gaps in the gesso. The widths of the gaps made by the transverse and diagonal battens are different (9 cm and 5 cm, respectively), but the likelihood is that in cross-section, both battens measured approximately 5 cm W x 9 cm H, and the height and width of the two battens were oriented at right angles. This arrangement, in which the wider dimension of the diagonal batten is placed perpendicular to the back of the panel (fig. 22), giving extra strength to the diagonal battens, remains in place on intact altarpieces (Dion 2008).

The layout of the diagonal battens shows that *The Birth of the Virgin* was the lower scene on a panel containing two or more scenes. Extending the diagonal battens to intersect and form an X-shape would bring the complete panel height to approximately two meters, and it would allow for two other scenes–one of equivalent size and a smaller vignette—to sit above *The Birth of the Virgin* (diagram 8).

This proposed height is supported by the locations of the nails from the transverse battens as well as by the locations of the dowels. The interval between the known locations of what would have been the two lower transverse battens is approximately one third the proposed height of the reconstructed panel, meaning that a total of four evenly spaced transverse battens would have fit perfectly along the height of the panel. Likewise, assuming four dowels to have been present, a similar set of calculations applied to the spacing of the surviving dowels results in the same proposed height of approximately two meters. [4] Though at first this panel seems

Figure 18. Jaume Mateu, *Annunciation of the Death of the Virgin*, c. 1430-35, tempera and tooled gold on wood panel, approximately 34 1/4 x 22 3/4 x 3 in. (87 x 58 x 7.5 cm). Private collection. Photo: Carl Strehlke.

Figure 19. Jaume Mateu, *Virgin and Child Enthroned*, c. 1430-35, tempera and tooled gold on panel, 76 5/8 x 34 1/2 in. (194.6 x 87.6 cm). Museum of Fine Arts, Boston, 37.328. Photo: Museum of Fine Arts, Boston.

Figure 20. X-radiograph mosaic of *The Birth of the Virgin*, by Jaume Mateu, c. 1430-35, tempera and tooled gold on wood panel, 31 1/4 x 22 3/4 x 13/16 in. (79.4 x 57.9 x 2.0 cm). Philadelphia Museum of Art, Johnson Collection, Inv. 2493. © Philadelphia Museum of Art, Conservation Department, Joe Mikuliak.

Figure 22. Reverse of *Retable of the Eucharist*, attributed to the Villahermosa Master, tempera and tooled gold on wood panels. Parochial church of Villahermosa del Rio, region of València. Photo: Author.

Figure 21. Reverse of *The Birth of the Virgin*, by Jaume Mateu, c. 1430-35, tempera and tooled gold on wood panel, 31 1/4 x 22 3/4 x 13/16 in. (79.4 x 57.9 x 2.0 cm). Philadelphia Museum of Art, Johnson Collection, Inv. 2493. © Philadelphia Museum of Art, Conservation Department, Joe Mikuliak.

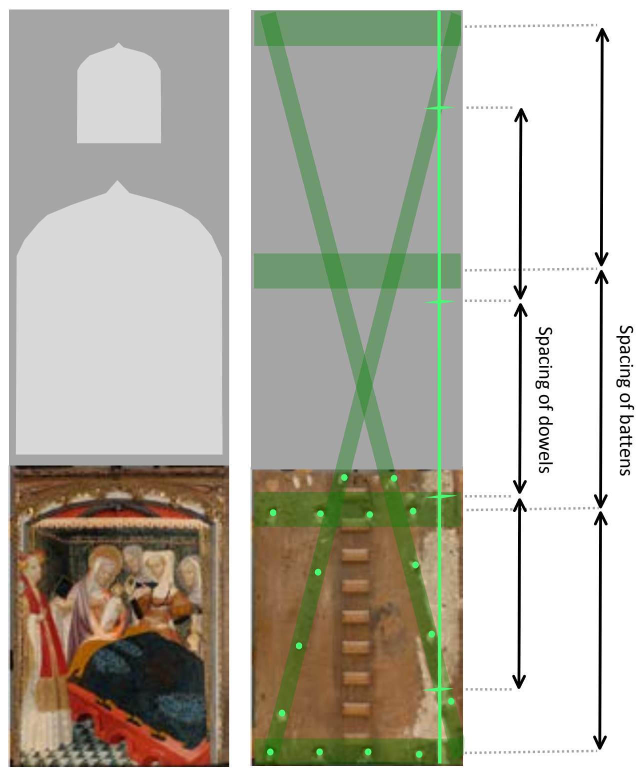


Diagram 8. Hypothetical reconstruction of the intact height of the panel containing *The Birth of the Virgin*, with layout of the face and reverse, and a proportional breakdown of the spacing of the battens and dowels.

improbably tall, it is very close to the 194.6 cm height of the central panel, *The Virgin and Child Enthroned*.

The width of *The Birth of the Virgin* was altered when a wide framing element called an *entrecalle* was removed from its left edge. As described above, most panels were painted all the way to one of their original edges, however both the left and right edges of the painted area of *The Birth of the Virgin* are bounded by slim, twisted columns that are original framing elements. Though both edges have likely been regilded, comparison of them shows that a gesso ground layer is present on the right edge, whereas the later gilding on the left edge was applied directly over wood (figs. 23, 24). This occurred because a framing element called an *entrecalle* was present on the left edge, and the panel itself was slightly wider. An *entrecalle* is a vertical framing element gilded and painted with inset vignettes. It takes the place of the pilaster on an altarpiece, with a single *entrecalle* serving as a lateral transition between two *calles*. The *entrecalle* is made from a wide board attached to the panel during construction; it is gessoed, gilded and painted with the panel. As a permanent fixture on the panel, the wood beneath it remains unprepared, and is exposed only if the *entrecalle* is removed in an alteration of the panel (figs. 25, 26).

The panel itself would have been several centimeters wider to accommodate placement of the *entrecalle*, however once it was removed, the unpainted width of the panel was likely trimmed to match the opposite edge (diagram 9). The material was removed from the narrower of the two boards, providing an explanation for the extremely narrow width (5.8 cm) of this board in its current state.

The Annunciation of the Death of the Virgin mirrors the construction of the PMA's panel. Though grime and later markings make it more difficult to see nail holes from the diagonal battens on the back of this panel (fig. 27), they are discernable with close study. Coarse gesso is also present on the back of the panel along the joint. The same basic reasoning applied to *The Birth of the Virgin* was used to make a hypothetical reconstruction of the panel from which this painting came. The angling of the diagonal battens indicates that the panel containing *The Annunciation of the Death of the Virgin* would have been slightly shorter than the panel containing *The Birth of the Virgin*. It would have had space to hold only two narrative episodes, with *The Annunciation of the Death of the Virgin* in the upper half and an *entrecalle* along the right side. The difference in format between these two reconstructed panels suggests that they came from different levels of a very large altarpiece. The placement of the *entrecalles*, respectively on the left and right sides of the panels, indicates that the episodes were located on opposite sides of the altarpiece, and a chronological ordering of the events depicted supports this.

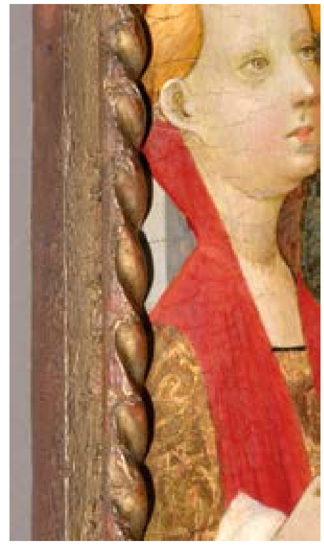


Figure 23. Later gilding is applied over bare wood adjacent to the original vertical framing element. Left edge detail of *The Birth of the Virgin*, by Jaume Mateu, c. 1430-35, tempera and tooled gold on wood panel, 31 1/4 x 22 3/4 x 13/16 in. (79.4 x 57.9 x 2.0 cm). Philadelphia Museum of Art, Johnson Collection, Inv. 2493. © Philadelphia Museum of Art, Conservation Department, Joe Mikuliak.

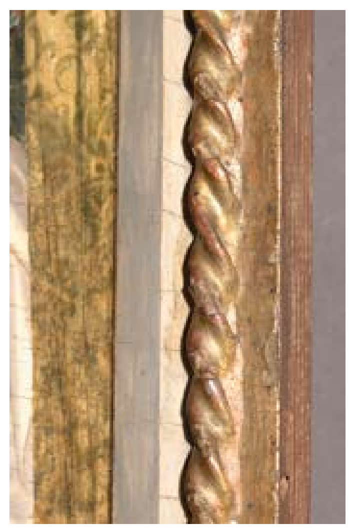


Figure 24. The original preparation layer extends all the way to the edge of the panel. Right edge detail of *The Birth of the Virgin*, by Jaume Mateu, c. 1430-35, tempera and tooled gold on wood panel, 31 1/4 x 22 3/4 x 13/16 in. (79.4 x 57.9 x 2.0 cm). Philadelphia Museum of Art, Johnson Collection, Inv. 2493. © Philadelphia Museum of Art, Conservation Department, Joe Mikuliak.

Figure 25. Entrecalle in place on the left side of a panel. Unknown Aragonese artist (possibly Master of Retascón), *The Birth of the Virgin*, c. 1420-1440, tempera and tooled gold on wood panel. Lady Lever Art Gallery. Photo: Author.

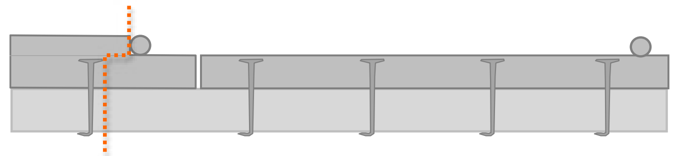


Diagram 9. Hypothetical reconstruction of the full width of The Birth of the Virgin in cross-section view; the dashed line indicates the parts removed.

Figure 26. Entrecalles as they appear on an intact, assembled altarpiece. Detail of *Altarpiece of St. George*, attributed to the Master of the Centenar, first quarter of the 15th century, tempera and tooled gold on pine panels, 21 1/2 x 18 ft. (6.6 x 5.5 m). Victoria and Albert Museum, 1217-1864. Photo: Author.

Figure 27. Reverse of *Annunciation of the Death of the Virgin*, by Jaume Mateu, c. 1430-35, tempera and tooled gold on wood panel, approximately 34 1/4 x 22 3/4 x 3 in. (87 x 58 x 7.5 cm). Private collection. Photo: Carl Strehlke.

Similar steps can be taken with the central panel, so that the three basic building blocks of the disassembled altarpiece are formed. By filling in the missing pieces with like-sized panels and estimating the size of the *banco*, a hypothetical reconstruction of the entire altarpiece can be made (diagram 10). With three scenes located, and estimated thirty remaining scenes are lost or remain undiscovered. A nearly intact comparison, also from the region of València, is a retable by Gonçal Peris dedicated to the life of the Virgin, in the Church of Santa María la Mayor, in Rubielos de Mora (fig. 28).

CONCLUSION

The majority of altarpieces created in the 15th century have been disassembled or destroyed, and the survival of only a fraction of an altarpiece is common. The persistence of the gold ground and the continued use of an antiquated style of painting through the fifteenth century have perhaps caused Spanish altarpieces to be overlooked in the past. However, the level of workmanship and refinement of technique present on both the front and back of these paintings is on par with works from other regions at the time. Knowledge of the steps taken in the construction of the altarpiece can aid in the rediscovery of the context from which fragments were taken, and may lead to a deeper understanding of the object as a whole.

ACKNOWLEDGEMENTS

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Diagram 10. Hypothetical reconstruction of the altarpiece dedicated to the life of the Virgin painted for the Convent of the Trinity, in València, by Jaume Mateu, c. 1430-35. Three scenes from the altarpiece, indicated above, have been located.

Figure 28. Gonçal Peris, altarpiece dedicated to the life of the Virgin, c. 1420, tempera and tooled gold on wood panels. Church of Santa María la Mayor, Rubielos de Mora, region of València. Photo: www.flickr.com/photos/albtotxo/5990259438/in/set-72157627313666438 (accessed 08/16/11).

ENDNOTES

1. Observations presented here are based on details recorded in the author's unpublished fellowship research from the Philadelphia Museum of Art (Dion 2008), in which approximately 150 altarpieces or panels from altarpieces were studied for evidence of construction.
2. Wood identification was not in the scope of this study generally, however when possible the wood was characterized or recent analysis was cited (Dion 2008). Contrary to Marette's (1961) observations, the use of Baltic oak was more widespread in Spain than it was generally thought to be.
3. A vertical batten attached at the center of a panel, described by Berg-Sobré (1989, 52), was never observed by the author.
4. The lowest dowel is located at 21 cm H. The space between this and the next dowel is 53 cm. The panel height is arrived at by adding 21+53+53+53+21, which equals 201 cm.

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AUTHOR

Judy Dion
Associate project conservator of paintings and painted surfaces
The Barnes Foundation
300 N. Latches Lane
Merion, PA 19066
judydion@gmail.com

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DAWN V. ROGALA

Industrial Literature as a Resource in Modern Materials Conservation: Zinc Oxide House Paint as a Case Study

ABSTRACT

This paper is an introduction to the benefits of incorporating period industrial literature into conservation research. Conservators of post-WWI art regularly work with objects containing industrial materials of unknown composition and behavior. Period publications offer unique insight into material properties and formulations that may be at odds with preservation goals. Industrial literature is an accessible and informative resource, and should not be overlooked by the modern materials conservator. This paper reviews the available mid-century literature related to zinc oxide-containing house paint, as a case study in the assessment of industrial literature and its value to conservation efforts.

The research and related bibliography are the result of a Conservation of Museum Collections postgraduate fellowship at the Smithsonian Institution, Washington, DC. A literature search initiated in the early stages of the fellowship revealed only a small number of relevant articles in the existing conservation literature. An expanded search identified a wealth of period industrial literature. Patterns within the literature became apparent, and an informed examination of the assembled articles revealed unique and useful information. This resource was instrumental to the final outcome of the project. This paper reflects the focus of its associated fellowship research: mid-century, American, oil-based zinc oxide house paint.

Note: This paper was also presented at the May 2011 international symposium "From Can to Canvas: Early uses of house paints by Picasso and his contemporaries in the first half of the 20th century," a joint effort of the Centre Interrégional de Conservation et Restauration du Patrimoine (Marseille), The Art Institute of Chicago, and the Musée Picasso (Antibes).

INTRODUCTION

Conservators of twentieth-century art regularly work with objects containing industrial materials, and the design of a conservation treatment plan can be complicated by period additives and formulations that work against the long-term stability of an artwork. Although the growing need for conservation of twentieth-century artwork has recently led to a number of important collaborative research ventures, conservators looking for reference material on particular paints may find a limited number of scholarly publications on their topic. Viewed with a critical eye, period industrial literature can be a valuable resource for the conservator.

The motivation for this project stemmed from a research effort focused on a group of Abstract Expressionist oil paintings in the collection of the Hirshhorn Museum and Sculpture Garden, Smithsonian Institution. Analysis of these works revealed a relationship between zinc oxide ground layers and certain types of upper layer paint failure. A literature search initiated during the early stages of the project produced few articles related to zinc oxide in the existing conservation literature, but documentary and anecdotal evidence of the Abstract Expressionists' use of house paints supported the idea of expanding the original literature search to include contemporaneous industrial publications. This expanded literature review identified a wealth of industrial publications from the same period as the research group paintings. The inclusion of selected earlier and later publications placed the mid-twentieth century articles within a larger context of technological advances and commercial influences, and patterns within the literature became apparent. Examination of the assembled articles revealed unique and useful information that was instrumental to the final outcome of the research project (Rogala et al. 2010; Maines et al. 2011).

Whether faced with an analytical similarity between paints formulated for industrial markets and commercially-prepared artists' paints, or acknowledging an artist's use of industrial materials as an integral part of their artwork, the conservator can only benefit from a well-informed review of the publications emanating from within the commercial industry. This paper presents an overview of the available literature related to zinc oxide-containing house paint from the first half of the twentieth century, as a case study in the examination and assessment of industrial literature in the service of modern materials conservation. The commentary on literature from this period has been organized into 25-year periods, followed by a discussion of parallel trends and industrial and conservation research, and a brief review of modern industrial research topics. The role played by period literature in the associated Smithsonian research project is noted throughout the paper. The extended bibliography includes an overview of zinc oxide in the conservation literature, as well as a chronological list of industrial zinc oxide paint literature of relevance to those interested in the properties of zinc oxide-based paints.

Methodological Note on the Classification of Literature

The term "industrial literature" is used in this paper as an inclusive category for material published by all non-conservation industries. The industrial resources discussed in this paper range from paint manufacturing texts and papers to technical manuals for the professional and the amateur, as well as peer–reviewed scientific literature. The information contained in these period publications is a valuable addition to the research available in traditional conservation texts.

ZINC OXIDE IN INDUSTRIAL LITERATURE BEFORE 1925

The industrial literature produced before 1925 reflects the commercial coatings industry's struggle to fashion an opaque and durable alternative to lead (carbonate hydroxide) white paint. Prior to the 1920s introduction of titanium dioxide white as a bulking agent, early lead white substitution efforts were focused on zinc oxide coatings. Much of the early literature, such as G. Petit's 1907 treatise *The Manufacture and Comparative Merits of White Lead and Zinc White Paints*, reflects a marketplace wary of the new material. In the chapter entitled "Zinc White Paint and Zinc White Coatings—Their Merits and Defects," Petit raised early doubts about zinc oxide's suitability as a durable paint. A public backlash by displaced lead white raw materials producers is to be expected, and is evident in the back matter advertisements for lead white materials and technical manuals. Yet even at this early stage in the pigment's introduction there are concerns about zinc oxide's stability, including Petit's own admonition that "Zinc white covers poorly. It dries poorly. It stands the weather badly" (Petit 1907, 84).

Within a few years a shift in industry attitude towards zinc oxide is apparent in the literature, which now portrays the switch to zinc white as inevitable. Practical manuals such as P. Fleury's 1912 *The Preparation and Uses of White Zinc Paints* address the commercial painter directly, suggesting that the pigment's reputation as a temperamental material is easily combated with training in the appropriate handling techniques. Yet concerns remain about zinc oxide's stability. Both Petit and Fleury acknowledge the brittle nature of a zinc oxide paint film, as do H. A. Nelson and G. W. Rundle in a 1923 article for the American Society for Testing Materials. Paintings conservators will be especially interested to note that the high incidence of cracking in zinc oxide paint films led to E. Täuber's 1909 (86) warning against using zinc white as a ground layer: "Sehr gefährlich erweisen sich als Untergrund auch Zinkweiß . . ." Interestingly, in the research on Abstract Expressionist paintings associated with this literature review, all of the research group paintings exhibiting severe paint layer failure were found to have zinc oxide ground layers.

ZINC OXIDE IN INDUSTRIAL LITERATURE BETWEEN 1926-1950

The most useful articles from this period appear mostly in industry journals and symposium post prints. Articles from this period focus mostly on market demand and product adaptation, which may not initially seem applicable to conservation, but in fact provide uniquely informative material that is available only in the industrial literature.

Competitive Bias

As zinc oxide paint was adopted by the consumer market, the commercial debate shifted to determining the best raw material for successful paint formulations. The audience for these articles was the paint manufacturer, and accordingly, much of the information regarding raw materials was conveyed through papers presented at industrial symposia. Of the nearly fifty articles gathered from this period, the authors of approximately a quarter of the studies note their affiliation with a university or scholarly research center, while a far larger number of authors acknowledge their role as employees of paint and raw pigment manufacturers. Sponsored symposia articles are suspect, especially when the authors present the superior qualities of their product with little explanation of analytical methods and limited bibliographies (some examples are Kekwick 1938, Calbeck 1941, Davidson 1949). The 1949 Zinc Oxide Symposium, sponsored by the Victorian Section (Australian Branch) of the Oil & Colour Chemists' Association and reproduced in a special issue of *Paint Notes: A Journal of Paint Technology* (1949), contains several examples of so-called "comprehensive" literature surveys whose bibliographies are limited to authors with similar agenda. For example, K. R. Bussell's survey of literature promoting the use of acicular zinc, which begins with the statement: "the literature on zinc oxide is, of course, very extensive" (1949, 217) contains a bibliography of articles exclusively by industry representatives. Such publications should not be ignored, however. Symposia post prints also include papers by impartial authors who offer comprehensive citations and unbiased discussions of paint film behavior. The writings of F. L. Browne (1936 and 1941), D. W. Robertson (1935 and 1936), J. R. Rischbieth (1949) and F. C. Schmutz (1935) stand out because of their inclusive references and accessible language. Despite an irregular citation style, bibliographies from these articles are invaluable in building comprehensive period literature lists. Period post prints also contain pertinent information about period additives (such as surplus post-WWII rubber plasticizers) or industrial formulations based on engineered failure properties, a topic of particular relevance to the conservator.

Weathering Tests and Engineered Paint Film Behavior

Unique information about engineered paint film behavior can be found in weathering test articles from this period, which contain several examples of "common knowledge," defined for the purposes of this article as the repeated mention—in various publications and by varied authors—of assumed information. For example, Rischbieth's article from the Australian symposium (1949) focuses on zinc oxide paint performance in Australia, but also notes a global industrial preference for acicular zinc pigment, purposefully used because the brittle acicular zinc oxide paint films will preferentially micro-fissure during failure. Such widespread chalking caused the upper layers of zinc oxide house paint to slough off in the rain, creating the appearance of a perpetually clean paint surface. Weathering test literature from this period debate the best formulation for achieving this so-called "renewal" of the paint film surface, which was preferred over more sporadic crack patterns that were difficult to level and prepare for repainting. This engineered difference between industrial paint and artist's paints of the same period is useful information for the modern paintings conservator. In relation to the associated conservation research, paints engineered for such failure characteristics would provide an ineffective support layer for the heavy paint application of Abstract Expressionist compositions.

Industrial paint formulations also reflect regional climate differences. As Robertson stated in his 1935 article for the *Official Digest of the Federation of Paint & Varnish Production Clubs*: "fifty percent of the day, a house in a latitude such as that of England has no direct sunlight" (Robertson 1935, 252). As weathering test performance determined the viability of paint in different environments, paint formulations would be changed to respond to regional climate differences. For conservation concerns, this means that different formulations (and behaviors) could exist in the same brand of zinc oxide paint used by contemporaneous artists from different regions. On a larger scale, formulations using zinc oxide as the primary pigment may remain in the house paints used by artists in mild European climates well beyond the mid-1950s replacement of zinc oxide (by titanium dioxide) in industrial paint formulations for the wide-ranging climate of the American market. As Robertson noted (1935, 252): "In France, Germany, and Panama we have high zinc content paints. In England we have paint that will last from five to six years, but it would not last two years in the United States."

It is worth remembering that early house paints were not formulated for long-term stability. Frequent statements in the weathering literature confirm that while zinc oxide was still considered a poor film-former, the industry requirements for durability differed significantly from those of the modern paintings conservator. As proclaimed by S. Werthan in a widely-distributed 1947 promotional publication from The New Jersey Zinc Company entitled *Post-War Exterior House Paints* (reproduced the same year in the *Paint, Oil, & Chemical Review*): "a white house paint possesses real merit if it maintains a clean-bright surface free of significant film failure for a period of three years" (Werthan 1947, 38). This sentiment is repeated in later literature, including a comparative exposure tests article by R. W. Bailey and A. Pass for a 1953 issue of the *Journal of the Oil & Colour Chemists' Association* (171): "Zinc fails by checking and cracking with flaking and erosion which seems fairly severe. . . . Paints containing zinc pigments have, however, a natural useful life of at least three and a half years." (As early as 1935 (241) Robertson observed: "No [exterior] paint containing zinc oxide in any form . . . has failed to show cracking after one year.") An engineered three-year life expectancy for zinc oxide paint is important information for conservators faced with the prevalence of house paint use by artists in the first half of the twentieth century.

Two-Coat Paint Systems

A number of articles appeared in the 1930s and 40s regarding the challenges posed by the use of zinc oxide in a composite paint system; conservators working with objects that may contain industrial paints should not overlook the literature on house paint primers. Articles by Browne (1941), Robertson and Jacobsen (1936) and Schmutz (1935) echo Täuber's earlier warnings against the use of zinc oxide as a priming layer. As emphasized by Robertson and Jacobsen (1936, 403): "There is a direct relationship, in terms of performance, between relative hardness of undercoat and top coat, and that certain combinations are incompatible." In his article for the *Paint, Oil, and Chemical Review*, Schmutz notes (1935, 356): "In the aim of developing a better primer it is possible that too little thought has been given as to how this primer might work under the different finishing paints. . . . In some cases there is a marked increase in checking and cracking of the finishing coats and in others an actual decrease in adherence of the whole system vitiating all of the desirable properties shown by the primer alone." Industrial articles regarding the behavior of two-coat paint systems are particularly useful when applied to the conservation of paintings and painted objects. The associated Abstract Expressionist study group paintings exhibited the same behavior foretold thirty years earlier: cracking of the upper compositional paint layers indicating widespread failure and delamination of an underlying zinc oxide ground layer. That study concluded that Abstract Expressionist works produced during the early twentieth-century era of popular house paint usage should be carefully observed during instances of mechanical stress or changes in the environment, when the stress response behaviors of the zinc oxide ground and adjacent compositional paint layers may be incompatible. As stated by Browne in 1941 (901): "Complete elimination of zinc oxide from primers is recommended by one school of thought on the subject and is opposed by another. . . . Conclusions about the use of zinc oxide in primers must be subordinated to the more fundamental problem of compatibility between primer and finish paint."

FORESHADOWING CONSERVATION RESEARCH IN THE INDUSTRIAL LITERATURE

Despite the disparity between early twentieth-century analytical techniques and today's scientific methodology, the period literature contains forward-thinking articles on topics that have recently gained attention in conservation research. For example, period articles regarding the impact of zinc oxide on the mechanical properties of paint film foreshadow the conservation community's examination of the relationship between environment and paint film mechanics that began in the 1980s and 90s in the United States (Mecklenburg et al. 1991 and 1992), Canada (Michalski 1991, Moar and Murray 2007), the United Kingdom (Young et al. 2004; Hagan et al. 2007) and Europe (et al. 2006); later industrial research on zinc ion migration in anti-corrosive coatings (van Eijnsbergen 1978) may parallel recent conservation science analysis of ion migration between paint films (Mecklenburg 2010).

Period zinc oxide literature also addresses the role played by critical pigment volume concentration (CPVC) in film failure characteristics, a topic explored in the 1960s by conservation scientists such as Robert Feller (1964). Period CPVC topics include blistering and peeling (Hess 1965), as well as articles by Browne (1955 and 1957), Funke (1967) and the team of Eissler and Princen (1966, 1968, 1970, 1972) on the effects of zinc oxide on the water sensitivity of oil paints, also the focus of recent conservation research in the United Kingdom and Europe (Mills et al. 2008; Tempest et al. 2010). Period authors may cover more than one topic of interest, such as Browne, who writes about zinc oxide's role both in two-coat paint systems (1941) and water sensitivity (1955 and 1957, in an unexpected resource entitled *Forest Products Journal*).

A striking example of industrial literature presaging modern conservation inquiry appears in the coatings industry's early interest in the formation of zinc soaps, a topic of recent conservation research worldwide (van der Weerd et al. 2003; Singer and Liddie 2005, Noble and Boon 2007; Shimadzu et al. 2008). Zinc soaps are mentioned as early as Petit's 1907 manuscript, with articles focused solely on the subject of soap formation appearing in the early 1940s. In a 1941 issue of *Industrial and Engineering Chemistry*, Jacobsen and Gardner hypothesized a lamellar structure for saponified zinc oxide oil films. The authors' discussion of zinc oxide's unique behavior in relation to oleic acid was instrumental in interpreting the unusual oleic:azelaic fatty acid ratios found in gas chromatography analysis of the Abstract Expressionist study group paint samples (Rogala et al. 2010; Maines et al. 2011).

Zinc Oxide in Acrylic Paint

A discussion of acrylic paint media lies outside the scope of this article, but it is worth noting that industrial literature regarding attempts to formulate stable zinc oxide latex paints begins in the early 1970s (Hoffmann and Saracz 1969 and 1972; Madson 1971 and 1974; Johnson et al. 1991; Diebold et al. 2003). Early industrial literature on latex formulation may also foreshadow current conservation research on acrylic paints. Conservators researching this topic may find useful bibliographies within these early texts.

ZINC OXIDE IN RECENT INDUSTRIAL LITERATURE

Returning zinc oxide topics found in the post-1975 industrial literature include the role of CPVC (Bierwagen 1992; Perera 1995), and the role of particle shape in mechanical behavior (Feliu et al. 1993; Hare and Kurnas 2000). The bulk of modern zinc oxide research, however, has shifted to the technological sector as the properties of zinc oxide are explored for use in electronic circuitry (Klinshirn 2007). Like Jacobsen and Gardner, recent articles by the teams of Xu et al. (2004) and Vasudevan and Barman (2006 and 2007) hypothesize a plate-like structure within a zinc oxide paint film, which would weaken the film by sporadic disruptive bond formation. Earlier zinc oxide film failure site comparisons by Funke (1967) and Eissler and Princen (1972) support the idea of plate formation on a macro scale within the paint film layer. In combination with an understanding of fatty acids distribution within the zinc oxide matrix (Keune 2005; Boon 2006), this recent industrial research played an important role in interpreting the zinc oxide intra-layer cleavage pattern observed in the associated Abstract Expressionist study group paintings.

CONCLUSION

The articles presented in this literature review focus on the mid-twentieth century development and production of oil-based zinc oxide house paint. The sequence of the industrial literature is familiar: introduction of a new material, competition for market share, consumer feedback and product adaptation, and new research spurred on by potential new markets. But an examination of even this narrow range of articles illustrates the useful information that can be obtained through a review of the period literature. Industrial articles produced at the same time as an artist's use of a material provide unique information about formulation and behavior, which is especially important if the purposeful manufacture of the material is at odds with the long-term preservation goals of the conservator. When read carefully, industrial literature is an accessible and valuable resource for the modern materials conservator.

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AUTHOR

Dawn Rogala
Postgraduate Research Fellow, Museum Conservation Institute, Smithsonian Institution
Doctoral student, Preservation Studies Program, University of Delaware
E-mail: RogalaD@si.edu

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ALEXANDER W. KATLAN

The Salmagundi Palette Collection

ABSTRACT

A discussion of the American palette collection of the Salmagundi Club formed in the late 19th and early 20th centuries and which numbers approximately 120 palettes. The history of how the Salmagundi Club's collection was formed which includes such American artists as J. Francis Murphy, George Inness, John Dolph, J.G. Brown, and the conservation treatment of the selected palettes from the Club's collection. The ethical problem in preserving artist tools (in this case palettes) is talked about and the importance of committing scarce conservation funds for the preservation of a unique collection opposed to the assumption that conservation funds should only be used for the preservation of artworks.

INTRODUCTION

As Gettens and Stout stated in *Painting Materials a Short Encyclopedia,* although palettes have been made out of various materials--porcelain or enameled ware, glass, slate and aluminum--the standard material for artist palettes for centuries has been hardwood. Cherry wood, walnut and mahogany were common in the nineteenth century, while whitewood (tulip wood), and birch wood as well as hardwood veneers have been used in the twentieth century. It has been suggested that palettes have been used as early as Egyptian pre-dynastic times. Early palettes also appear in a Pompeian wall painting from an artist studio. Palettes are depicted in the eleventh century, in old master paintings of Saint Luke, and paintings of artist studio interiors showing various shapes. However, according to Gettens and Stout, *"… few actual palettes …have survived"* from the eighteenth century or earlier. Thus, it is in the nineteenth and twentieth centuries that palette collections (that still survive today), were beginning to be formed, with emphasis not on American artists but on nineteenth century

Figure 1. Entrance Hallway of the Salmagundi Club at 12 West 14th Street, New York, New York, ca. 1896. George Inness Palette with brushes hanging on the wall. The larger panels were by J. Francis Murphy, F.K.M. Rehn, Robert Minor, R.M. Shurtleff, H. Bolton Jones, Frank Green, Frederick Naegele, George H. McCord, Thomas Craig, Henry Mosler and James Tyler. The smaller panels were signed by W. C. Fitler, William V. Birney, A. T. Van Laer, Frank Jones, Paul Moran, De Scott Evans, Carle J. Blenner, Herbert Morgan, W.H. Shelton, Charles E. Proctor, J. N. Marble, Henry P. Smith, L. C. Earle, William H. Howe, and De Cost Smith. Courtesy Salmagundi Club.

European artists. Most museum palette collections are almost solely European in orientation, and a large museum collection would have a maximum of a dozen or so European palettes with at the most one or two American artist palettes. For example, the National Academy of Design of New York, a center for American art for over a century, has in its collection, only three American artist palettes; James Carroll Beckwith, George Willoughby Maynard, and John LaFarge.

PALETTES

According to Gettens and Stout, there are three modern shapes for palettes: the oval, the oblong or rectangular, and the studio or arm palette. The studio or arm palette is larger than the other two types and varies from about twenty to nearly thirty inches in length and from fourteen to about eighteen inches in width. The thumb hole is set well back from the edge, and the edge which is held towards the painter is cut out to fit around the elbow.

The studio palette in particular is of varying thickness from one half to three quarters inch at the thumb hole side and tapered to about an eighth inch. This provides strength where the strain is greater and gives a certain weight to the end which is shorter, allowing a balance to the whole. Today, however, many modern artists prefer to use the top of a painting cabinet or table, covered with a piece of glass, ceramic, plastic, or cardboard which can be brought into a position conveniently near an easel. Many modern artists today consider a wooden palette a quaint tool and merely a symbol of their craft. They never use a wooden palette when they paint. The change in using wooden palettes may be directly related to the change in artists' grounds and painting techniques previously using red or multiple grounds on canvases, common in the seventeenth and eighteenth centuries and replaced in the nineteenth and twentieth centuries with single and double layer lead white grounds on canvases. The brown tone of a wooden palette became less desirable to use for color mixing.

HISTORY

It is most unusual to find a palette collection numbering approximately one hundred and twenty American artist palettes at the Salmagundi Club. The Salmagundi Club's Collection includes palettes by such member artists as J. Francis Murphy, J. G. Brown and by non-members George Inness and Thomas Dewing; The collection is composed mostly of nineteenth and early twentieth century artists. It is probably the largest remaining collection of its kind in the United States. The likelihood that such a palette collection could be formed again, today, is very small.

The Salmagundi Club began in 1871 as a sketch club (Salmagundi Sketch Club), which met in various artist studios where members would critique each others drawings, sketches, and oil studies. Some of the Club's meetings were first held at the skylight studio of American sculptor, Jonathan Scott Hartley, who was the son-in-law of the artist George Inness. Meetings were also held in Napoleon Sarony's photography studio at 37 Union Square. The name of the Club comes from two sources; the word "salmagundi," according to the *Random House Dictionary*, is a mixed dish consisting of chopped meat, anchovies, eggs, onions, oil, etc. with a second meaning of "bits and diverse pieces," like an Irish stew with various meats of beef and pork, or a Caesar's salad. The actual source of the name is most likely from the essays by Washington Irving and William and James K. Pauling called the *Salmagundi Papers* which poked fun at the staid and puritanical New York high society of the time.

The palette collection was not begun until the Salmagundi Club had a permanent clubhouse, first located at 14 West 12th Street when their wanderings from artist studio, to studio ended. This was formerly the American sculptors John Rodger's studio before he moved to New Canaan, Connecticut, and the Club resided at this location starting in 1894 until 1917. It was during these years the Club began to form its library, art collection and palette collection from donations by artists members. Some of the books in the library were donated by John La Farge and by his widow after LaFarge's death in 1910. It is probably in 1896 that the first palette came into the Club's collection; this was George Inness palette, with brushes, and it was a donation by George Inness Jr. (who became Club president in 1903) and by Jonathan Scott Hartley (married to Helen Inness). An old albumen photograph of the hallway of the club house shows the Inness palette hanging from the wall. Artist members of the time created the panel paintings that line the hallway, many of which are still in the Club's collection . The larger panel paintings are by J. Francis Murphy, Frederick Rehn, Robert Minor, R. M. Shurtleff, Hugh Bolton Jones, Frank Green, Frederick Naegele, George McCord, Thomas Craig, Henry Mosler, and James Tyler. The smaller panels, to name a few, are by Paul Moran, De Scott Evans, Carle Blenner, and William Howe.

By 1917, the Club purchased the brownstone mansion of Irad Hawley, former president of the Pennsylvania Coal Company; it was built in 1852-54. Shortly after 1917, the Club received the donation of approximately 67 American artists' palettes from the artist Harry W. Watrous, who was first secretary and then director of the National Academy of Design. The artist Watrous gathered many palettes from painters he knew many of whom were his friends. Most of Watrous' collection were demonstration palettes and not working palettes, due to their small size; they were never actually used by the artists. Harry Watrous probably supplied the oval blanks, because of the similarity of sizes, and asked the artists to arrange their colors as they normally worked and to sign the palettes on the front. Included are palettes by Ralph Blakelock, Emil Carlson, and William Merrit Chase to name a few artists in the collection. Over the decades artists and their families would donate artwork and palettes to the club. Upon the death of the American tonalist J. Francis Murphy in 1921, his working palette was donated by his wife and now resides along side the main entrance hallway of the Club in a place of honor opposite the George Inness palette and paint brushes.

The personal arrangement of colors on a palette relies on each painter's development of personal working methods and application of paint. The non-painter might assume that an artist would lay out the colors in order of the spectrum, but that apparently would be no more convenient than if your computer keyboard was arranged alphabetically. The choices and arrangements of colors for an artist to work easily, are as individual as the finished picture and often more enlightening. As Harry Watrous states in a 1908 letter,

> *In examining this collection, you will notice the individuality in the setting of the colors, some with the white in the center, some with it on the end, with the reds, yellows, greens, and blues grouped in entirely different manners… but always beautiful and harmonious. It also shows the simplicity of the artist's choice of colors, and how a hundred or more painters will take the same palette and work an entirely different color scheme, the dry and hard, the rich and mellow, the sparkling and somber, each proclaiming the master in brain and brush. Some of these palettes have been "Studio Gods" have been used for years, some for the painting of a single picture, and some have never been used, but have been "set" for me, and on each is the signature used by the painter in signing a picture. For they (the palettes) are pictures, and in living with them I see the painters and what they love to paint, though many hands that held these palettes will never again clasp mine on earth, having gone "where only the Master shall praise us, and only the Master shall blame."*

PROJECT

At the Salmagundi Club, the palette collection was hung on the walls, in the library, and in the hallways of the Club. This was probably done not only because of the large number of palettes, but also to keep the collection safe. The collection was basically ignored for decades, just as other museums and art organizations ignored their own collections. Artist tools, palettes, and other artist implements were not considered valuable by the public or by the museum community in general. For the curator, although an interesting adjunct to the craft of painting, palettes were important enough to collect but not to care for. This attitude of the 1960s and 1970s has changed through the efforts in past years by Ross Merrill, former Director of Conservation at the National Gallery of Art, who established the Art Materials and Research Study Center at the National Gallery of Art, Washington DC, and by Montgomery County College Professor Ed Ahlstrom's on-going research into American palettes.

Over the years, New York City dirt and grime were deposited on the Club's palette surfaces, so much so that the original colors and tints were no longer visible but simply visible as a grayish black tone; even the signatures on these palettes became difficult to read. At a time when funds were scarce, the palette collection of the Salmagundi Club suffered from benign neglect. The attitude towards the palette collection changed when it was discovered, a couple of years ago, that some palettes in the Club's collection actually had paintings on them when most of them were either working or demonstration palettes. The palette surfaces were so discolored by dirt that the images of the painting were dulled and obscured; with the palettes hanging high on the walls, in some cases hung upside down, the painted images were not easily visible to the viewers. The palettes were numbered with paper labels that were adhered directly to the palette surface. In the course of treatment these labels were removed and bass numbers were attached to the walls near the palettes.

Out of the Club's collection of about one hundred and twenty palettes, only nine palettes had paintings on them. Seven palettes were chosen by the Club for conservation treatment, cleaning and stabilization. The artist's palettes that were chosen were: G. Glenn Newell, George Inness Jr., John G. Brown, John Dolph, Herbert Morgan, Charles Henry Miller, and the 75th Anniversary palette of 1945. Some of the palettes had splits in the wood, caused in some cases by improper mounting onto the wall and drilling holes into the palettes or in other cases, by water damage from a leaking roof. Some of these structural problems could be locally repaired, stabilized, or consolidated using thickened Paraloid B-72 adhesive or Beva-371 solution. In other cases the best method of treatment was minimal intervention, to prevent the splitting from extending in the wood and to stabilize the palettes such as in the case of J. Dolph's palette. The damages and splits remained visible. The palettes were cleaned with a pH-adjusted aqueous solution of citric acid and sodium hydroxide adjusted to a pH 6.5 and 7.5, depending on the solubility, to remove the heavy layer of surface grime and dirt. According to the stipulations of the Board of Trustees, pigment sampling and analysis were declined at this time. Cleanings were limited to surface cleanings to reveal the true colors and the consolidation of some of the pigment paint dabs that were chipping. In some cases, the damages existed in the pigment blobs, (dabs) and stabilization was done to prevent further pigment loss. It was decided after discussion with the trustees that a varnish coating of Paraloid B-72 would be applied to minimize future deposits of grime and dirt on the palette surface. A discussion of possibly encasing the collection was done, however the logistics of enclosing such a large collection that was permanently on view, may not be possible.

Figure 2. Palettes, hand painted mugs, and thumb box oil sketches. Portrait of J. Sanford Saltus (a founder of Club Library) by artist George M. Reeves. Courtesy Salmagundi Club.

CONCLUSION

In closing, the ethical problems in preserving artist's tools and the need to convince an institution of the importance of preserving artist's tools, was successful only because of the discovery of paintings on the palettes. The need to commit scarce monetary funds to conserve artists' tools was the purpose of this discussion. The assumption that conservation funds should only be used for the preservation of artworks is open to debate, as individual artist tools, such as palettes, brushes, paint boxes, and paint tubes, may be as unique and important as the individual works of art created with them. These artist materials may be as significant for future authentication as the artwork itself.

Figure 3. Artist George Inness working palette and brushes. Presented to the Salmagundi Club in 1896 by J. Scott Hartley. Courtesy Salmagundi Club.

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AUTHOR

Alexander W. Katlan
President/Owner, Alexander Katlan Conservator Inc.
56-38 Main Street
Flushing, New York 11355
Tel. 718-445-7458
E-mail: www.alexkatlan@aol.com
www.alexanderkatlan.com.

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Figure 4. Artist Harry Watrous working palette. Courtesy Salmagundi Club. Before treatment.

Figure 5. Artist Elihu Vedder demonstration palette. Untreated. Courtesy Salmagundi Club.

Figure 6. Artist Charles Henry Miller demonstration palette with painting. Before treatment. Courtesy Salmagundi Club. Before treatment.

Figure 7. Signature (C.H. Miller N.A.) and pigment loss in paint dab. Courtesy Salmagundi Club.

Figure 8. Test Cleaning. Courtesy Salmagundi Club.

Figure 9. After Treatment. Courtesy Salmagundi Club.

RUTH BARACH COX

The Long-term Relationship between a Museum Collection and Contracted Conservator Explored through the Treatment of *Spring Turning* by Grant Wood

ABSTRACT

How does a conservator best serve the needs of an institution when they are not a permanent staff member and part of the daily functioning of the museum? The key to establishing a successful relationship is through the joint efforts and communication between the staff and conservator. Each has to be aware of the potential role of a full-time staff conservator and be willing and committed to planning a long-term strategy to address the needs of the collection.

This paper will discuss one relationship between a conservator and institution. Topics will include how as part of an ongoing treatment plan the physical and visual needs of the individual works of art, as well as educational and research goals of the institution and conservation are met.

Grant Wood's masterpiece *Spring Turning,* painted in 1936, has been in the Reynolda House Museum of American Art's collection since 1991 when it was gifted to the Museum by their President on the occasion of their 25th anniversary as a museum of American Art. It was a key gift and is much beloved by the museum patrons. It is also one of the most interesting pictures that Wood painted both technically and ideologically. The re-examination of this artwork has brought to the fore ethical questions regarding the physical conservation and visual presentation of Wood's paintings and provided an opportunity for gaining further knowledge of Grant Wood's working techniques and artistic maturation. This treatment and associated research adds modestly to the corpus of work begun on Wood in the 1990s when the Davenport Museum of Art compiled the monograph *Grant Wood: An American Master Revealed* in conjunction with the 1995 exhibition. Without the Reynolda House Museum staff's commitment to continued learning and examination of the paintings within their collection this could have just been a simple varnish removal, reapplication and inpainting treatment. However, it culminated in the discovery of several new facts about Wood's technique and an educational video for the Museum's website that promotes a deeper understanding and appreciation of this artist's work and the profession of conservation.

Since its creation the Reynolda House Museum of American Art's collection has been cared for by a variety of skilled and dedicated conservators. This is one of many stories written by conservation professionals in this collection. It is a link temporarily located between the past and the future until this work also becomes part of history.

The relationship of this conservator with the Reynolda House Collection and staff began with a letter written over twenty years ago and placed in a file. The letter sat for almost ten years and then a new director of collections, Rebecca Eddins, reached for the file and a new alliance began. The initial meeting involved walking through the collection discussing the "look" of individual works of art—their surfaces, the visual balance within the composition, what read properly and what did not. Later on we discussed the appropriateness of lighting and the location of artwork within the historic house. HVAC and light filtering systems also made it to the table. But first and foremost it was the pictures that led the discussion and the desire to present them in a manner true to the intent of the great artists who produced them.

The question to be addressed in this paper is whether the increasing trend of collecting institution towards outsourcing conservation services affects the long term preservation of cultural heritage. Simplistically one can answer both yes and no. It is up to the reader to consider the issue on the content of this and others presentations. This conservator believes it is possible for a contracted conservator to provide adequate, if not perfect, longterm planning and collection care if the institution is committed to these issues and recognizes conservators as professionals and an integral part of the collection's longevity. Because the staff of Reynolda House Museum places their collection custodianship and historic house before all other museum priorities, and recognizes the importance of conservation, it has been possible for a contracted conservator to impact the future of the collection.

In 1912, Katharine Smith Reynolds commissioned the Philadelphian architect, Charles Barker Keen, to design a residence and 40 support buildings. Until 1964 several generations of the Reynolds family lived in the country estate. At that time the furnished house and 19 acres were incorporated as a non-profit institution dedicated to arts and education. In 1967 the Z. Smith Reynolds and Mary Reynolds Babcock Foundation provided funds for a collection of American art, and the house and its collection were opened as a museum to the public. The fine art collection ranges from mid-18th century American portraiture to some of the great pioneers of the American Modernist movement.

One of Ms. Eddin's most pressing concerns for the 225+ painting's collection was the routine thorough surveying and documentation of their condition. Though this had been done in the past, the format required updating and systemization. Periodic formalized examination of the entire collection would help devise a master list of treatment priorities and alert the custodians to any adverse condition changes. Into this priority list acute conservation needs could be inserted. To date, the painting's collection has been surveyed twice using this updated system. Notebooks have been compiled with detailed survey examination forms and photographs annotated with condition issues. All of this information is now being digitized and linked to the curatorial files for each picture. The ongoing challenge is the design of a direct computer-based system for future surveys. This digitized information along with their substantial archive of over 18,000 documents will be accessible to approved researchers.

In addition to the the survey work, a disaster preparedness plan was developed and reviewed with the staff. An abbreviated art handling and transport workshop has also been given. The role of conservation in the context of collection maintenance has been presented to the museum's governing board as has a selection of recent treatments. To further conservation education, a lecture was presented to the general museum membership discussing various conservation treatments and answering general conservation related questions. In conjunction with this lecture a brochure was designed by the staff and conservator for the maintenance of member's personal collections. To further conservation education outreach, the Museum decided that a video of the treatment of Grant Wood's *Spring Turning,* would be illustrative of conservation work done within the collection.

Through the 2002 and 2006 survey of this picture, it was prioritized primarily because of aesthetic issues and its importance to the collection. The painting's failing visual appearance had been noted by previous conservators: however, for a variety of reasons the conservation work had not been undertaken (figs.1, 2). The visual problems of the painting were related

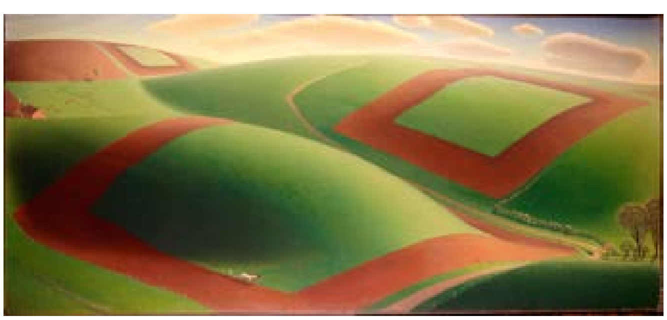


Figure 1. Obverse, before conservation treatment, Grant Wood, *Spring Turning*,1936. Oil on masonite panel, 18 ¼ x 40 ⅛ in. (45.62 x 100.31 cm). Reynolda House Museum of American Art 1991.2.2

Figure 2. Reverse, before conservation treatment, Grant Wood, *Spring Turning*, 1936. Oil on masonite panel, 18 ¼ x 40 ⅛ in. (45.62 x 100.31 cm). Reynolda House Museum of American Art 1991.2.2

Figure 3. Details of shriveled paint and wide aperture cracks in the paint film of *Spring Turning*.

to the aging of a past conservation effort and long standing paint condition problems brought about by Wood's painting technique (fig. 3).

One of this conservator's primary art historical and technical sources for Grant Wood's artistic production was a well-crafted catalogue and collection of essays published by the Davenport Museum of Art in conjunction for their 1995 exhibition entitled *Grant Wood: An American Master Revealed*. It included two art historical essays and three technical studies. The process by which *Spring Turning* was made was discussed; however, the picture was not part of the analytical study. There was only one picture from the mid-1930s entitled *Dinner for Threshers* from which data was collected. Consequently, it was felt that if a careful technical study was permitted during treatment it would provide a unique opportunity to expand our knowledge about Wood's technique and artistic evolution.

During the 1920s Wood made three trips to Paris, and in 1928 a trip to Munich. The art and society that surrounded him informed his future work. In Paris he experimeted with impressionism and post-impressionism and adopted the pontilist technique and classical form from artists such as Georges Seurat (fig. 4). Like Seurat, he rendered form with short staccato brushstrokes. Unlike Seurat, who uniquely combined complimentary colors, Wood used local color to describe his form. However, the technique of working from broad color to

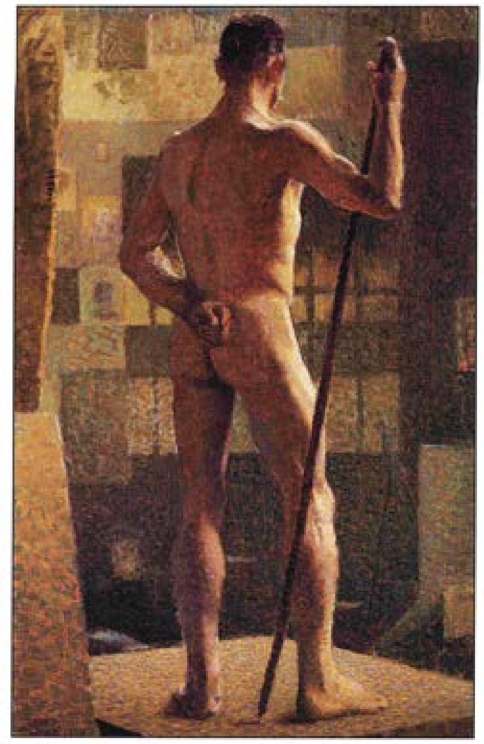


Figure 4. Grant Wood, *The Spotted Man*, 1924. Oil on canvas, 32 x 20 in. (80 x 50 cm) Davenport Museum of Art 75.14

finer and finer brushwork stayed with Wood throughout his career. As we will see, *Spring Turning* represents one of his most calculated, layered and finely controlled compositions. The linear brushwork and juxtaposition of specific local color can be traced back to his days in Paris.

Wood's 1928 trip to Munich exposed him to a huge gamet of ideologies and pictorial style from Northern Gothic Art to Neue Sachlichkeit. The tension between abstraction and realism, and the expression of psychological tenor and social commentary filtered to the fore of his consciousness. Technically, Wood was exposed to the hard edge clarity of late Gothic representation produced with meticulous planning, disciplined tight brushwork, and controlled layered glazing. To summarize Franz Roh's definition of the Neue Sachlichkeit movement, it included: one point perspective, three-dimensional form, realistic proportions, aloof point of view, hard edge depiction, and a use of local color [1] (fig.5). The aloof viewpoint, hard edge depiction, three dimensional form, and use of local color is clear in *Spring Turning* (fig. 6).

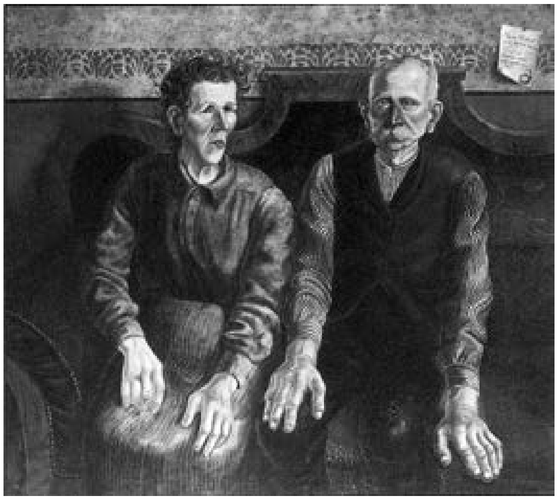


Figure 5. Otto Dix, *Die Eltern des Kunstlers II*, 1924. Oil on canvas 46 ½ x 51 ⅜ in. (116.25 x 129.38 cm). Sprengel Museum, Hannover, Germany

It is evident through Wood's known readings on art and design theory in the 1920s and his writings in the 1930s that he was well versed in art theory as proposed by the Fenollosa-Dow system of abstraction, Ernest A. Batchelder's "curve sense," Leo Stein's A-B-C of Aesthetics (1927) as well as the tenants of the Arts and Crafts movement. All of these works informed his theoretical design and helped him by the early 1930s develop a "precise linear stylization that distinguished his paintings from earlier works."[2]

By the 1930s Wood returned to Iowa and focused on applying his personal synthesis of abstraction, modernism and design to the rural landscapes and portraits of the people of Cedar Rapids. Wood rejected the trend of progressively abstracted modernism–both American and Continental. As the decade progressed he continued to modified his views and became firmly defined as an American Rural Regionalist. He is now counted among the "first generation of American Modernist due to his adherence to reductive abstraction."[3] He never stepped out of the context of "story-telling" into pure abstraction.

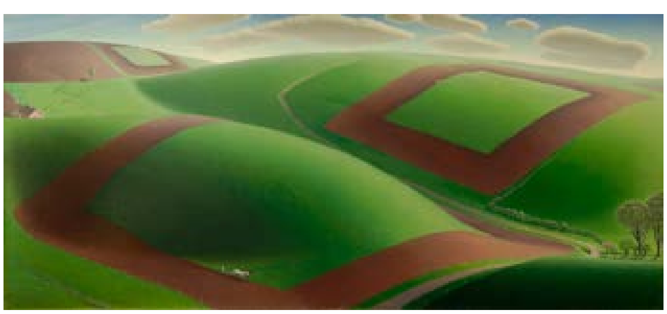


Figure 6. Obverse, after conservation treatment, *Spring Turning.*

During the 1930s Wood further "developed a system of teaching design and perspective he called the principle of "thirds." He recommended dividing each edge of the paper or canvas into thirds, then placing every major compositional line along one of the diagonals formed by connecting these points. In this way, the eye would always be carried back to the center of interest rather than out of the picture."[4] An example of this is seen in a drawing entitled March, dating from 1941 currently in the Davenport Museum of Art (fig.7). As an exercise my assistant, Maria Fiorito, divided the rectangular space of *Spring Turning* into thirds in a similar manner on a mylar overlay (fig.8). It was then placed over the finished picture and found that the focal points adhered to this theory supporting the idea that he was using this mechanical technique well before the extant drawing from the 1940s.

Evidence for the preparation for the painting of *Spring Turning* is a full-sized pencil, charcoal and chalk drawing now in The Henry E. Huntington Library and Art Gallery in San Marino,

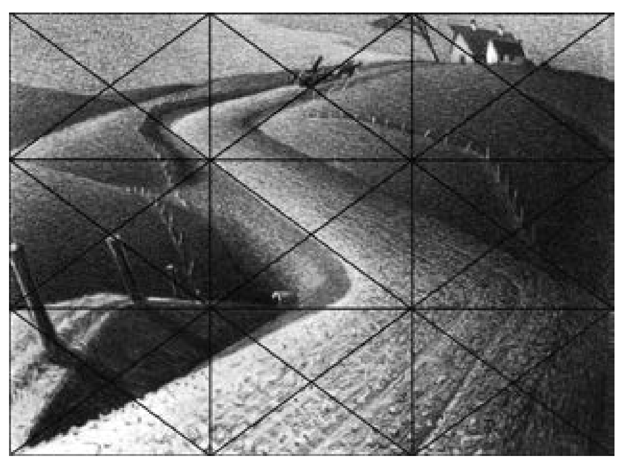


Figure 7. Grid with diagonals superimposed to illustrate Wood's "thirds" method of composition, Grant Wood, *March*, 1941. Charcoal and white chalk on paper, 9 x 12 in. (22.5 x 30 cm). Davenport Museum of Art, 60.1014

Figure 8. Grid with diagonals superimposed in a system of thirds (as in Figure 7) as seen on *Spring Turning*.

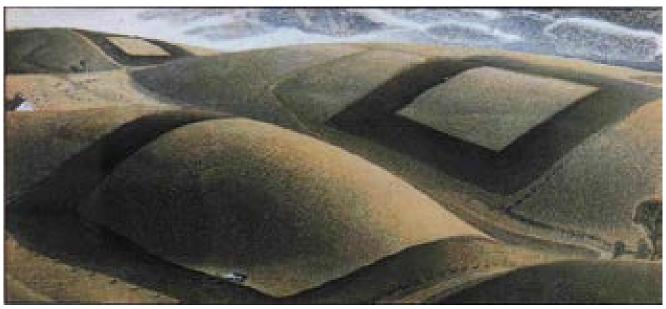


Figure 9. Study for Grant Wood, *Spring Turning,* 1936. Pencil, charcoal, and chalk on paper, 17 ½ x 39 ¾ in. (43.75 x 99.37 cm). The Henry E. Huntington Library and Art Gallery, San Marino, California, 83.8.53

California (fig. 9). Probably as a precursor to the highly refined drawing, Wood is known to have modelled the entire landscape in clay. This was done ostensibly to assure the accuracy of the angle of the lighting and form definition.[5]

Spring Turning was executed on a reinforced masonite panel measuring 46 3/16 in. in width and 24 in. in height. Masonite, introduced in 1926, was well suited as a support for Wood's picture. It provided a uniform, flat surface that could be cut to any desired size. This was a departure from supports used in the early 1930s in that *American Gothic* and *Arnold Comes of Age* were painted on a layered pulp board, and *Stone City Iowa* is on plywood. It is also interesting to note that by the late 1930s Wood was attaching canvas as an interleaf between the masonite or plywood supports and the paint film.

When the picture came into the conservation studio for treatment the edges were covered with a layer of black tape that hid the junction of the original panel and its support system (fig.2). It was questioned whether the support system was added during the previous conservation treatment or was original to his structure. After removal of the tape it became clear that Wood had modified the masonite support himself (fig.10). Both the drips of the ground and paint accretions were found on the support structure. Wood must have been aware that a masonite panel of *Spring Turning's* size, if unsupported would flex dangerously stressing the paint film's integrity. To this end he had constructed the wooden collar, brace with metal plates, to keep the panel planar. Additionally, when the tape was removed a printed paint title and signature was uncovered on the auxiliary support's reverse.

Fortunately permission was granted to take several cross-sections from *Spring Turning* to answer specific questions about the composition of the ground and the complexity of the paint structure (fig. 11). Another pertinent question was whether a varnish technique, documented on other works by Wood, had been used on this picture and the layer for the most part removed during the previous conservation treatment. The analytical work was done by James Martin of Orion

Figure 10. Details of the edges and support system, Grant Wood, *Spring Turning*.

Analytical. He is also the scientist who did the analysis for the technical studies conducted in 1995.

The ground proved to be consistent with the 1930s grounds. It was made of an oil binder pigmented with barium sulfate and reflective flakes of talc. Interestingly the two pictures sampled in the 1995 study that date from before 1926 had lead white grounds. From 1926 through data collected from pictures until 1941, Wood appears to have been consistent in the material chosen for his grounds. As mentioned by James Horns and Helen Mar Parkin in their technical study, Wood's assistant Arnold Pyle recorded that the artist often applied several coats of Benjamin Moore's white undercoat, an oil-based paint, instead of a gesso ground to prepare his panels.[6] The composition of Benjamin Moore's paint is consistent with the data collected in this and previous studies. Another chronicler, Lee Allen, discussed Wood's technique in the late 1930s mentioning that he used a commercial white paint for the ground, which he allowed to settle and then poured off the excess oil that rose to the top and used the thicker paint below as a ground.[7] The direction of the ground application brush strokes are faintly visible in this raking light photograph (fig.12). Inscribe lines from the design transfer are also visible as seen in this raking light detail (fig.13).

It is thought that Wood began painting the picture by broadly washing lean paint to define the composition. This technique of laying in color would correspond to extant sketches such as the study for *Fall Plowing* 1931 and in *Iowa Landscape* dating from 1941.[8] Seeing this technique at the beginning, middle and end of the decade suggests it was a standard working practice. James Martin identified that the cross-sections showed a number of layers some of which were worked wet into wet and others with varnish layers interleafed. Visually one can see that some of the "layers" of hatching were worked wet into wet, while zones were enriched and uniformly saturated with pigmented resin layers (fig.14). Unlike American Gothic there are no areas of ground or underpaint visible from the surface (fig.15). The work is densely painted with design zones abutting one another with thin transitional washes to assure there are no visual gaps in the work. This is a trend that continues into his work in the late 1930s (fig. 16). In *Spring Turning*, unlike in his later works, Wood reserves staccato brushwork for specific design elements and does not use it overall as evidenced in these comparative illustrations (figs. 17, 18).

Despite all of Wood's careful planning, design changes are still visible in this work.[9] Additionally because of his layering technique the film developed a plethora of drying and incompatibility issues. Shriveled paint and wide aperture cracks riddle the surface (fig.19). The wide aperture cracks in particular were visually distracting prior to conservation because of discolored overpaint (fig. 20). The textured paint had collected pools of natural resin in the interstices that was not

Figure 11. One of three sample sites originally chosen from *Spring Turning* to determine Wood's painting technique. This site and sample also answers a question raised during the AIC conference. It clarifies that there was no visual or microscopic (Figure 21a) evidence to support the presence of atmospheric glazing in this area of the painting.

Figure 12. Diagonal relief of ground strokes visible in this slightly raking light photograph of *Spring Turning.*

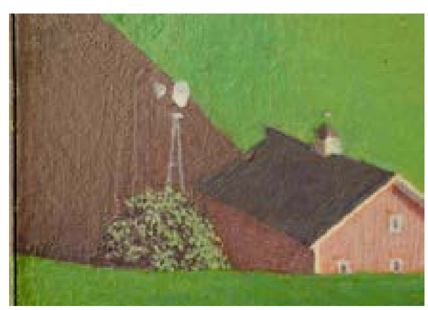


Figure 13. Design transfer inscribed lines and compositional changes visible in this raking light detail of *Spring Turning*.

Figure14. Photomacrograph of cross-hatching brushwork seen in *Spring Turning*.

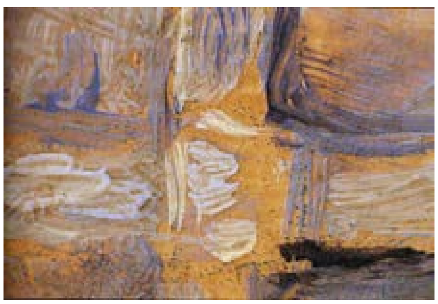


Figure 15. Detail of open brushwork with ground exposed in Grant Wood, *American Gothic*, 1930. Oil on beaver board, 29 ⅞ x 24 ⅞ in. (74.38 x 62.18 cm). The Art Institute of Chicago copied here from *Grant Wood: A Technical Study* James S. Horns and Helen Mar Parkin (1995), Illus. 39 in Davenport Museum of Art's Exhibition Catalogue entitled *Grant Wood: An American Master Revealed*.

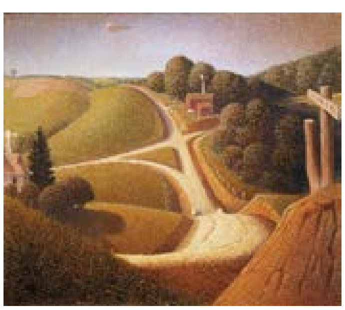


Figure 16. Note the density of brushwork in this later work by Grant Wood, *New Road*, 1936. Oil on canvas adhered to paperboard mounted on hardboard, 13 x 14 ⅞ in. (32.5 x 37.18 cm). National Gallery of Art Washington, 1982.7.2

Figure 17. Note the restrained use of staccato brushwork in *Spring Turning*.

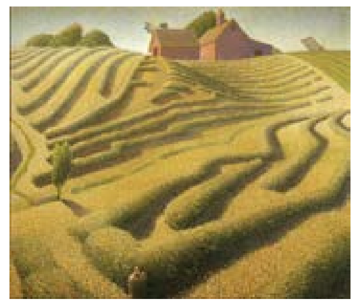


Figure 18. Compared to the brushwork in *Spring Turning*, the brushwork in *Haying* is consistently staccato with no relief from visual texture. Grant Wood *Haying*, 1939. Oil on canvas adhered to paperboard mounted on hardboard, 12 ½ x 14 ⅞ in. (31.25 x 37.18 cm). National Gallery of Art, Washington, 1982.7.1

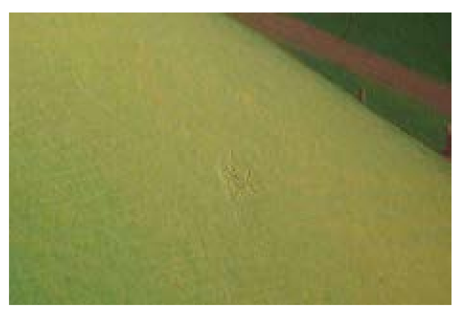


Figure 19. Detail of schriveled paint in *Spring Turning*.

removed during the previous conservation treatment. These residues had discolored further and dappled the surface in a incoherent manner interrupting the smooth abstract curves of the rolling landscape.

The cross-section analysis of the varnish layers showed natural resin residues nearest the paint film covered with a later acrylic coating (figs. 21a, 21b). Of considerable interest were these globular natural resin residues that were scattered over the surface (fig. 22). Clearly these residual globules had discolored and were now completely out of context with the majority of the surface. But the question of whether these residues once comprise the entire last coating or were a dappled layer beneath a final uniform brushcoat remains undetermined. Arnold Pyle commented that the artist would apply a uniform pigmented glaze, wait several hours and then using a dry cloth blot off portions of the glaze or layer.[10] Over this broken layer Wood is known to have sometimes applied a retouch varnish.[11] Stippling that might produce a resin globule like those seen in *Spring Turning* are clearly visible in *American Gothic* (fig. 23). In this macro-photograph an artist change that overlay the stippled layer is visible. In this case the layer appears to be discolored unpigmented resin. If the layer were clear as suspected when applied, its purpose may have been to modify surface texture not the color. The resin nodules tested in *Spring Turning* likewise did not contain pigment and it is thought that they too adjust the surface gloss and texture rather than provide a toning hue. Furthermore these globules appear predominately in the sky.

The ethical question of whether or not to remove highly discolored coatings on paintings by Grant Wood needs to be evaluated on a case by case study. Clearly Wood was very particular about the nuance of tonal graduations and subtle glaze application. The area where light strikes the green hills has a bright clear yellow glaze that subtly alters the tonality.[12] The overall yellowed synthetic coating that overlay this picture masked the beauty of this particular tonal modulation. (figs.1, 6) However, if the present coatings were applied by the artist and specifically manipulated should they be removed? There are also areas in *Spring Turning* where a mildly pigmented, unifying glaze *may* have been removed during the previous conservation treatment as seen in these juxtaposed color zones that lack a bridging glaze as seen in the upper left area of the sky.[13] In comparison to the nuance of glazing found in the hills the abrupt demarkation between color zones seems stark. This may be due to the removal of a toning glaze during a previous cleaning. Though these observations are speculative it is worth considering how the subtleties of this picture have been altered through time.

Figure 20. Detail of discolored overpaint covering cracks in *Spring Turning.*

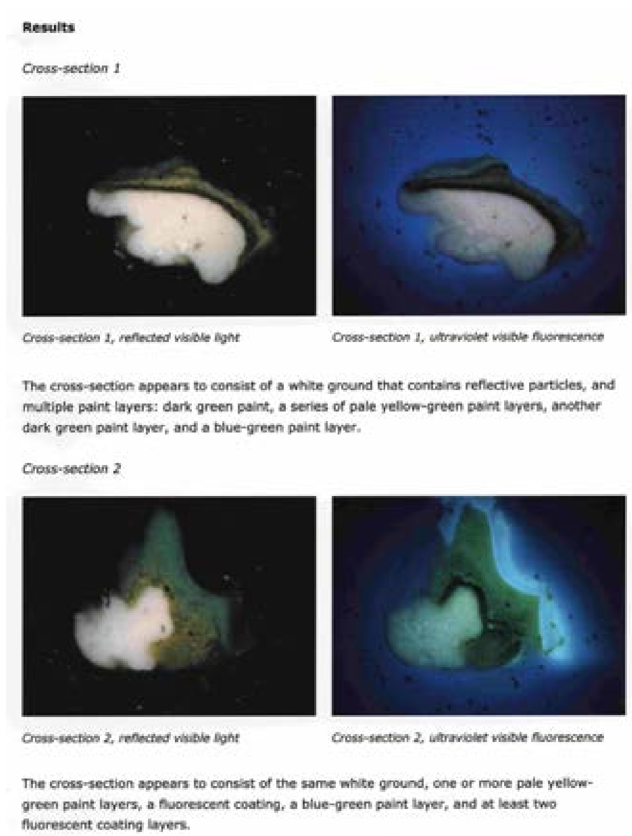
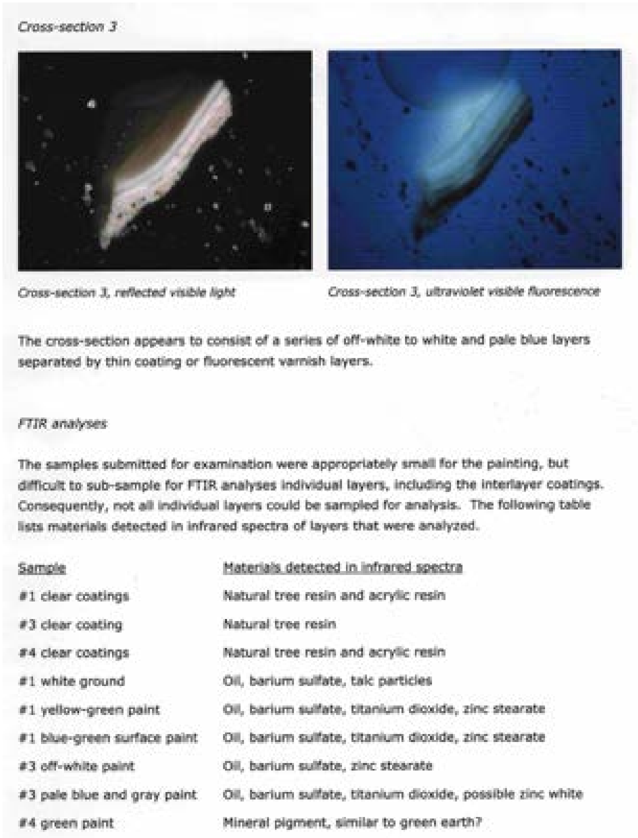


Figure 21a. Cross-section photomicrographs of samples 1 and 2 from *Spring Turning*. Courtesy of James Martin of Orion Analytical, LLC



Cross-section 3

Cross-section 3, reflected visible light — *Cross-section 3, ultraviolet visible fluorescence*

The cross-section appears to consist of a series of off-white to white and pale blue layers separated by thin coating or fluorescent varnish layers.

FTIR analyses

The samples submitted for examination were appropriately small for the painting, but difficult to sub-sample for FTIR analyses individual layers, including the interlayer coatings. Consequently, not all individual layers could be sampled for analysis. The following table lists materials detected in infrared spectra of layers that were analyzed.

Sample	Materials detected in infrared spectra
#1 clear coatings	Natural tree resin and acrylic resin
#3 clear coating	Natural tree resin
#4 clear coatings	Natural tree resin and acrylic resin
#1 white ground	Oil, barium sulfate, talc particles
#1 yellow-green paint	Oil, barium sulfate, titanium dioxide, zinc stearate
#1 blue-green surface paint	Oil, barium sulfate, titanium dioxide, zinc stearate
#3 off-white paint	Oil, barium sulfate, zinc stearate
#3 pale blue and gray paint	Oil, barium sulfate, titanium dioxide, possible zinc white
#4 green paint	Mineral pigment, similar to green earth?

Figure 21b. Cross-section photomicrographs of sample 3 from *Spring Turning*. Courtesy of James Martin of Orion Analytical, LLC

In conclusion, though the final educational video by necessity simplified the complexity of this work art historically and technically, it did provide an pleasing introduction to both the artist, his technique and some of the conservation issues. The museum's support for technical research and inquiry beyond their immediate needs shows the institution's commitment to scholarship. It is also illustrative of the broad possibilities that mutual respect, and the development of a ongoing contract relationship, can do to further the corpus of knowledge regarding specific artists and preserve the integrity of a collection.

My sincerest thanks go to the staff of the Reynolda House Museum of American Art for their continued support of conservation work and trust in my abilities. I would also like to thank James Martin of Orion Analytical for the many years of his technical assistance, superior work and friendship and the numerous conservators whose previous work made this presentation possible. This work very modestly added to the huge amount of research sponsored by the Davenport Art Museum in preparation for the 1995 exhibition and I heartily thank those who participated in that seminal publication.

Grant Wood was an exceptional artist, full of nuance, irony, and joy. It is the artists who truly desire our gratitude for providing us with a vision of their present and giving us a glimpse into our past.

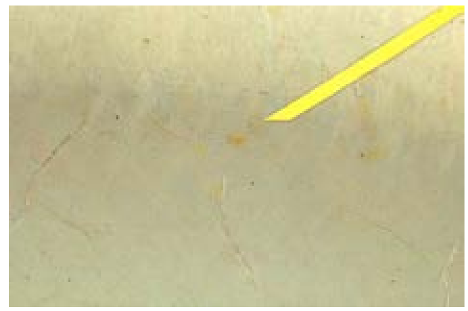


Figure 22. Photomacrograph of resin nodules found in the sky of *Spring Turning*.

Figure 23. Photomacrograph copied here from *Grant Wood: A Technical Study* James S. Horns and Helen Mar Parkin (1995) Illus. 42 within the Davenport Museum of Art's Exhibition Catalogue entitled *Grant Wood: An American Master Revealed*.

ENDNOTES

1. Brady M. Roberts,"The European Roots of Regionalism: Grant Wood's stylistic Synthesis," *Grant Wood: An American Master Revealed,* Davenport Museum of Art, 1995, pp.20–21
2. James M. Dennis,"Grant Wood's Native-Born Moderism," *Grant Wood: An American Master Revealed,* Davenport Museum of Art, 1995, p. 46.
3. *Ibid*., p. 55.
4. James S. Horns and Helen Mar Parkin, "Grant Wood: A Technical Study," *Grant Wood: An American Master Revealed,* Davenport Museum of Art, 1995, p. 81.
5. *Ibid.,* pp. 80–81.
6. *Ibid.,* p. 74.
7. *Ibid*., p. 74
8. Please see illustrations of *Fall Plowing*, 1931. Oil on canvas (30 x 40 ¾ in.) John Deere Art Collection and *Iowa Landscape*, 1941. Oil on masonite panel, (13 x 15 in.), Davenport Museum of Art, 65.7.
9. Please see Figure 14 to illustrate this point.
10. James S. Horns and Helen Mar Parkin, "Grant Wood: A Technical Study," *Grant Wood: An American Master Revealed,* Davenport Museum of Art, 1995, p. 85.
11. *Ibid.,* p. 85.
12. Please examine Figure 6, Grant Wood, *Spring Turning*, 1936. Oil on masonite panel, 18 ¼ x 40 1/3 in. (45.62 x 100.31 cm). Reynolda House Museum of American Art 1991.2.2
13. Please examine Figure 6, Grant Wood, *Spring Turning*, 1936. Oil on masonite panel, 18 ¼ x 40 1/3 in. (45.62 x 100.31 cm). Reynolda House Museum of American Art 1991.2.2

AUTHOR

Ruth Barach Cox
Painting Conservation, Inc.
4314 Cobscook Drive
Durham, North Carolina 27707

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SUZANNE QUILLEN LOMAX, BETH A. PRICE, CHARLES DAVIS, BORIS PRETZEL, MARCELLO PICOLLO, AND RYAN GRIEB

Raman Revealed: A Shared Internet Resource for the Cultural Heritage Community

ABSTRACT

The use of Raman spectroscopy for cultural heritage studies has increased in recent years. However, its greater use has been limited by a lack of readily-accessible, high-quality, relevant reference data. To help address this need, the Philadelphia Museum of Art and Infrared and Raman Users Group (IRUG) have partnered to create a Raman spectral database, supported by an Institute of Library and Museum Services National Leadership Grant. The database project is the second of its type undertaken by IRUG, which previously developed and distributed infrared spectral compilations. This paper provides a brief introduction to IRUG and the Raman database project.

INTRODUCTION TO THE INFRARED AND RAMAN USERS GROUP

IRUG is an independent, not-for-profit corporation that promotes the use infrared and Raman spectroscopy to study the world's cultural heritage. Formed in the United States in 1993, IRUG represents the largest group of museum conservation scientists dedicated to the principle of sharing scientific data. In addition to compiling and distributing reference spectra of standards, the group fosters professional connections and exchange, especially through its biennial conferences. The first IRUG conference was held in 1994 at the Philadelphia Museum of Art. Subsequent conferences took place at the Victoria and Albert Museum, London (1995); Winterthur Museum, Garden and Library, Winterthur, Delaware (1998); Bonnefanten Museum, Maastricht (2000); Getty Conservation Institute, Los Angeles (2002); Institute of Applied Physics "Nello Carrara", Florence, Italy (2004); Museum of Modern Art, New York (2006); Academy of Fine Arts, Vienna (2008); and University of Buenos Aires (2010).

The tenth biennial conference will be held on March 28–31, 2012 at the University of Barcelona, Spain (www.ub.edu) and hosted by the Department of Analytical Chemistry, Faculty of Chemistry. Further information regarding the upcoming conference can be obtained on the IRUG website at www.irug.org and the IRUG10 conference home page at www.ub.edu/IRUG10BCN.

Since its inception, a major focus of IRUG has been the development of its collaborative spectral database. Thus far, over 100 institutions have contributed more than 2,100 infrared spectra. The first IR collections published in 1993 and 1995 were in hardcopy. Later, a reliable, customized spectral file format was established based on the scientific data standard JCAMP-DX (Joint Committee on Atomic and Molecular Physical- Data Exchange), along with peer review and uniform criteria for quality and accuracy of material identification.[1] These guidelines were applied to subsequent editions that were distributed in both digital and hardcopy formats in 2001 and 2009.[2] An online, keyword searchable database version was created under a 2002 grant from the National Center for Preservation Technology and Training (NCPTT) [3] and placed on the IRUG website.[4] Further information about the history of the group, its activities, and individuals and institutions that have contributed to the database is available on the website.

RAMAN SPECTRAL DATABASE PROJECT OVERVIEW

IRUG is now engaged in an effort to create an online Raman spectral database for the cultural heritage community that will complement the existing infrared database. This work is being supported by a National Leadership Grant from the Institute of Library and Museum Services (IMLS), awarded to the Philadelphia Museum of Art (PMA) in partnership with IRUG. [5] The new software features will allow for extensive use of the Raman database and include an interface for online submission, peer-review, editing, and formatting of spectra, as well as a searchable Raman bibliography with a library of open source papers.

The project is progressing through four overlapping stages:

1. Enhancement of Website Infrastructure and Database Construction
The existing IRUG website infrastructure is being enhanced for the new Raman features and the database constructed using an open-source framework to provide custom-programmed processes to handle the Raman data. The new infrastructure will meet best practice and security standards.

2. Development of Spectra Submission Process
A user-friendly submission process will enable contributors to electronically upload and save native (raw) JCAMP-DX spectra to their own account on the website. An online data formatter will transform the submitted spectra with supporting information provided by the user into IRUG's extended fully-described JCAMP-DX files to enable universal access. Software is under development for peer-review of submitted spectra. The peer-review will be conducted by the Raman Review Committee (see committee below), who will evaluate and approve or return submissions. After approval, the Raman data will be parsed into the database for safe centralized storage and dissemination via the IRUG website. A web-based user interface will be developed to allow users to perform online searches and downloads of digitized and printed Raman spectra.

3. Construction of Raman Bibliographic Library
This library will be constructed with an interface for contributors to upload Raman literature citations and open source papers. High-quality references relevant to cultural heritage materials will be accepted based on peer-review. Users will be able to perform searches and export citation results and papers.

4. Beta Testing and Launch
A full beta testing will involve numerous users and Raman experts and be followed by launch and training for IRUG Raman database users. At launch, the database will contain 700 high-quality peer-reviewed reference spectra and 300 library citations.

PROJECT ACCOMPLISHMENTS

Raman Review Committee
A review committee of Raman experts from the museum field has been formed to oversee the collection, evaluation (quality control), and formatting of the contributed Raman data. The chair of the committee is Suzanne Quillen Lomax at the National Gallery of Art, Washington, DC. Current members of the Raman Review Committee are:

- Lucia Burgio, Victoria & Albert Museum, London
- Silvia Centeno, Metropolitan Museum of Art, New York
- Suzan DeGroot, Netherlands Cultural Heritage Agency, Amsterdam
- Howell G. M. Edwards, University of Bradford, UK
- Glenn Gates, Walters Art Gallery, Baltimore
- Richard Hark, Juniata College, Huntington, Pennsylvania
- Suzanne Quillen Lomax, National Gallery of Art, Washington
- Odelie Madson, MCI, Smithsonian Institution, Washington
- Jennifer Mass, Winterthur Museum, Delaware
- Richard Newman, Museum of Fine Arts, Boston
- Marcello Picollo, Istituto di Fisica Applicata "Nello Carrara", Florence
- Boris Pretzel, Victoria & Albert Museum, London
- Beth Price, Philadelphia Museum of Art
- Adriana Rizzo, Metropolitan Museum of Art, New York
- Laurianne Robinet, Synchrotron Soleil, Gif-sur-Yvette
- Greg Smith, Indianapolis Museum of Art
- Karen Trentleman, Getty Conservation Institute, Los Angeles

Customized Format for Raman Files
A file format for the Raman spectra has been developed by the Raman Review Committee. Adapted from the previously defined IRUG infrared file format, it is based on JCAMP-DX ASCII text files. The Raman general file format is shown in File 1 below. Each file consists of a series of labeled data records, known as LDR's, with 80 character per line limits. Each LDR line includes a label that is followed by a sequence of text fields. As shown in File 1, the labels are in caps following ## (or ##$) whereas the fields are situated in brackets. The various fields are used to store important descriptive information regarding the JCAMP version, data type, origin of data,

instrument, sample and sampling details, and the x, y spectral data. Twenty-one of the ninety fields listed below are unique to Raman. Full definitions for the LDR's and fields can be found in the IRUG white paper, *Revised JCAMP-DX Spectral File Format for Submissions to the Infrared & Raman Users Group (IRUG) Database,* on the IRUG website.[1]

File 1 - General Format for IRUG Raman Files
##TITLE=[IRUG filename (0)] [common/trade/chemical name (36, 37, 38)], [sample source 1, 2 or 3 (55, 58 or 61)], [sample identifier 1, 2 or 3 (57, 60 or 63)], [ORIGINATING INSTITUTION ACRONYM (2)], [mode (28)]
##JCAMP DX=[JCAMP version number and software version number (14)]
##DATA TYPE=[data type (15)]
##APPLICATION=[application (16)]
##ORIGIN=institution: [originating institution name (1)]; address: [originating institution address (3)]; analyst(s): [analyst(s) name(s) (4)]; tel: [analyst telephone (5)]; fax: [analyst fax (6)]; email: [analyst e-mail (7)]; submitter: [submitter name (8)], [submitter institution name (9)]
##OWNER=COPYRIGHT (C) [year YYYY] BY [originating institution name (1)]
DATABASE COPYRIGHT (C) [year YYYY] BY Infrared and Raman Users Group (IRUG) (on separate lines)
##$LICENSE=By accepting this database user agrees to be bound by the terms of the IRUG user's license. Any reference written/oral made to this file must include accreditation to BOTH the originating individual/institution and IRUG. Contributor agrees to be bound by the terms of the IRUG contributor's license.
##$INSTITUTION FILE NAME=[originating institution filename (10)]
##DATE=[date YY/MM/DD (11)]
##LONGDATE=[longdate YYYY/MM/DD (12)]
##TIME=[time HR:MIN:SEC (13)]
##SPECTROMETER/DATA SYSTEM=spectrometer: [spectrometer manufacturer and model (17)]; software: [instrument software version and release (18)]; detector: [detector type (19)]; monochromator: [monochromator (68)]
##INSTRUMENT PARAMETERS=apodization: [apodization type (20)]; accumulations: [accumulations (71)]; purge: [instrument purge Y/N, purge gas (22)]; range: [spectral range cm-1 (23)]; source: [excitation source nm (69)]; power: [power mW (70)]; calibration: [calibration (72)]; data collection: [data collection type (73)]; integration time: [integration time sec (74)]; other detector parameters: [other detector parameters (75)]
##RESOLUTION=[resolution cm-1 (24)]
##DATA PROCESSING=baseline corr.: [baseline correction Y/N (26)]; fluorescence corr.: [fluorescence correction Y/N (76)]; cosmic ray removal: [cosmic ray removal Y/N (77)]; detector binning: [detector binning Y/N (78)]; other data processing: [other data processing (27)]; further data processing information may automatically be inserted by JCAMP converter
##SAMPLE DESCRIPTION=mode: [mode (28)]; accessories: [accessories (29)]; support: [sample support (30)]; objective magnification: [objective magnification x (79)]; numerical aperture: [numerical aperture (80)]; working distance: [working distance micron/ mm (81)]; spot size: [spot size sq. micron/ mm (82)]; confocal: [confocal Y/N (83)]; angle: [angle degrees (84)]; polarization: [polarization Y/N (85)]; filters: [filters (86)]; cut-off freq.: [low cut-off frequency cm-1 (87)]; grating type: [grating type (88)]; grating density: [grating density lines/mm (89)] ; laser defocus: [laser defocus Y/N (90)]
##SAMPLING PROCEDURE=mode: [mode (28)]; prep: [sample preparation (31)]
##PATHLENGTH=[pathlength cm (32)]
##PRESSURE=[pressure (33)]
##TEMPERATURE=[temperature degrees C (34)]
##CAS NAME=[CAS name (35)]
##NAMES=[common name (36)],[trade name (37)],[chemical name (38)] (each on separate lines)
##MOLFORM=[molecular formula (39)]
##$STRUCTFORM=[structural formula (40)]
##CAS REGISTRY No=[CAS Registry No (41)]
##WISWESSER=[Wiswesser line notation (42)]
##BEILSTEIN LAWSON No=[Beilstein Lawson No (43)]
##MP=[MP degrees C (44)]
##BP=[BP degrees C (45)]
##REFRACTIVE INDEX=[refractive index (46)]
##DENSITY=[density g/cc (47)]
##MW=[molecular weight (48)]
##CONCENTRATIONS=[concentrations (49)]
##STATE=state: [physical state (50)]; form: [form (51)]
##CROSS REFERENCE=[cross reference to additional spectra (52)]
##$LITERATURE REFERENCE=[literature reference (53)]
##$OTHER ANALYTICAL METHODS=[other analytical methods (54)]
##$MATERIAL SOURCE 1=[sample source 1 (55)]
##$SOURCE LOCATION 1=[source location 1 (56)]
##$SAMPLE IDENTIFIER 1=[sample identifier 1 (57)]
##$MATERIAL SOURCE 2=[sample source 2 (58)]

##$SOURCE LOCATION 2=[source location 2 (59)]
##$SAMPLE IDENTIFIER 2=[sample identifier 2 (60)]
##$MATERIAL SOURCE 3=[sample source 3 (61)]
##$SOURCE LOCATION 3=[source location 3 (62)]
##$SAMPLE IDENTIFIER 3=[sample identifier 3 (63)]
##$COLOR=[color (64)]
##$AGE=[age (65)]
##$IRUG MATERIAL CLASS=[IRUG Material Class (66)]
##$OTHER=[other (67)]
##DELTAX=[automatically inserted]
##XUNITS=[automatically inserted]
##YUNITS=[Arbitrary intensity]
##FIRSTX=[automatically inserted]
##LASTX=[automatically inserted]
##FIRSTY=[automatically inserted]
##XFACTOR=[automatically inserted]
##YFACTOR=[automatically inserted]
##NPOINTS=[automatically inserted]
##XYDATA=[automatically inserted]
##END=[automatically inserted]

Once the LDR's and corresponding fields have been assembled by the system in the format shown above and the file meets IRUG requirements, it becomes a discrete, universal, electronic data record that can be opened and viewed in any text editor (e.g., Notepad®, WordPad® or Word®) or in any instrument software equipped with a JCAMP-DX translator. Additionally, IRUG formatted Raman files can be transferred between various instruments and users and incorporated into searchable libraries created on local computers.

DISCOVERY AND TECHNICAL ASSESSMENT

The discovery and technical assessment phase of the Raman project has been completed and a Systems Requirements Document (not shown) has been produced with detailed workflow diagrams for the new website functionality. The workflow diagrams specify the life cycle of a Raman spectrum from upload and submission to evaluation by reviewers and senior editors, final edit and approval, and publish. Additional requirements specifications have been developed for the bibliography, glossary and feedback functionalities.

PRE-BUILD CONTRIBUTIONS OF RAMAN SPECTRA

Raman spectra are being solicited and collected from a number of contributors. These pre-build phase spectra help to estimate the quantity and establish the quality of the Raman data that will be received and will be used to prime the Raman database. They also aid in the development of the website software that must be built to accommodate the data generated by the various instrument software. Files from Bruker, Renishaw, Perkin Elmer, and Thermo have been examined and thus far 410 Raman spectra have been pledged by the following individuals:

- Organic pigments from the 20th and 21st century (Nadim Scherrer, Bern University of the Arts)
- Early synthetic dyes (Suzan de Groot, Netherlands Cultural Heritage Agency)
- Pigments (Francesca Casadio, Chicago Art Institute)
- Lapis lazuli (Richard Hark, Juniata College)
- Polymeric materials from The Resin Kit (Greg Smith, Indianapolis Museum of Art)
- Dry pigments (Deborah Lau, Commonwealth Scientific & Industrial Research Organisation, Australia)
- Plastics, polymers, plasticizers, bone, teeth, tortoiseshell, and naturally aged conservation materials (Odile Madden, MCI, Smithsonian Institute)
- Logwood inks, synthetic organic pigments (Silvia Centeno, Metropolitan Museum of Art, New York)
- Synthetic organic pigments from the Tate Collection and pigments from the Forbes Pigment Collection (Jennifer Mass, Winterthur Museum)
- 19th Century Winsor Newton watercolors (Lucia Burgio, Victoria & Albert Museum)
- Tate Collection and other pigments (Richard Newman, Michele Derrick, Museum of Fine Arts, Boston)
- Synthetic organic pigments (Suzanne Lomax, National Gallery of Art, Washington)
- Red pigments from the Forbes Pigment Collection (Philadelphia Museum of Art)

RAMAN SPECTRA SUBMISSION AND REVIEW PROCEDURE

Once the website software construction is completed, the Raman spectra submission and peer-review will proceed in the following manner:

First, a contributor opens an IRUG website account by contacting the appropriate regional IRUG chair to be provided a user name and password. Next, the contributor logs into their account and uploads a native (raw) Raman file that has been translated into JCAMP 4.24 or 5.01 using the JCAMP converter in their spectrometer software or other software (e.g., GRAMS32®), along with supporting information as requested on the online submission form. An example native (raw) JCAMP spectral file opened in Word® is shown below as it was uploaded by a contributor (the x, y data have been truncated for brevity). In its native format, the file contains minimal information beyond the x, y data. Furthermore, the value of 0.5 for ##RESOLUTION= in the native JCAMP file reflects its data spacing rather than the resolution of the spectrum as measured, and the units for the ordinate (##YUNITS=) are listed as absorbance rather than arbitrary intensity (or counts) as is customary for Raman spectral data.

File 2 – Native (Raw) Raman JCAMP-DX File as Uploaded to IRUG

```
##TITLE=Aragonite (HU Min. Museum 116189), 50X, 785 nm.1
##JCAMP-DX=4.24
##DATA TYPE=RAMAN SPECTRUM
##SAMPLING PROCEDURE=Reference collections
##XUNITS=1/CM
##YUNITS=ABSORBANCE
##RESOLUTION=0.5
##FIRSTX=70
##LASTX=1550
##DELTAX=0.5
##MAXY=29326.285
##MINY=689.02875
##XFACTOR=1
##YFACTOR=2.7312231e-005
##NPOINTS=2961
##FIRSTY=8123.4546
##XYDATA=(X++(Y..Y))
70.00...
##END=
```

Once the native JCAMP file is uploaded and the contributor is satisfied that the supporting information on the submission form is complete and accurate, she/he submits the spectrum, which then is directed to the Raman Review Committee. The system's software automatically sends the submission (spectrum with supporting information) to a least two expert reviewers based on the spectrum's designated material class or type (carbohydrate, mineral/pigment, natural resin, oil/fat, organic dye/pigment, protein, synthetic resin, wax, or unclassified).

Next, the reviewers evaluate the submission for spectral quality and accuracy of identification using a custom designed website software "review tool" to display and compare side-by-side the LDR's with the supporting information provided on the submission form by the contributor. Once the evaluation is completed, the reviewers will vote either: 1) to accept the spectrum "as is", or 2) to accept the spectrum "with minor revision", or 3) to return the spectrum to the contributor for revision and possible resubmission.

The reviewers' votes and comments pertaining to the submission are collated by the system and sent to senior editors for a final review. The senior editors may make minor revisions to the file based on recommendations by the reviewers. The system then stores the spectrum and supporting information in the online Raman database. When two or more acceptances are tallied, the spectrum is assembled by the system in the described IRUG JCAMP-DX format and published. Shown below is File 2 <u>after</u> it was peer-reviewed, edited and formatted to meet the IRUG JCAMP-DX standard (the x, y data have been truncated and 80 character per line limit ignored for brevity). In contrast to the native file, the final IRUG file is a complete data record. For example, the appropriate resolution and y units now have been included along with other important descriptive information ranging from excitation source (line) wavelength to material source, as shown below. The final file is displayed as a spectrum in Figure 1.

File 3 –Final Raman File Meeting IRUG JCAMP-DX Standard

```
##TITLE=RMP00002 Aragonite, Morro Bay, San Luis Obispo, MMHU, 116189, MFAB, scat
##JCAMP-DX=5.01
##DATA TYPE=RAMAN SPECTRUM
##APPLICATION=
##ORIGIN=institution: Museum of Fine Arts, Boston; address: 465 Huntington Avenue, Boston, MA, 02115, USA; analyst(s): Michele Derrick, Richard Newman; tel: +1 617 267 9300; fax: +1 617 369 3182; email: mderrick@mfa.org, rnewman@mfa.org; submitter: Beth Price, Philadelphia Museum of Art
##OWNER=COPYRIGHT © 2008 BY Museum of Fine Arts, Boston
DATABASE COPYRIGHT © 2011 BY Infrared and Raman Users Group (IRUG)
##$LICENSE=By accepting this database user agrees to be bound by the terms of the IRUG user's license. Any reference written/oral made to this file must include accreditation to BOTH the originating individual/institution and IRUG.
```

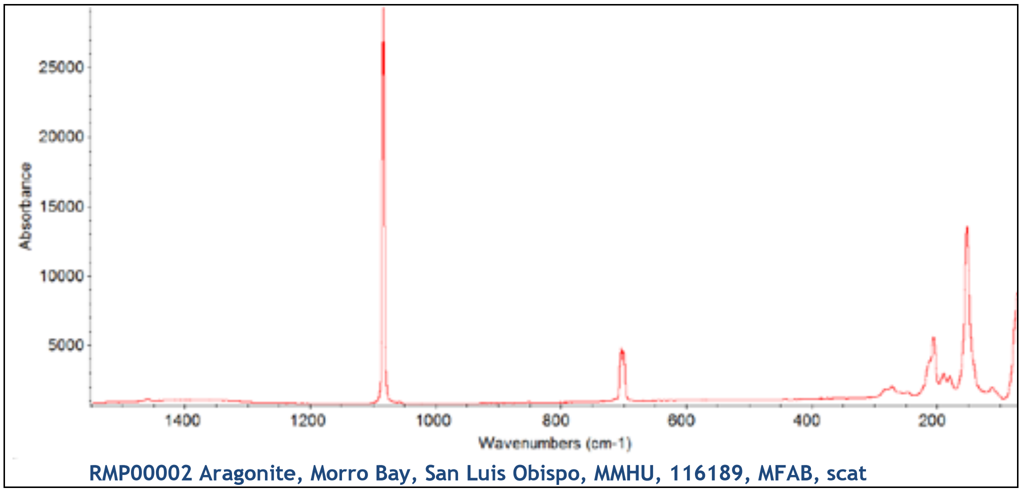

Figure 1. Published IRUG JCAMP-DX Raman Spectrum

Contributor agrees to be bound by the terms of the IRUG contributor's license.
##$INSTITUTION FILE NAME=Aragonite (HU Min. Museum 116189), 50X, 785 nm.1.dx
##DATE=08/07/29
##LONGDATE=2008/07/29
##TIME=12:55:37
##SPECTROMETER/DATA SYSTEM=spectrometer: Bruker Optics Senterra RMS spectrometer; software: Opus 6.5; detector: CCD; monochromator: dispersive
##INSTRUMENT PARAMETERS=accumulations: 1; purge: N; range: 70-1550 cm-1; source: 785 nm; power: 9.4 mW; calibration: multiband Neon; data collection: static; integration time: 30 sec
##RESOLUTION=3-5 cm-1
##DATA PROCESSING=baseline corr.: N; fluorescence corr.: N; cosmic ray removal: N; detector binning:Y; other data processing: smoothing: N
##SAMPLE DESCRIPTION=mode: scat; accessories: Senterra microscope; support: glass slide; objective magnification: 50x; numerical aperture: 0.75; working distance: 0.38 mm; spot size: 2 microns; confocal: N; angle: 180 degrees backscattered; polarization: N; filters: Rayleigh, dielectric; cut-off freq: 89 cm-1; grating type: holographic; grating density: 1200 lines/mm; laser defocus: N
##SAMPLING PROCEDURE=mode: scat; prep: bulk, neat
##PATHLENGTH=
##PRESSURE=
##TEMPERATURE=
##CAS NAME= aragonite
##NAMES=Aragonite
Calcium carbonate
##MOLFORM=C Ca O3
##$STRUCTFORM=CaCO3
##CAS REGISTRY NUMBER=14791-73-2
##WISWESSER=
##BEILSTEIN LAWSON No=
##MP=Tr. to calcite 520 degrees C (lit., CRC Handbook of Chem. and Physics, 61st Ed.)
##BP= Dec. 825 degrees C (lit., CRC Handbook of Chem. and Physics, 61st Ed.)
##REFRACTIVE INDEX=1.530, 1.681, 1.685 (lit., CRC Handbook of Chem. and Physics, 61st Ed.)
##DENSITY=2.930 g/cc (lit., CRC Handbook of Chem. and Physics, 61st Ed.)
##MW=100.09 g/mol (lit., CRC Handbook of Chem. and Physics, 61st Ed.)
##CONCENTRATIONS=
##STATE=state: solid; form: powder
##CROSS REFERENCE=infrared spectrum: Aragonite, Ref 116189, Morrow Bay, San Luis Obispo
##$LITERATURE REFERENCE=Howell G. M. Edwards, et al., FT-Raman spectroscopic study of calcium-rich and

```
magnesium-rich carbonate minerals, Spectrochimica Acta Part
A 61 (2005) 2273-2280.
##$OTHER ANALYTICAL METHODS=FTIR, EDS
##$MATERIAL SOURCE 1=Morro Bay
##$SOURCE LOCATION 1=San Luis Obispo, CA, USA
##$SAMPLE IDENTIFIER 1=
##$MATERIAL SOURCE2=Mineralogical Museum Harvard University (MMHU)
##$SOURCE LOCATION2=24 Oxford Street, Cambridge, MA, USA
##$SAMPLE IDENTIFIER2=MMHU# 116189
##$MATERIAL SOURCE3=Sample housed at Museum of Fine Arts, Boston
##$SOURCE LOCATION3=465 Huntington Avenue, Boston, MA, 02115, USA
##$SAMPLE IDENTIFIER3=MFA Reference # 116189
##$COLOR=White
##$AGE=
##$IRUG MATERIALS CLASS=MP
##$OTHER=
##DELTAX=0.5
##XUNITS=1/CM
##YUNITS=ARBITRARY INTENSITY
##RESOLUTION=0.5
##FIRSTX=70
##LASTX=1550
##FIRSTY=8123.4546
##MAXY=29326.285
##MINY=689.02875
##XFACTOR=1
##YFACTOR=2.7312231e-005
##NPOINTS=2961
##XYDATA=(X++(Y..Y))
70.00...
##END=
```


If upon review a submission is not accepted, the system returns it to the contributor along with a correspondence summarizing the reviewers' comments. Contributors can track the status of their spectral submissions during the review process on-line, as well as their status of their contributions to the online Bibliography. Once a contributor has met the minimum terms for IRUG participation, she/he will be able to download periodic updates and new editions of the IRUG Spectral Database in digital format as automatically assembled by the new website software. The current minimum terms are 10 Raman or infrared spectra accepted into the collection or other support such as acting as a reviewer or providing standards.[6]

Participation

The IRUG Infrared and Raman Spectral Database is an ongoing collaborative project. Its success stems from the generous contributors of spectra by participating individuals and institutions. At this time, the website submission and supporting software are under development, and spectra cannot be submitted online. In the meantime, the IRUG Regional Chairs and Raman Committee Chair will work with potential contributors to develop their Raman submission profiles and details, and upload native spectra in bulk into a secure account in advance of the website launch. IRUG also is receiving literature citations and open source papers for the online Bibliography. Interested participants should contact one of the Regional Chairs listed on the IRUG website, Beth Price (bprice@philamuseum.org), Marcello Picollo (m.picollo@ifac.cnr.it), or Boris Pretzel (boris.pretzel@vam.ac.uk), or the Raman Committee Chair, Suzanne Lomax, (s-lomax@nga.gov).

ACKNOWLEDGEMENTS

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ENDNOTES

1. For specifics on the IRUG JCAMP-DX format, see Price, B., B. Pretzel, and J. Carlson. 2011. Revised JCAMP-DX Spectral File Format for Submissions to the Infrared & Raman Users Group (IRUG) Database. www.irug.org/ed2k/jcamp.asp, (accessed 08/18/ 2011). For details on JCAMP-DX, see McDonald, R. S., and P. Wilks, Jr. 1988. JCAMP-DX: A Standard Form for Exchange of Infrared Spectra in Computer Readable Form, *Applied Spectroscopy* 42(1): 151-162; Grasselli, J. G. 1991. JCAMP-DX, A Standard Format for Exchange of Infrared Spectra in Computer Readable Form (IUPAC Recommendations 1991), *Pure & Applied Chemistry* 63(12): 1781-1792; and Lampen, P. et al. 1999. An Extension to the JCAMP-DX Standard File Format, JCAMP-DX V.5.01 (IUPAC Recommendations 1999), *Pure & Applied Chemistry* 71(8): 1549-1556.
2. Carlson, J., B. Price, and B. Pretzel, eds. 2001. *Infrared and Raman Users Group Spectral Database, Edition 2000*, Philadelphia: IRUG; and Price, B. and B. Pretzel, eds., 2009.

Infrared and Raman Users Group Spectral Database, Edition 2007, Philadelphia: IRUG.

3. The NCPTT is part of the US National Park Service and was created under the Historic Preservation Act Amendments of 1992. Its mission is to advance the application of science and technology to historic preservation. The NCPTT accomplishes this mission through training, education, research, technology transfer and partnerships within the fields of archeology, architecture, landscape architecture and materials conservation. For more information, see http://ncptt.nps.gov/.

4. See Carlson, J., B. Pretzel, and B. Price, eds., IRUG Spectral Database Edition 2000 Search Engine, www.irug.org/ed2k/search.asp (accessed 08/ 18/ 2011).

5. The Institute of Library and Museum Services (IMLS) is the primary federal support source for libraries and museums in the United States. Its mission is to create strong libraries and museums that connect people to information and ideas; to sustain heritage, culture, and knowledge; to enhance learning and innovation; and to support professional development. For grant announcement, see www.imls.gov/news/2009/092409b_list.shtm#PA.

6. Please note that by contributing to IRUG, the contributor explicitly accepts the terms of the IRUG Contributor's License Agreement. The copyright to a contributor's files remains with the contributor and the originating institution, whereas the contributor grants IRUG the free, indefinite and perpetual right to compile and distribute the contributions as part of the IRUG Database to others as deemed appropriate by the IRUG Board of Directors.

AUTHORS

Suzanne Quillen Lomax, Organic Chemist,
National Gallery of Art
Conservation Division
2000B South Club Drive
Landover, MD, 20785
USA

Beth A. Price, Senior Scientist
Philadelphia Museum of Art
Box 7646
Philadelphia, PA 19101
USA

Charles Davis, Database Architect Specialist
The Dow Chemical Company
100 Independence Mall West
Philadelphia, PA, 19106
USA

Boris Pretzel, Materials Scientist
Victoria & Albert Museum
Cromwell Road
South Kensington, London, SW7 2RL
UK

Ryan Grieb, Senior Technical Project Manager
R2integrated
2400 Boston Street
Baltimore, MD, 21224
USA

Marcello Picollo, IFAC-CNR Researcher
Istituto di Fisica Applicata "Nello Carrara" del Consiglio Nazionale delle Ricerche (IFAC-CNR)
Via Madonna del Piano 10, 50019, Sesto Fiorentino
IT

EMILY MACDONALD-KORTH

Speed, Precision, and a Lighter Load: Metigo MAP 3.0, a Great Advancement in Condition Mapping for Large-Scale Projects

ABSTRACT

Graphic documentation refers to data recorded using pictorial representation over a photograph or drawing of a work of art. The optimal graphic documentation method would incorporate three major functions: digital imaging, mapping, and area quantification tools. Metigo MAP, a digital condition mapping program, is a combination of image processing and computer-aided design. Metigo MAP is comparable to other digital graphic documentation programs, but the comprehensive functionality, compatibility, price, and free annual updates set it apart.

The paper includes the following sections: Introduction to graphic documentation and related software; Introduction to Metigo MAP; Metigo MAP workflow; Metigo MAP Case Study 1: Fengguo Temple, China; Metigo MAP Case Study 2: Yuan Dynasty murals in Beijing, China; Metigo MAP Case Study 3: Metigo MAP as a measuring tool; Graphic documentation software comparison and commentary; and Graphic Documentation Methods Comparison Table; Conclusions.

INTRODUCTION TO GRAPHIC DOCUMENTATION AND RELATED SOFTWARE:

Graphic documentation refers to data recorded using pictorial representation over a photograph or drawing of a work of art; the image of the work of art is called the base map. Graphic documentation is an important phase of conservation because it allows the conservator to accurately document works of art and their condition and aids in making estimates for treatment. The optimal graphic documentation method would incorporate three major functions: digital imaging, mapping, and area quantification tools. Digital imaging (a digital base map and the ability to manipulate the image appearance) allows the user workflow to be more efficient and more flexible than is possible using non-digital means. With digital imaging, the user can create a map inside a computer application, adjust the image to make it easier to use, and facilitate importing and exporting the file between other applications. Mapping means to precisely record surface or structural features on a base map and is the core requirement of any graphic documentation method. Area quantification tools enhance the value of any graphic documentation method, allowing the user to accurately describe how much of each condition or class is present and aiding in comparative condition studies and treatment estimates.

The traditional method of on-site condition diagramming uses colored pencils on paper prints or markers on sheet protectors; however, the paper method is not efficient. The paper method and its diagramming techniques are easy to learn, but because the base map is not digital, area quantification is not possible and the maps cannot be used in peripheral applications unless they are converted to a digital file by being redrawn into another program or digitally scanned. Storage of paper maps is also an issue; the maps can become cumbersome, especially for large-scale projects. Digital imaging programs, such as Adobe Photoshop and Illustrator, have offered new methods and approaches for graphic documentation. Adobe imaging programs work well for mapping but are of limited use for quantification; making measurements and calculations within the programs is difficult. The design program, AutoCAD (CAD, Computer-Aided Design) works well for making graphic maps using digital images and for making to-scale diagrams. CAD requires a large investment of time and energy to learn how to use the complicated software but is commonly used for large-scale projects.

INTRODUCTION TO METIGO MAP:

The shortcomings of these other methods led to the creation of Metigo MAP, a digital condition mapping program made by a German company named Fokus. Fokus is a preservation imaging firm that specializes in architectural photogrammetry and building surveys. Metigo MAP was designed for use by conservators of art and architecture, archaeologists, preservationists, and for other large- and small-scale condition assessment projects. Metigo MAP is a combination of image processing and computer-aided design and applies only the most useful functions for conservators from Adobe Photoshop and CAD. Metigo MAP allows users to create rectified to-scale images of the art object, architectural surface, or site and then to use the images to digitally draw highly detailed maps that indicate the location and extent of the various condition issues with visual designations, while also recording and calculating accurate surface area measurements of each condition issue. With Metigo MAP, the user makes the map directly in the computer by drawing the map on the image within the software while examining the artwork; this makes the documentation process faster by eliminating any intermediate steps. Metigo MAP is widely used in Europe; the scope of use has recently spread to other continents. Two institutions in China now use Metigo MAP, and a few institutions in the United States are using the software as well.

METIGO MAP WORKFLOW:

First, the user takes digital images of the work of art or architecture and then loads the images into the Metigo MAP software.

From there the user can rectify the images to make them straight and true-to-scale. For example, if the photographer cannot stand far enough away from the artwork to take the picture perpendicularly, the picture must be taken at an angle, and the result is a distorted image. The rectification function in Metigo MAP solves this common problem for large-scale projects: the distorted image is loaded into the software, the exact measurements collected on-site are entered into the software, and the software rectifies the image to be the correct format. After rectification, the software knows the actual dimensions of the artwork, and the location of every point on the artwork; by moving the cursor around the base image, the software gives the user the exact coordinates of any location on the image.

The user can process or adjust the images to improve sharpness, contrast, or brightness. Subtle color differences can be made more pronounced and easier to see for mapping by using the image processing settings.

From there, the user can create a map by making several categories of condition phenomena, called classes, each with a graphic representation on the map, and then organize the classes into groups. Each class or group of classes can be applied to the image in layers. For example, the user could make groups such as paint and ground, surface coatings, and restoration, and classes that fall under each group like flaking, blanching, and retouching, then view either the entire group or an individual class over the base map in the software. The list of groups, classes, and graphic representations do not have to be recreated for every project. The user can save the list in Metigo MAP as a template, creating a list that can grow, and choose only what is needed from the list for each project.

Because the image is rectified and true-to-scale, the program can calculate the total area or length of each class using the area quantification functions. This function can help, for example, in understanding the severity of each type of degradation phenomena. The area mapping function can also help in making accurate estimates for treatment.

When a map is completed, the user can design and insert a legend, and then the maps with all or a selection of layers can be exported as tiff files to be used in other programs or printed out. All the quantification data collected from area and length mapping can be exported into an Excel file for further use.

METIGO MAP CASE STUDY 1: FENGGUO TEMPLE, CHINA

The Art Conservation Department of the University of Delaware (UD) was invited by Tsinghua University of Beijing, a school famous for its architectural history program, to collaborate on an examination and condition reporting project at one of China's great cultural treasures, the Fengguo Temple, located in Yixian County, Liaoning Province, a rural region of northeastern China. Fengguo is a Buddhist temple, and was built between the 11th and 12th centuries during the Liao dynasty and is an exceptional and rare example of early traditional Chinese timber-frame construction. The temple holds an outstanding collection of polychromy which includes seven 30-foot, polychrome Buddha statues, painted architectural elements, and Buddhist murals most likely dating from the Yuan dynasty during the 12th century. Led by Dr. Susan Buck (Winterthur/University of Delaware Program in Art Conservation) and Dr. Liu Chang (Tsinghua University), the team included graduate and undergraduate students from both universities. The UD team examined the condition of the wall paintings while Tsinghua University examined the temple architecture using 3D laser scanning.

The goal of the project was to examine the murals and write a report about the materials, techniques, degradation, and preservation concerns; the team decided to use Metigo MAP for the first time on the Fengguo Temple project. The interior of the temple has four walls covered in Yuan dynasty Buddhist murals which include 18 seated Buddha figures and two attendants. The murals were in poor condition; there was extensive loss in the paint and ground layers, cracking, and water damage, among other condition issues. Because there was not enough time to make condition maps for all twenty murals during the two-week on-site phase of the project, three of twenty Yuan dynasty murals were examined and mapped to represent the condition of the twenty murals overall.

The team used flashlights, handheld magnification tools, and ultraviolet light to examine the murals and identify the condition phenomena, and Metigo MAP to record the condition information. Classes with visual representation for each of the condition issues were created in Metigo MAP, and then mapped, one class at a time, in two-person teams. Each two-person team consisted of an examiner, or a person examining the mural at close range and outlining condition issues using a pointing device (e.g. a laser pointer), and an operator, a person with a computer who operates the software and creates the maps. Metigo MAP can also be used by an unaccompanied user who is positioned close to the mural while accessing a computer. On the Fengguo Temple project, optical mouse pens were used for more accurate control during mapping. However, the best way to use Metigo MAP is to directly map onto a tablet pc, using a stylus on the screen.

Maps made at the Fengguo Temple show condition phenomena plainly, because visual representations of classes are brightly colored compared to those on the base map. For example, by looking at a large wall, two very similar mural segments may appear to be in similar condition, but when a map is made with distinct and brightly contrasted colors that indicate individual classes, the condition differences can be more clearly and quickly understood. In conjunction with the total area and total length data output features in Metigo MAP, these condition differences can be described with an actual number in addition to a graphic representation.

METIGO MAP CASE STUDY 2: YUAN DYNASTY MURALS IN BEIJING, CHINA

The same University of Delaware student team that examined and documented the Fengguo Temple (Case Study 1) had the opportunity to examine and map another Yuan Dynasty mural using Metigo MAP; the mural was located in a collection in Beijing. The mural was approximately 20 meters long and 3.5 meters high. The room that housed the mural was not deep enough to take a picture of the entire mural, and there were columns blocking areas of the mural. Professional photographers at the site took high-resolution images of the mural in overlapping sections, and at angles. The collection that owns the Yuan Dynasty mural wanted to see the mural in one continuous image, something no one had ever seen.

A useful function of Metigo MAP beyond rectification is tiling, or lining up separate images next to each other to make one larger image. The UD team used the tiling function in Metigo MAP to digitally reassemble the Yuan Dynasty mural. The mural was cut apart at some point, probably to facilitate removal from the original location, then reassembled and installed in the current location. The de-installation involved cutting the mural; this resulted in visible seams on the mural surface creating block-like segments. To tile the photographs of the mural together, the mural segments were measured in situ according to the area included in each hi-resolution photo, using the seams as measuring points. Next, the high-resolution images were loaded into Metigo MAP and rectified based on the exact measurements taken on-site. Because the rectification process makes all the images true-to-scale, the pictures can line up perfectly if the measurements are accurate. The rectified images were layered one by one within Metigo MAP and tiled by aligning the seams and imagery. The result is a continuous image of the mural, dead-on and unobstructed, and visible in entirety for the first time.

Metigo MAP Case Study 3: Metigo MAP as a measuring tool
The author used Metigo MAP as a measuring device on a project for the Getty Conservation Institute, where the main type of documentation is photography. Using the area quantification functions of Metigo MAP, photodocumentation can be converted into numerical data. The experiment involved

the testing of anti-graffiti coatings; a selection of coatings was applied over an outdoor test mural at the Getty Center in a location concealed from public view. Graffiti materials were applied over the anti-graffiti coatings, then removed, to test the functionality of each anti-graffiti coating. One photograph was taken after the graffiti material was applied, and one was taken after the graffiti material was removed. After the removal process, some residual graffiti was left behind, and Metigo MAP was used to quantify the amount of residual graffiti.

By rectifying the photograph of the experimental mural section using measurements taken at the site, Metigo MAP computes the actual dimensions of the mural section and every point in that mural section. By using polygon and magic wand selection tools (like those in Adobe Photoshop), and marking the areas of residual graffiti material on the image, the total area of the digitally selected graffiti material becomes quantified and produces a number to use for comparative data. Using Metigo MAP as a measuring tool allowed an actual number to be used to compare results, rather than visual analysis alone; these numbers represent one of several parameters used to evaluate each coating.

GRAPHIC DOCUMENTATION SOFTWARE COMPARISON AND COMMENTARY:

The Graphic Documentation Methods Comparison Table (see Table 1) lists graphic documentation methods used in conservation and the significant characteristics of each method. The table includes previously discussed methods such as: paper maps, Adobe Photoshop and Illustrator, AutoCAD, and Metigo MAP. Two other programs are included in the table that have not yet been discussed: AutoCAD LT, a drafting and design version of CAD that does not include 3D functionality but does include all the 2D mapping functions of CAD, and MonuMap, made by Kubit, which works only within AutoCAD and was designed to streamline the otherwise complicated mapping process.

As mentioned above, the three most important functions for an optimal graphic documentation method include: mapping, digital imaging, and area quantification tools. All methods listed in the table allow for mapping, and all but the paper method use a digital base map and have some image processing functions. All methods, except the paper method, include rectification and quantification functions, although Adobe Photoshop and Illustrator are lacking in this area. The table also lists the compatibility of each method with AutoCAD, because AutoCAD is widely used, and it is likely that CAD compatibility will be a requirement for maps of large-scale projects. Metigo MAP is fully compatible with AutoCAD, and Monumap is inherently compatible because is runs inside AutoCAD; AutoCAD and AutoCAD LT are also naturally compatible.

The learning curve for graphic documentation methods can be steep, but through trial and error, the use of an instruction manual, lessons with a teacher, or all of the above, it is possible to learn each method listed. The final column on the table lists the approximate costs of each method or piece of software. Paper mapping involves minimal costs; Adobe Creative Suite 5 which includes Photoshop and Illustrator is approximately $1000; AutoCAD is about $3500; AutoCAD LT is about $1000; Metigo MAP is approximately $2200 (or 1500 EUR), and Monumap costs $2095 plus the cost of AutoCAD.

CONCLUSIONS

In summary, Metigo MAP has several favorable features and only two obvious drawbacks. Metigo MAP allows for easy graphic mapping on a digital base map, with image processing capabilities, image rectification, and area and length quantification functions. Metigo MAP is fully compatible with AutoCAD and is relatively easy to use. Metigo MAP is not inexpensive, but the purchase price includes free annual updates, while other programs require yearly fees to keep the software current. The first drawback of Metigo MAP is the instruction manual; originally written in German, it can be difficult to use. The second drawback is that the image processing capabilities in Metigo MAP do not include white balancing. No piece of software can be considered a stand-alone conservation program without the ability to white balance images for truly accurate color representation.

Finally, Metigo MAP software is an improvement over non-digital methods of condition mapping. Because the information goes directly into the computer as the work is examined, the software allows for greater accuracy and specificity in condition reporting and surface area measurement, and the system requires minimal storage space and hardly any extra hardware. Metigo MAP is comparable to other digital graphic documentation programs, but the comprehensive functionality, compatibility, price, and free annual updates set it apart.

Graphic Documentation Methods Comparison Table						
Software	**Mapping**	**Digital Imaging and Processing**	**Image Rectification and Quantification**	**AutoCAD Compatible**	**Ease of Use**	**Price**
Hand-Drawn Paper Maps	Yes	No	No	No	Easy	Inexpensive
Adobe Photoshop and Illustrator	Yes	Yes	Yes, limited	No, only as a base map	Easy/ Moderate	CS5 Suite ~$1000
AutoCAD	Yes	Yes	Yes	Yes	Difficult	~$3500
AutoCAD LT	Yes	Yes	Yes	Yes	Moderate/ Difficult	~$1000
Metigo MAP	Yes	Yes	Yes	Yes, limited	Moderate	~$2200
Monumap (within AutoCAD)	Yes	Yes, in AutoCAD	Yes	Yes	Moderate	~2095 + AutoCAD or AutoCAD LT

Table 1. The Graphic Documentation Methods Comparison Table lists graphic documentation methods used in conservation and the significant characteristics of each method.

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AUTHOR

Emily MacDonald-Korth
Graduate Fellow, Winterthur/University of Delaware Program in Art Conservation
Graduate Intern, Getty Conservation Institute
1200 Getty Center Drive
Los Angeles, CA 90049
E-mail: emacdonaldkorth@getty.edu

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JUDITH BANNERMAN, ZANE CUNNINGHAM, AMANDA HEATH, MARK UNDERHILL, AND JOYCE H. TOWNSEND

Microclimate and Anoxic Frames

ABSTRACT

The ideal storage and display environment has been debated by conservators, curators, and conservation scientists for many years. Museums spend significantly to achieve the best general environment in which to display objects, but some of the more fragile and environmentally sensitive artifacts still deteriorate rapidly or are kept in a storage facility for scholarly access only and no longer enjoyed by the public. One solution is a microclimate system where sensitive artifacts can have conditions tailored to their specific needs. By using a customized microclimate an artifact can be preserved and its display duration extended without a corresponding increase in damage, thereby providing improved public access. Previous research (now being submitted for publication) has shown that anoxic and hypoxic environments prevent degradation of all papers and a majority of colorants. With this in mind, Tate has designed and developed a sealed microclimate enclosure to enable the display of artworks at a controlled oxygen level in argon or nitrogen. The frame facilitates the display of delicate works of art which would otherwise be limited due to restrictions on display duration. The design consists of an aluminum frame with an adhesive bond to secure the glazing to the front and elastomer "O" rings front and back to ensure tight sealing. A removable aluminum back-plate allows easy unframing of the artifact and reuse of the frame. The frame is purged and filled with the chosen mix of gases through integrated inlet and outlet ports fitted with check valves to ensure no backflow of gas. The design is compact and can be mounted invisibly in a traditional—or even in the original—frame. Prior to and during the frame design and production, microfadometry was used to show the benefits of an oxygen-free, or low oxygen, environment of the fading rates of different objects and to determine the optimal oxygen concentration. Remote oxygen sensing and relative humidity monitoring using RH indicator strips was also conducted. Once an object is placed into the frame and the frame sealed, the micro-environment conditions can be adjusted. Several case studies were conducted using materials such as paper documents with iron gall inks, watercolors, pigments, printer inks, basketry, etc., and the conditions used included 0%, 5%, and 21% oxygen at different RH levels. The results from the iron gall ink case study for example, indicate that many of the iron gall inks are fugitive between a Blue Wool #1 and a Blue Wool #3, and therefore should be displayed with caution. However, when placed in an anoxic frame, the inks stabilized to a Blue Wool #3—#4, indicating that the display duration of the object can be extended by reducing its exposure to oxygen. Tate's Anoxic framing is a new tool for conservators to accurately create a micro-environment specifically made for fugitive and fragile objects. Anoxic framing can greatly extend and contribute to our knowledge of how objects fade and how to preserve them for the future.

AUTHORS

Judith Bannerman
Zane Cunningham
Amanda Heath
Mark Underhill
Joyce H. Townsend
Tate
London

LORA V. ANGELOVA, KRISTIN R. DEGHETALDI,
CHRISTOPHER A. MAINES, RICHARD G. WEISS, AND BARBARA H. BERRIE

A Cleaning Application of Poly(Vinyl Alcohol-Co-Acetate)/ Borate Gel-Like Dispersions on *Multiple Views* by Stuart Davis

ABSTRACT

The properties of gel-like dispersions prepared from partially hydrolyzed poly(vinyl acetates) crosslinked with borate ions which contain aqueous organic liquid mixtures have been investigated and modified for potential use by the conservation community.. The systems have been designed to comprise up to 75% organic liquids while remaining optically transparent and retaining a pliable, elastic texture. A fluorescent probe was covalently attached to the polymer chains to assess if polymeric residues are deposited on the surfaces being treated. The successful removal of a complex surface coating on *Multiple Views*, an oil painting by Stuart Davis (1918), using these materials is described.

Gel-like materials (hereafter referred to as 'gels') obtained by the crosslinking of partially hydrolyzed poly(vinyl acetate) (PVAc) by borate ions (fig. 1) have been used to reduce a degraded surface coating on *Multiple Views*, an oil painting by Stuart Davis created in 1918 towards the beginning of his career (fig. 2). During a contest held at the Whitney Club Studio in New York, the artist applied thick layers of paint to

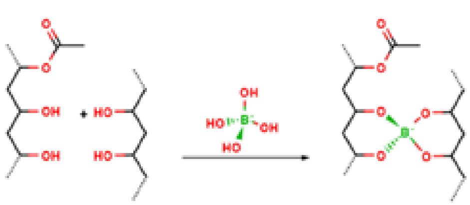
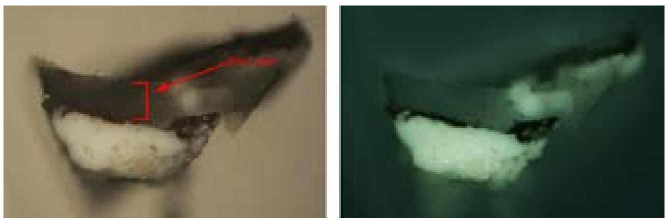


Figure 1. The cross-linking of partially hydrolyzed poly(vinyl acetate) by borate ions.

Figure 2. Stuart Davis, *Multiple Views*, 1918, oil on canvas, 120.02 x 89.54 cm (47 1/4 x 35 1/4 in.) Gift of Earl Davis, National Gallery of Art, Washington DC.

the canvas, creating several areas of high impasto as he worked over a three-day period (Hill 1996).[1] Examination of the painting in 2008 revealed that the canvas had gone through an extensive restoration campaign before its arrival at the National Gallery of Art in Washington, DC. The painting had been inexpertly wax-lined as an excessive amount of wax could be detected across the surface of the painting and along all four tacking margins. Cross-sectional analysis revealed that in some regions the layer of wax was as thick as the paint and ground layers combined (figs. 3a and 3b).[2]

Much of the painting's surface was also covered with a discolored, degraded coating that was imbedded within the folds of the thick impasto. Examination of cross-sections did not reveal whether the surface coating was original to the painting but did confirm that the coating had been applied



Figures 3a and 3b. a) Cross-section taken from the bottom, proper left edge of painting as viewed in normal visible light (left) and b) ultraviolet illumination (right) at 200x magnification. The sample shown contains the ground, traces of black/purple paint, and an excessive amount of wax from a previous restoration campaign.

previous to the wax lining. This degraded layer was only present in some of the cross-sections, either suggesting that the coating was unevenly applied or that the painting may have been partially cleaned.[3] Analysis of the degraded coating using gas chromatography and pyrolysis-gas chromatography coupled with mass spectrometry confirmed the presence of drying oils as well as resin, protein, and polysaccharides.[4] Some of these residual materials were possibly left over from an earlier facing or local consolidation, and may have contributed to some of the challenges encountered during the cleaning process. The Modular Cleaning Program was consulted in order to develop a testing procedure that would assist in the removal of the wax, drying oil, resin, polysaccharides, and protein components.[5]

Free solvents, aqueous solutions containing chelating agents and/or surfactants, and solvent gels were found to be unsuccessful at removing the degraded coating. Tests performed using an aqueous emulsion based on the acrylic polymer Pemulen® TR-2 proved to be the most effective treatment.[6] Pemulen is a block co-polymer of poly(acrylic acid) and poly C15-C30 acrylic acid esters that form up to 60-80% organic solvent-water emulsions. A 5% benzyl alcohol emulsion at a pH of 7.5 ultimately proved to be efficient at gradually removing the intractable surface coating. The emulsion was cleared from the painting's surface using distilled water followed by a final rinse with mineral spirits.

The coating still remained on some areas of the surface of the painting after the entire picture had been treated using the Pemulen emulsion. Tests performed using a 75% hydrolyzed PVAc-borate gel containing 30% acetone indicated that this aqueous-based gel was very successful at removing the recalcitrant residual material (figs. 4a, 4b, and 4c). The gel was applied to the surface and Melinex® was placed over the gel to ensure slow evaporation of the gelated liquid and allow for unobstructed viewing. After approximately 3-4 minutes, clearing was performed using cotton swabs and de-ionized water followed by a 1:1 acetone/mineral spirits mixture.[7] In this case it seems that the gel system may have softened, swelled or partially dissolved the oxidized surface coating, allowing the cleaning to proceed with combinations of free solvents that had initially proved ineffective. The semi-solid nature of these gels also allows them to be molded to the topography of the paint impasto, effectively softening the residues entrenched within the texture of the impasted paint strokes (figs. 5a and 5b).

To ensure that the PVAc-borate gel was not leaving residual polymeric material on the painting surface, tests were performed using fluorescein-tagged PVAc-borate gels. Absorption and emission spectra of the surface were recorded using a Jobin-Yvon Fluorolog spectrofluorimeter with external fiber optics prior to the cleaning procedure, during the cleaning procedure, and after clearance of the gel from the surface. The fluorescent gels were used in several different locations on the painting to ensure that deposits were not left on any of the colors of the paint. The results suggest that the gels did not leave a detectable residue on the surface of *Multiple Views*.

It is interesting to note that in dealing with such a complex surface coating, two different aqueous based systems yielded

Figures 4a, 4b, and 4c. a) Detail of painting's surface before (left), b) during (center), and c) after (right) removal of the degraded coating using a PVA-borate gel containing 30/70 acetone/distilled water.

Figures 5a and 5b. Details of lower, proper left corner of *Multiple Views*, a) before (left) and b) after (right) cleaning with both Pemulen® TR-2 emulsion and PVA-borate gels.

the best results, indicating that such systems should not be ruled out as possible options for cleaning. Aqueous cleaning systems hold great promise of offering conservators another tool when they are faced with a difficult cleaning problem.

The PVAc-borax aqueous gels can hold large amounts of commonly used organic liquids while retaining an elastic, malleable texture and optical transparency. Due to the highly entangled and crosslinked nature of these networks, the opportunity for residue deposition is greatly reduced and can be monitored via the use of fluorescence spectroscopy. The materials used in the gel preparation are inexpensive and readily available as well as environmentally friendly. The gels' properties are affected by a number of variables including the pH, temperature, polymer and borate concentrations, hydrolysis degree, polymer molecular weight, and solvent composition. The complexity of the system calls for a detailed analysis of how each of these factors can be controlled and optimized so as to create materials suitable for applications in the art conservation field. A comprehensive study of the properties of PVAc-borate gels has recently been published (Angelova 2011). Although research on this system as applied for conservation is ongoing, the results presented here and in recent publications by Natali *et al.* (2011) and Carretti *et al.* (2010, 2009) show that PVAc-borate gels are useful cleaning agents for cultural heritage works.

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ENDNOTES

1. In a discussion with Hermon More in 1953, Davis recalled that Whitney Club members "were invited into the two galleries of the Club headquarters on Fourth Street and confronted with blank canvases of varying sizes that hung on the walls. A table in the center of the room was filled with paints and brushes, whiskey bottles, cigars, and cigarettes. The artists had three days to paint a picture in that atmosphere of drinking and conviviality during which a tipsy George Luks threatened to overpaint everyone's canvases" (Hill 1996).
2. All cross-sections were imbedded in Extec® Polyester Resin and analyzed under reflected light using a Leica DMRX polarizing microscope equipped with PL Fluotar objectives and a 1000W Hg arc lamp. Ultraviolet illumination was obtained using a D filter cube (excitation range: UV & Blue; Exciting Filter: Band Pass 355-425; Beam-splitting mirror: RKP455; Long Pass 460).
3. Examination using ultraviolet illumination was not especially helpful in identifying the nature of the coating, forcing the conservators and scientists to turn to other analytical methods for additional information about the varnish.
4. For GC-MS all samples were placed in glass inserts inside a 1 mL reaction vial and analyzed using a Varian CP3800 gas chromatograph equipped with an autosampler and a Saturn 2200 mass spectrometer. For fatty acid analysis the samples were hydrolyzed and methylated to examine the fatty acid profile using 10 μL of trimethyl(α,α,α-trifluoro-m-tolyl)ammonium hydroxide (TMTFTH, TCI America, 0.5 M in MeOH). The vials were allowed to sit overnight, and were then examined by gas chromatography. For protein analysis a norleucine solution was added to yield a final concentration of approximately 50 ppm in the final injection volume. Fifty μL of 6.0 M hydrochloric acid was added to the insert and the vial was capped with a septum and evacuated using a vacuum pump. The sample was heated at 105°C for 24 hours on a heating block, removed from heat and allowed to stand until cool. The vial was then centrifuged, and evaporated to dryness using a nitrogen stream while warming to 60°C. One μL of silylating reagent containing MTBSTFA/TBDMCS was added per 2μg of sample. For pyrolysis GC-MS each sample was derivatized using two microliters of tetramethylammonium hydroxide (TMAH). The Varian 3800 GC was interfaced to a Varian Saturn 2000 ion trap, the transfer line being held at 300°C. Data analysis was performed on all samples using the Saturn GC/MS Workstation 6.9.2 software and the NIST 2008 spectral libraries.

5. Information on the Modular Cleaning Program can be found online. http://cool.conservation-us.org/byform/mailing-lists/cdl/2009/0753.html - accessed 7/10/2013
6. The coating was only slightly solubilized by an 80:20 benzyl alcohol:xylene gel, however this system would have required an excessive number of cleaning passes and was therefore determined to be unsatisfactory. Pemulen® emulsifiers were first introduced to the field of art conservation in 2007 by Prof. Richard C. Wolbers at the Winterthur/University of Delaware Program in Art Conservation. For more information on Pemulen® emulsifiers consult Noveon® Consumer Specialties.
7. It should be noted that no immediate effect was observed until the 1:1 acetone:mineral spirits mixture was brought to the surface after the PVA-borate gel had been cleared.

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AUTHORS

Lora V. Angelova is a graduate student at Georgetown University working under the joint mentorship of Dr. Richard G. Weiss (Georgetown University) and Dr. Barbara H. Berrie (National Gallery of Art). She can be contacted at E-mail: lva2@georgetown.edu

Kristin deGhetaldi received an M.S. in Art Conservation from the Winterthur/University of Delaware Program in 2008 and is currently completing the Andrew W. Mellon Fellowship in Painting Conservation at the National Gallery of Art. She will be starting the PhD program in Preservation Studies at the University of Delaware in the fall of 2011.

Christopher A. Maines is a conservation scientist at the National Gallery of Art. His expertise includes analysis of natural and synthetic polymeric materials used in works of art.

Barbara H. Berrie is senior conservation scientist at the National Gallery of Art. She has examined hundreds of works of art and published extensively on artists' materials and methods.

Richard G. Weiss is a Professor of Chemistry at Georgetown University. His research interests are in gels, polymers, ionic liquids, liquid crystals, and photochemistry.

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TIARNA DOHERTY, CHRIS STAVROUDIS, AND JENNIFER HICKEY

Developing Cleaning Systems for Water-Sensitive Paints By Adjusting pH and Conductivity

ABSTRACT

Advances in the understanding of cleaning painted surfaces have allowed conservators to explore pH and conductivity simultaneously for cleaning water-sensitive paint films with promising results. The process of mixing solutions with adjusted pH and conductivity levels is reviewed.

The integration of new water-based cleaning systems with solvents as well as with silicone copolymers in emulsions is discussed as a treatment option for water-sensitive paint films. Two case studies are presented to illustrate how various cleaning systems were developed using the parameters above.

The methodological approach to cleaning tests carried out on a water-sensitive acrylic painting from the 1960s is shared. The painting was evaluated in the conservation studio using basic examination techniques and by taking pH and conductivity measurements from the surface of the paint films. Water-based cleaning systems as well as silicone-based emulsions were tested. A recent treatment of a water-sensitive oil painting, which involved using a silicone copolymer, silicone emulsion and silicone solvent, is also presented.

INTRODUCTION

Cleaning water-sensitive acrylic and oil paintings has proven challenging for conservators. While the understanding of both modern oil and acrylic paint in the field of conservation science has grown in terms of its formulation, [1] we are still learning about how these paints interact with cleaning systems. Pigments, modifications of the basic medium, as well as environmental and condition histories of paintings play significant roles in the sensitivity of paint surfaces to aqueous treatment.

Conservators have published the now historical approaches to cleaning these surfaces which include using sponges, water with limited additives adopted from the approach to cleaning traditional or old-master painted surfaces, and hydrocarbon solvents.[2] Thanks to the contributions from Richard Wolbers and others, we have begun to increase our knowledge of water-based chemistry and understand how we can relate the published research about paint formulation to the chemistry of cleaning.[3]

pH has long been recognized as an important factor in cleaning paintings. Adjusting pH can be used to great effect. The pH of purified water varies considerably based on its source and storage. Therefore careful measurement and observation of the water being used in cleaning is important, even when starting with distilled or deionized water.

Over time, as water is exposed to air, carbon dioxide reacts with water to form carbonic acid. Carbonic acid has a pKa_1 of 6.352 and can dissociate into a hydrogen ion and a bicarbonate ion. Deionized or distilled water from laboratory taps is most often processed and then stored in holding tanks where it is exposed to air. Bottled distilled or deionized water is also exposed to air when left open or decanted into smaller containers. The pH of what is assumed to be pH-neutral water is often below 7 due to the formation of carbonic acid.

The use of pH-buffered, water-based cleaning systems is generally recommended because the conservator sets the pH of the cleaning solution and therefore has control over this parameter. Buffers are used to maintain the pH of a cleaning system, preventing the pH from changing as acidic or alkaline materials are brought into solution. Buffers commonly used in cleaning painted surfaces can be found in the Modular Cleaning Program.[4] The use of pH-buffered, water-based cleaning systems is promoted in the Modular Cleaning Program (every mixture contains a buffer solution) since they allow the conservator to maintain the pH of a cleaning system and thus provide a measure of control in the cleaning process.

pH-adjusted waters are made by adding an acid and a base to water. If one or both are weak acids or bases, the solution can also work as a buffer. Depending on the pKa of the weak acid and base, these solutions are either in a buffered state or simply a pH-adjusted state. For example, a dilute solution of acetic acid can be adjusted to any pH level by the addition of ammonium hydroxide. Acetic acid and ammonium hydroxide both have the ability to act as buffers. Acetic acid, having a pKa of 4.76, will act as a buffer in the range of approximately pH 3.8 to 5.7, and ammonium hydroxide, with pKa 9.25, buffers from about pH 8.3 to 10.1. This means that an acetic acid/ammonium hydroxide solution will only be buffered in these pH ranges. At all other pH values, the solution can be described as pH-adjusted, emphasizing that it is not buffered. One of the great advantages of the pH-adjusted and pH-buffered solutions of acetic acid and ammonium hydroxide is that they do not require rinsing since both the acid and base are volatile.

When functioning as a pH buffer, a weak acid or base is present in both its molecular form and its disassociated, ionic form. As ions from acidic or alkaline components of the dirt dissolve into the cleaning solution, they are essentially neutralized by the complimentary base or acid of the buffer itself. As the buffer's ionic and molecular components rearrange, the pH of the solution will only change slightly until a significant amount of the buffer has reacted.

In order to determine which weak acid or base is appropriate as a buffer for a certain pH range one checks the dissociation constant or pKa. A weak acid or base will function as a buffer in the pH range near its pKa (plus or minus 1 pH unit). A number of buffers and their physical constants are included in the Modular Cleaning Program. The pH-buffered, water-based cleaning systems work within the context of the Modular Cleaning Program and allow for the quick addition of surfactants and chelators (set to the same pH). If using a pH-buffered, water-based cleaning system, a pH-buffered or pH-adjusted water made with dilute acetic acid and ammonium hydroxide can be used for rinsing.

Sensitivity to water-based cleaning systems has been observed in both modern and contemporary oil and acrylic paintings. A significant amount of analysis has been published on the formulation of acrylic paints.[5] Less has been published on the chemistry of modern oil formulations.[6] While published research has informed conservation practice, the quantifiable parameters of pH and conductivity appear to be extremely useful in developing cleaning systems for sensitive paints. Modifying these parameters appears to control the swelling of paint films. Less swelling of the paint film will generally mean less sensitivity.

Conductivity is a property that has only been recently explored in cleaning chemistry for conservation. Richard Wolbers proposed using conductivity as a parameter for developing a cleaning system, and some promising applications of adjusted conductivity have been published already.[7] Conductivity may be understood as the ability of a material to conduct an electrical current. In an aqueous environment, ions carry the electrical current through the solution. Increasing ions in a solution will increase the ability of the solution to conduct current. Thus the conductivity is related to the total number of ions in solution, the ionic strength. The units used to measure conductivity are milli-Siemens/cm and micro-Siemens/cm (although we normally just refer to the units as milli-Siemens [mS] and micro-Siemens [µS]).

It is probably impossible for a practicing conservator to measure the ionic nature of the paint film they are working on, as an accurate reading of conductivity would require destructive sampling of the paint layer. However, information about the conductivity and the ionic environment of the painting's surface can be obtained by measuring the conductivity of a drop of water placed on the surface of the painting. This is done by applying a water droplet on the paint surface for a fixed amount of time, removing the droplet, and placing it into a conductivity meter. Our readings from dirty and cleaned (the same area after surface cleaning) surfaces suggest that the surface dirt has had the greatest effect on our readings.

To increase the conductivity of the pH-buffered cleaning solutions one can add salts. To decrease the conductivity, one can simply dilute the solution. However, remember that dilution will also lower the concentration of other active species in the solution such as a surfactant. One wouldn't want to dilute a surfactant below its critical micelle concentration. For pH-adjusted water, one can alter conductivity by increasing or decreasing the amount of the acetic acid and ammonium hydroxide. Increasing the amount of the acid and base means there are an increased number of ions in solution which causes the conductivity to increase. Even at seemingly high conductivities the solutions remain dilute since the concentrations of acid and base remain low. Since acetic acid and ammonium hydroxide evaporate, there is no concern about residues from the cleaning systems.

In theory, a low pH would be appropriate for cleaning an acrylic surface. Acrylic paints have a lot of components and are formulated to have a pH around 9 when manufactured. The dispersant and the poly(acrylic acid) thickeners in the binder are water-soluble at high pH. As the paint dries, the ammonia in the formulation evaporates and the paint becomes mildly acidic, rendering these materials much less soluble in water. However, these materials retain the potential to respond to an alkaline system by deprotonating, hydrating and swelling which leads to softening and disruption of the paint surface. A swollen paint film can trap dirt in the surface as the medium dries and shrinks down. A cleaning system at a sufficiently low pH will maintain the dispersant and the poly(acrylic acid) molecules in their acid forms, and they will be much less affected by the water. It is worth mentioning that carbonated water has been used to surface clean acrylic and oil paintings where deionized water was not as effective. The low pH of the carbonated water and its elevated ionic strength help explain this increased efficacy.

In 2010 Richard Wolbers reported his ongoing research on the responses of select colors of Liquitex and Golden acrylic paints to aqueous cleaning environments. In his study, paint samples were immersed for 15 minutes in test solutions of different pH levels and conductivities, and the samples were then characterized for swelling and leaching. While the results are complex and show variation between pigments and manufacturers, he has found that, as a general rule, a cleaning solution with a pH of 6.0 and a conductivity of 6000 µS resulted in the least amount of swelling.[8] While the conditions for acquiring data in research are not the same as those used in treating paintings, the physical and chemical effects observed are very informative.

Often, sensitive paints can be cleaned safely merely by controlling pH and conductivity. In cases where paint surfaces remain sensitive to water-based cleaning systems, we have explored incorporating water into silicone-based solvents with the aid of silicone surfactants and gelling agents, creating emulsions and micro-emulsions that allow for minimized interaction between water and paint film. These silicone-based solvents are extremely non-polar and are used widely in the cosmetic industry, serving as the building blocks for hair-care products, deodorants and lotions.

Velvesil Plus, the first silicone-based system to have been used for the treatment of water sensitive acrylic surfaces, was introduced to the authors by Richard Wolbers in the summer of 2009.[9] Velvesil Plus consists of a silicone copolymer gel and a silicone-based surfactant in a silicone-based solvent and is produced by Momentive. It is used in the cosmetic industry to formulate water-in-oil emulsions, particularly to incorporate polar sunscreen materials into the very non-polar gel base. One can add water-based cleaning systems to the Velvesil Plus and easily create a stable emulsion. Velvesil Plus is a concentrated solution of the silicone copolymer and surfactant in the solvent cyclomethicone. Therefore, the very non-polar cyclomethicone solvents are used to rinse the thickened emulsion from the painted surface.

Cyclomethicone is a term for cyclic silicone-containing solvents. The most stable of the cyclomethicones include octamethylcyclotetrasiloxane (also known as cyclomethicone D4) and decamethylcyclopentasiloxane (also known as cyclomethicone D5). These two solvents are cyclic methylsiloxanes with either 4 or 5 silicon atoms bound in a ring alternating with oxygen atoms. Each silicon has two methyl groups attached.

Cyclomethicone is a non-specific term and can also refer to a cheaper blend of the D4 and D5 solvents and possibly other, less stable versions of the solvent and/or hydrocarbons.[10] The cyclomethicones and other silicone-based products feel different compared to solvents like hydrocarbons and take some getting used to. Cyclomethicones can feel silky smooth and wet very well onto surfaces. Cyclomethicone D5 has a very slow evaporation rate, and it is normally the major component in the solvent blends. We observed that it took about twenty-five minutes for the paint surface to dry after it was "wet" with the solvent. The straight-chained silicone solvents evaporate much faster. For this reason hexamethyldisiloxane (often referred to as dimethicone) or octamethyltrisiloxane may be more practical as clearing agents for Velvesil and cyclomethicone-based emulsions.

Octamethylcyclotetrasiloxane (cyclomethicone D4) has been identified as bioacumulative and therefore potentially harmful to the environment. Because of its silicon content, it is recycled differently from hydrocarbon solvents.[10a] This means that the solvent should not be mixed with other solvents for hazardous waste but disposed of separately unless explicitly instructed otherwise by your waste hauler. In general, the family of volatile methylsiloxanes are considered safe for human exposure but there is growing concern over long term exposure, particularly in women, and particularly those with silicone-based implants.[10b] The decamethylcyclopentasiloxane (cyclomethicone D5) and polydimethylsiloxanes remain widespread in personal care products.[11]

CASE STUDY: DOOLIN'S *ARTIFICIAL LANDSCAPE*

A series of cleaning tests were carried out on an acrylic painting donated to the Getty Conservation Institute for research purposes. *Artificial Landscape* (fig. 1) was painted in 1964 by James Doolin (1932–2002) a Los Angeles-based landscape painter celebrated for his abstractions as well as hyper-realistic works that mapped his surroundings in meticulous detail. Doolin was born in Hartford, Connecticut and received a BFA from the University of the Arts, Philadelphia, in 1954.[12] In the early 1960s Doolin began work on a series of geometric abstractions, a response to the built environment of the city, which he termed *Artificial Landscapes*. Doolin traveled to Australia in the late 1960s, where he continued to produce the *Artificial Landscapes*, achieving a measure of critical success. His work from this period is represented in several Australian institutions. Doolin eventually returned to the United States, settling in Los Angeles and pursuing an MFA at the University of California, Los Angeles, which he completed in 1971. In his later work, Doolin moved away from abstraction, exploring his southern California surroundings through highly detailed representations of the cityscape.

Figure 1. James Doolin, *Artificial Landscape*, 1966, acrylic on canvas, 51 7/8 x 38 1/4 in. © James Doolin.

Prior to being donated, the painting, *Artificial Landscape*, had been rolled in plastic. Over the years, the canvas acquired surface grime and also suffered from some moisture damage. The painting is executed in acrylic emulsion paint on what appears to be an artist-primed canvas.[13] The canvas appears to be a cotton duck. Overall the painting is in good condition. The surface gloss of the various paint films differ depending on the color of the paint film. For example, the glossier passages are those of yellow and green paint while the fields of black paint are significantly more matte. Some colors, such as the silver metallic paint, are of medium gloss.

Before carrying out cleaning tests on *Artificial Landscape*, we decided to systematically measure the pH and conductivity of the surface of the painting. This was done as an experimental exercise in an effort to determine if consistent measurements could be acquired, to compare different types of paint surfaces and to see if the data could prove useful in designing effective surface cleaning systems.

pH and conductivity measurements were taken of each paint film three times. When a paint film was observed to cover another colored paint film, we took measurements of that area as well. In order to measure both pH and conductivity, a large drop of water was placed on the surface of the paint film. After 30 seconds the droplet was drawn up into a pipette and then placed in the sample well of a Horiba conductivity meter (fig. 2). Subsequently the same drop was extracted from the conductivity meter and placed in the Horiba pH meter. For *Artificial Landscape* we observed a range of both pH and conductivity measurements. The range for pH was 5.5 – 6.5. Conductivity ranged from around 100 to 500 µS (Table 1 and Table 2 for after treatment measurements).

In testing various surface cleaning methods on *Artificial Landscape*, it was observed that dry methods alone (cloths and sponges) were not very effective at picking up the dirt and staining on the surface of the paint films. The texture of the canvas was rough enough to deter us from using cotton swabs as it was hard to roll the swab over the surface smoothly. We

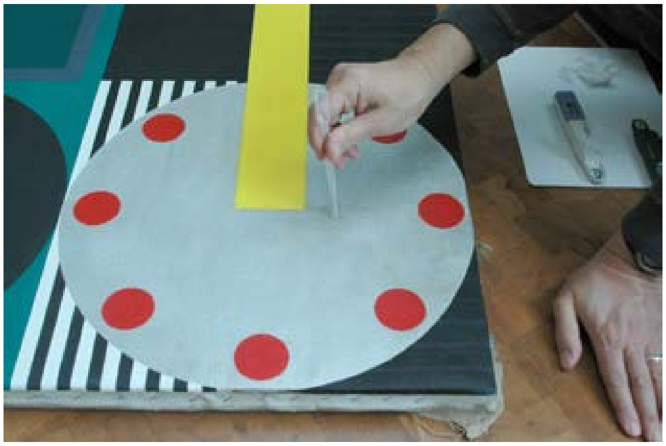

Figure 2. Measuring pH and conductivity on James Doolin, *Artificial Landscape*. © James Doolin.

quickly moved on to using sponges with the water-based cleaning systems. After reviewing recent conservation literature and consulting with colleagues, we tested a few sponges with our water-based systems. We found that various makeup sponges from Sephora and drug stores provided a useful, smooth contact with the surface that managed to pick up surface grime evenly.

Not knowing what these sponges were made of exactly, we were concerned about leaving residues. We did carry out very basic residue testing by wiping sponges, soaked in different cleaning solutions, on glass slides. This was done before and after the sponges were soaked in deionized water. As many colleagues have observed, often when these sponges are rinsed and squeezed they foam, indicating the presence of residual surfactant from manufacturing. The residues deposited on glass slides were significantly reduced with washing. We did our swipe tests after soaking the sponges lightly in various cleaning solutions.

Due to concerns regarding residues left from sponges, we decided to return to our cleaning tests with cotton swabs. Cleaning tests were carried out with pH-adjusted water at pH 5.5 and 6.5 across a range of conductivity levels. We made sure we had solutions that were of equal conductivity to the measurements we took of the paint surface as well as solutions with conductivity levels from 10 - 60 times as great and 10 times less than the surface measurements. We chose to work with pH-adjusted waters made with acetic acid and ammonium hydroxide since they would leave no residue.

After these initial tests we decided to try using both the pH-adjusted water solutions and pH-buffered solutions created in the Modular Cleaning Program. The advantage to using the Modular Cleaning Program solution set is that one can readily and quickly test additional materials such as chelators and surfactants since they are already mixed to the appropriate pH. These solutions were then rinsed with the pH-adjusted water solutions.

For *Artificial Landscape* we observed that the green paint, the very matte black paint and the red paint were sensitive to most pH-buffered and pH-adjusted solutions. We found that when we used our solutions with increased conductivity (a factor 10 times the conductivity of the paint layer), the red and black passages remained stable, and we saw no pigment on our swabs. These findings relate to Richard Wolbers' research which shows that pH levels of 6 or lower and conductivity levels as high as 6000 µS can be effective at reducing the swelling of acrylic paint.[14]

The green paint remained sensitive to cleaning with water even at a low pH. A reduced amount of pigment was removed when the conductivity levels were either very low or very high relative to the paint film. While there was only a faint disruption of the colored paint, it was clear that the solutions had little cleaning effect on surface grime. The challenge in surface cleaning well-bound grime is that water can be successful at removing grime, but swells and disrupts the paint. The next approach to cleaning the green paint was to try an emulsion. Using a water-in-oil emulsion reduces the amount of water in contact with the paint surface.

The pH 6.5-adjusted water with increased conductivity levels (made with acetic acid and ammonium hydroxide) was added in small quantities to the silicone-based Velvesil Plus. The pH 6.5-buffered water with Ethofat surfactant (based on the Modular Cleaning Program) was also added to the Velvesil Plus. In making these emulsions, the Velvesil Plus was first diluted with a commercial blend of cyclomethicones to a working consistency, and then the water-based cleaning system was added (10% water added by volume). This cleaning solution was applied to the surface with a stiff brush. The silicone emulsion was then cleared by rinsing the surface with cyclomethicone three times. The green paint was cleaned successfully with both of these emulsions without a noticeable disruption to the paint film. The paint surfaces were evaluated by eye, and the pH and conductivity measurements were repeated (Table 2). Conductivity measurements were observed to decrease significantly, which is to be expected from the superficial method of measurement.

CASE STUDY 2: TREATMENT OF *RED VERMILLION*

Red Vermillion was painted in 1961 by Jack Youngerman (fig. 3). In the 1950s Youngerman, trained as an artist in Paris on a US Government GI Bill and moved to New York in the 1960s.[15] His paintings are represented in museum collections including the Museum of Modern Art and the Guggenheim.

The painting *Red Vermillion* had been in storage at the Norton Simon Museum for a few decades. It had a significant amount of dust on the surface as well as a slightly hazy exudate. In our testing for surface cleaning, it was observed that dust could be brushed away while some material on the surface would become more or less hazy when brushed in place, an empirical characteristic of an exudate material. The effect of the exudate proved very difficult to photograph. In addition, extensive drip marks ran down the surface of the painting, and some of the drips ended in dark brown residue. Other small surface stains or accretions were present on the surface. The condition of the painting was deemed unacceptable for display in the spring 2011 exhibition "Surface Truths: Abstract Painting in the Sixties" at the Norton Simon Museum of Art. The painting came to the conservation department of the J. Paul Getty Museum for treatment in the fall of 2010.

Figure 3. Jack Youngerman, *Red Vermillion*, 1961, oil on canvas, 248.3 x 193 cm (97 3/4 x 76 in.) Norton Simon Museum, gift of Mr. Robert Halls. © Jack Youngerman.

The painting was laid flat on a table for a cleaning (fig. 4). In this orientation, we found it easier to get an overall sense of the differences in surface gloss, as opposed to when the painting was vertical, due to the direction of natural light entering the studio. Having the large painting flat also facilitated more than one person working at a time on the painting. Local consolidation of all edges, relaxation of cracks, and minimizing deformations in the canvas were carried out while the painting was in this position.

Since the painting has a lot of fine impasto, imparted by the large brushes used to apply the thick paint, there were reservations about achieving an even surface cleaning with sponges or cloths. There were also reservations about sponge residue based on the testing reported in recent conservation literature as well as the residues we observed in our own testing.[16] For these reasons, it was decided to explore solvent methods and emulsions for cleaning the painting.

Figure 4. *Red Vermillion* during treatment. Julia Burdajewicz and Tiarna Doherty surface cleaning.

We measured pH and conductivity from the paint films and then proceeded to test water solutions at low pH and high conductivity. The paint demonstrated water sensitivity to all of the pH-adjusted water solutions. Small additions of high conductivity water in a range of pH 5.5-6.5 were added at 5-10% by volume to the Velvesil Plus to create an emulsion. This appeared to work successfully. However, we observed that approximately one in eight swabs picked up a little color in the first contact with the painted surface. When the surface was rinsed with cyclomethicone, no color was removed. While the amount of color we observed on the occasional swab was very small, it was not acceptable to remove any original material. We therefore abandoned any inclusion of water and instead tested the Velvesil Plus alone, followed by rinsing the surface with cyclomethicone.

As mentioned before, an exudate material was suspected as being present on the painting. Under high magnification, agglomerates of a clear material were observed that also fluoresced under ultraviolet light. This material was more concentrated at the base of the areas of drip marks on the painting, suggesting it is, or at least was, water-soluble and that it had migrated with the water drips. The material was sampled for analysis by the Getty Conservation Institute, and the results of analysis are summarized below.[17] Treatment decisions were based on empirical testing and critical observation of the surface.

Solvent tests were observed on the surface of the painting under high magnification and photographed before, during and after testing. Hydrocarbon solvents including Shell Sol D38 and Shell Sol OMS did not appear to affect the clear agglomerates. The use of the polar solvent ethanol mixed 1:4 (v/v) with Shell Sol D38 was observed to partially remove the exudate material and alter the appearance of the paint surface. While the presence of a polar solvent dissolved the clear exudates, it also pulled up red and orange-colored paint onto the swab. Despite the painting's title, the pigment vermillion does not occur in the red or orange colored passages. The red and orange paints are composed mostly of cadmium colorants with barium sulfate, suggesting cadmium lithopone-type pigments.[18] Cadmium red in oil is sensitive to cleaning due to a variety of factors including the pigment's failure to act as a drier for the oil binder.[19] In addition, since cadmium sulfide is a semiconductor, known to convert absorbed light quanta into free electrons, we speculate that photo-oxidation degraded surrounding binding materials.

The use of hydrocarbons alone did not visibly disrupt the agglomerates of exudate material. However the hydrocarbons tested, including Shellsol OMS and Shellsol D38, did not "wet well" onto the surface: the swabs used to deliver the solvents would not roll very smoothly. In comparison, the solvent cyclomethicone wet very well onto the surface.

Cleaning with Velvesil Plus thinned slightly with cylcomethicone and rinsing with cyclomethicone did not appear to affect the clear surface exudate bound to the surface of the paint film. The surface was rinsed at least three times, allowing the solvent to evaporate between rinses so that the surface could be evaluated and monitored. The rinsing was carried out using swabs and Kimwipe tissues. Using the Velvesil Plus without a water phase as a means to surface clean the painting was successful. It is speculated that the surfactant in the Velvesil Plus provided the necessary polarity to have helped with the dirt removal and possible pick-up of non-polar exudate material.

While visibly reduced, the drip marks on the red and orange passages of the painting will always be present as it is clear that water irreparably damaged the paint in these areas. By removing the grime and some of the exudate material on the surface we were able to reduce the contrast between the areas of damage and the rest of the surface of the painting. The agglomerates of exudates, visible under magnification using the stereo binocular microscope, remained on the surface. These agglomerates are slightly glossy and fluoresce a yellow-green color typical of an aged organic material. As a patina on the surface of the art work, the exudate provides an overall aesthetic effect, imparting a slight sheen to the paint surface. The disruption of this subtle optical effect can be observed where the condensation drips occurred.

The painting was photographed before, during and after treatment. Ultraviolet photography was also taken before and after treatment to record the particular fluorescence of the clear, large agglomerates of exudates (fig. 5, 6). The ultraviolet photographs appeared to document a consistent presence of the larger agglomerates before and after cleaning. This observation, coupled with the observations regarding a hazy exudate effect before treatment, suggest that a smaller fraction of an oil-medium exudate material was probably removed in the surface cleaning process. Leaving the clear agglomerates of exudate material on the surface of the painting was very satisfying since this material is clearly bound with the paint and provides an optical saturation of the surface which gives the impression of the paint looking intact and rich. The material is not visible to the naked eye but only under high magnification. After treatment, this material is not disfiguring.

Figure 5. *Red Vermillion* under ultraviolet light before conservation treatment. © Jack Youngerman.

Figure 6. *Red Vermillion* under ultraviolet light after conservation treatment. © Jack Youngerman.

The passages of white paint did not appear to be water sensitive and had no visible exudate material present on the surface. The stability of this paint is most likely due to the drying effect of the zinc and lead white pigments present. There were a number of stains in the white passages that were cleaned with a Velvesil Plus emulsion with 10% (v/v) pH 5.5 adjusted water with a conductivity of 6000 µS. The cleaning of the painting was very successful as the disfiguring surface haze was removed and the dark stains in the white passages were successfully removed.

CONCLUSION

A tailored cleaning of surfaces to achieve an overall aesthetic effect is a working method that is easily set up. pH and conductivity are parameters of cleaning solutions that are easily changed, and they allow us to broaden our tool set in cleaning applications. Furthermore, incorporating the effectiveness of aqueous systems in silicon emulsions can be a solution to working on water-sensitive paints, since their solubility parameters are far removed from those of the paint materials.

Figure 7. *Red Vermillion* after treatment. © Jack Youngerman.

Modern and contemporary paintings alter differently over time due to the unique formulation of the paints used in creating each artwork. Though the stereotyped aesthetic for 20th century paintings has traditionally been a flawless, "new" surface, these paintings have aged, and many modern and contemporary paintings now have their own patinas. Developments in paint analysis as well as in cleaning chemistry can help conservators to understand the nature of these patinas. Materials identified as degradation products of paint films may be valued for aesthetic reasons on a paint surface, as was the case of the Youngerman painting. In contrast, some exudate materials can be severely disfiguring, compromising appreciation of the artist's intent and therefore warrant removal. A combination of scientific analysis as well as documented observations of how paint films react to specific treatments will help us better determine what a twentieth century patina looks like.

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17. Due to time limitations regarding the treatment of the painting, the analysis could not be completed before the treatment took place. Analysis of the paint binding media has been carried out at the Getty Conservation Institute. Various forms of instrumental chemical analysis of paint binder components were carried out at the Getty Conservation Institute. These analyses suggested, on the basis of palmitate/stearate ratios, that the binder of the red and orange paints was linseed oil; and azelate/palmitate ratios were well within the normal range for such paints. Samples of white paint, however, showed much higher P/S ratios more characteristic of poppy or safflower oil. It was observed, however, that the red and orange paints contained a substantial water-soluble fraction that was abundant in short-chain fatty diacids (mostly azelaic, with lesser amounts of suberic and sebacic or pimelic). Water-extracts were found (by ion chromatography and ESEM-EDS analysis) also to contain metal ions (Na, Mg and Ca) plus sulfur in some form, but not as sulfate. The precise cause of the abundance of fatty diacids in the water-extracts remains uncertain: oxidative scission reactions are implied, but whether the water-soluble matter derives from degradation just of the oil binder or partly from other paint additives (eg., pigment dispersants) cannot be determined from the available evidence.". In a report

summary from Alan Phenix, Getty Conservation Institute, 16 August 2010.

18. It appears that the various shades from red to orange were made by mixing, in various proportions, of two principal stocks of paint: one orange and one pure scarlet red. The scarlet red paints contain predominantly barium sulfate and cadmium sulfide, the combination of which suggests a cadmium lithopone (cadmopone) type pigment. Rather surprisingly for a red shade of cadmium pigment, no selenium (as cadmium selenide) was detected in the scarlet red paint. The presence of probably two organic red (azo) pigments was also suggested by FTIR spectroscopy, and calcium sulfate is present as an extender. The lighter, orange stock paint is generally similar in composition to the red stock just described, being also indicated as a cadmium lithopone type. Again, calcium sulfate is present as extender in the orange paint, and an organic pigment cannot be excluded." In a report summary from Alan Phenix, Getty Conservation Institute, 16 August 2010.

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SUPPLIES

Cyclomethicone D4 and D5
Shepard Brothers Incorporated
503 S. Cypress Street
La Habra, California 90631
Tel: (562) 697-1366

Horiba B-173 Twin conductivity meter
http://www.amazon.com/Horiba-Conductivity-Salinity-Pocket-Tester/dp/B003NUYMDK/ref=sr_1_5?s=industrial&ie=UTF8&qid=1312499917&sr=1-5
(accessed 8/4/2011)

Horiba B-213 compact pH meter
http://www.amazon.com/Horiba-B-213-Compact-Pocket-Tester/dp/B003NUU69O
(accessed 8/3/2011)

Velvesil Plus
Momentive Performance Materials
Waterford, NY 12188
Tel: (518) 237 3330

AUTHORS

Tiarna Doherty
Associate Conservator of Paintings
J. Paul Getty Museum
Los Angles, CA 90049

Chris Stavroudis
Conservator in Private Practice
Los Angeles, CA

Jennifer Hickey
2010 Summer Intern
Getty Conservation Institute

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BARBARA A. RAMSAY

Studio Tip: Slim Light for Use in Painting Conservation

A handy piece of equipment that has been used in the ARTEX Conservation Laboratory is the Rosco LitePad™. This compact LED light comes in various sizes in a slim profile (approximately 5/16 inches thick). The 3x3 inch model that we have has an adaptor and a fine 50 inch cord. There is virtually no heat build up, unless the light is left on for several hours at a time.

The Rosco LitePad™ has been used mainly to facilitate the tear repair process. The light is carefully placed below the torn canvas to provide a transmitted light source, enabling clear viewing of the weave structure and deformation. The conservator can repair the tear working alternately with transmitted and incident light. The smooth surface of the light has a grid pattern that is useful in realigning threads when the light is on or off, particularly when there are holes or gaps to mend.

Figure 2. Rosco LitePad ™ (verso)

Figure 1. Rosco LitePad ™ (recto, turned off)

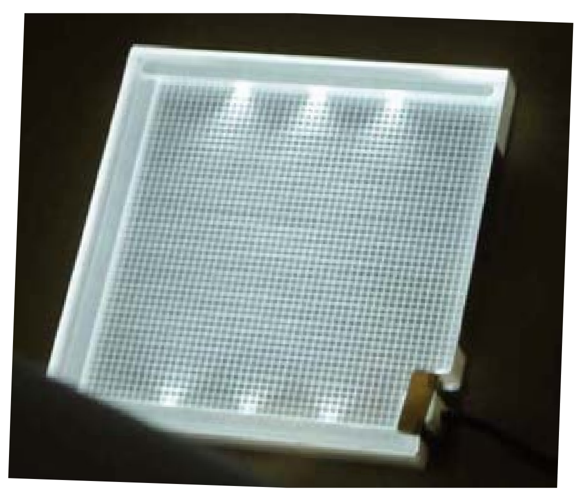

Figure 3. Rosco LitePad ™ (recto, illuminated)

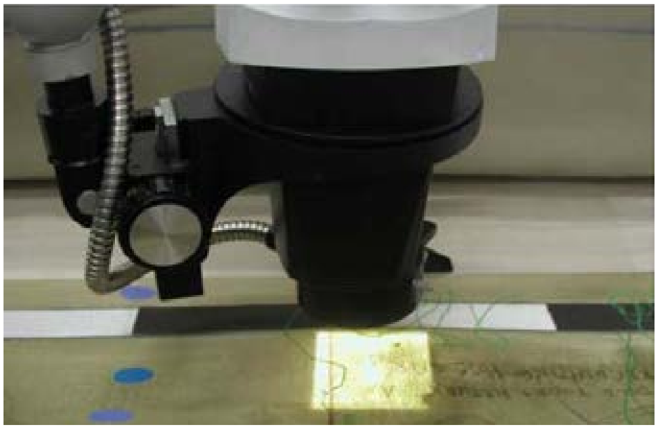

Figure 4. LitePad ™ positioned below canvas tear under microscope.

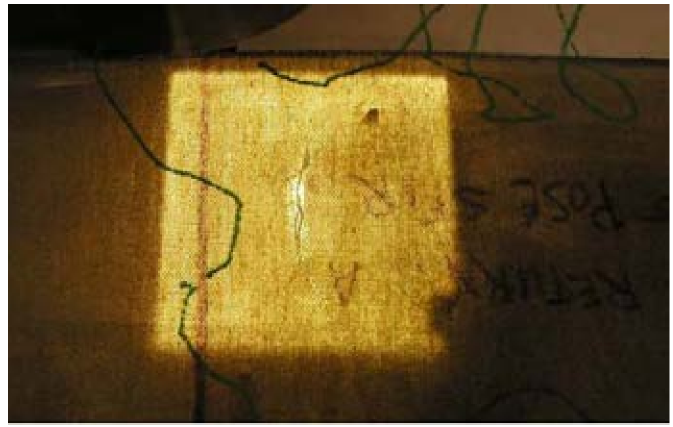

Figure 5. Detail of tear in transmitted light.

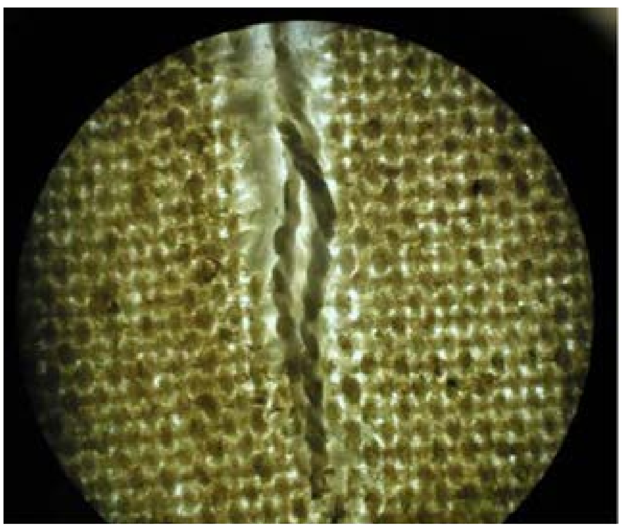

Figure 6. Photomicrograph of tear viewed in transmitted light, before treatment.

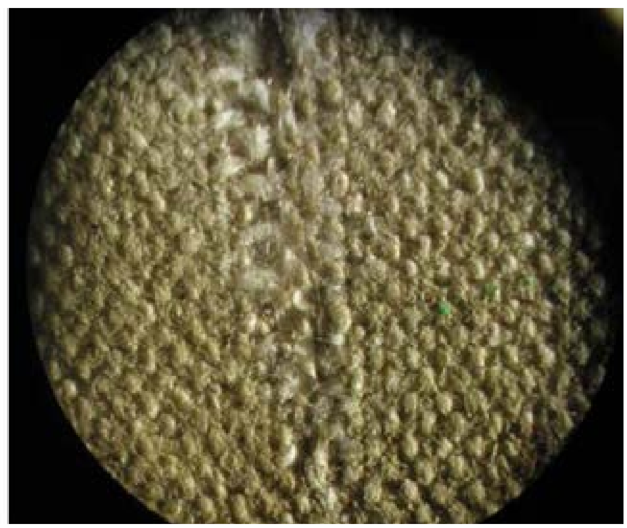

Figure 7. Photograph of tear viewed in incident light, during treatment.

The LitePad has also been used during the examination of paintings to view old tears, underdrawing, or inscriptions in transmitted light, avoiding excessive heat exposure that may be associated with the use of photographic lights or other light sources.

The Rosco LitePad™ comes in the following sizes:
3x3", 3x6", 6x6", 3x12", and 12x12".

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R&R Lighting, 813 Silver Spring Avenue
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(301) 589-4997 (800) 783-7255
http://www.rrlighting.com/

Rosco LitePad DL™ with Transformer (3x3") 120 VAC
60,000 hours ($42.88 on 7/10/13)
http://www.bhphotovideo.com

AUTHOR

Barbara A. Ramsay
Director of Conservation Services
ARTEX Fine Art Services
8712 Jericho City Drive
Landover, MD 20785-4761
(303) 350-5500 ext 123
E-mail: bramsay@artexfas.com

MONTSERRAT LE MENSE AND GABRIEL DUNN

Studio Tip: Do It Yourself Snakes: Easy, Versatile, Skinny Bag Weights for Conservation Use

Simple instructions on how to make the narrow weights called "snakes" in use at the Williamstown Art Conservation Center.

The snakes—long, skinny bag weights—are in constant use in the Williamstown Art Conservation Center (WACC) paintings department (fig. 1). Their origin is lost in the mists of time as they pre-date the longest serving member of our staff, but they have been in use in some incarnation since 1977. Their official function is to create the envelope on the vacuum hot table. With about 3 dozen snakes holding the membrane in contact with the table surface, a vacuum envelope roughly the size of our table (9' x 12') can be created to line or infuse a good-sized painting under controlled heat and pressure (fig. 2).

The snakes are about 2.5 kilos in weight and 3' long. Because they coil and double back, they make terrific weights for non-vacuum hot table use as well (fig. 3). When the snakes' bodies begin to fail (after about 12 years of very hard use), we scramble to remake the snake (fig. 4).

The original snakes were made of fabric soaker hose. The 1998 replacements were suede and made to order by a non-profit that no longer exists. The 2011 batch will be made from fire hose; however, since the hose did not arrive in time to illustrate this presentation, the process will be described using the old snakes.

Basics of Snake construction

- 36" x 2" body – fire or soaker hose is ideal
- 3" tab at top to allow space for a hanging grommet (fig. 5)
- Sew shut bottom of hose (fig. 6)
- Fill 'tube' with lead or steel shot (about ¾ full) (fig. 7)
- Do not overfill, allow for bends in the snake body
- Sew the tab line and the top line after filling
- Insert grommet in tab space
- The snake weight is completed and ready for use

Figure 1. Snakes begin to fall apart and leak lead pellets.

Snake body

Choosing a prefabricated hose minimizes the amount of sewing and guarantees a strong body that can hold up to abuse. It eliminates the side seam, and the seams are the weakest point. Hoses in widths of about 2" have been used in the past. Fabric soaker hose remains a good option, but is increasingly hard to find in a suitable fabric. Fire hose (either used or new will work) is a 2011 modification in the WACC snake design.

Fill

With one end of the hose sewn shut, fill with either lead or steel shot. WACC continues to use lead shot (fig. 8). Steel shot was tried in 1998 but was found to be insufficiently heavy to hold the membrane tight to the table. The steel shot snakes had to be un-stitched, the steel replaced with lead, and re-stitched before they could be used. Choose your fill based on your needs. WACC's use requires the extra weight, so lead remains the fill of choice.

Liner or no liner: in spite of lead concerns, WACC does not use a poly liner because the ability to drape the weight, to bend and shape it, is crucial to the function of the snakes. Whether or not one uses a liner, it remains a good idea to wash your hands thoroughly after using the lead filled weights.

When filling with shot, leave enough room to twist and bend. Don't over pack. WACC snakes have about 7" of empty hose in the 36" of overall length.

When closing the weight, leave a 2-3" tab for a grommet; sew the top edges.

The Essential Grommet

Key to WACC snake use is ready and easy storage, close to the hot table for semi-constant use by 5-6 conservators. A pile of lead bags on the floor or on a shelf would be a nuisance and a hazard. The addition of the grommet (fig. 9) allows them to hang close to the wall, saving space and keeping them ready to hand (fig. 10). It serves no other function, but is essential for WACC use. If you feel the same way, a grommet kit is inexpensive and easy to use. A quick search on the internet turns up a kit in the $25 range.

Grommet kits consist of a hole cutter, punch and base (fig. 11). The metal rings are purchased separately in the size needed. The process is manual: cut a hole with the cutter in the fabric, position it over the base with lower metal ring, place the upper ring, insert the punch, and strike (fig. 12).

SUGGESTED SOURCES FOR MATERIALS

Fabric soaker hose: Garden stores and on-line

New and used Fire hose: Manufacturers, fire stations, internet search.

- Post a request to local (and not so local) fire stations for used fire hose—many stations are happy to give away retired fire hose.
- Internet search: check eBay, Amazon.com, Craigslist, etc. for used and new fire hose.

Lead shot and steel shot: Gun shops

- Both lead and steel shot remain readily available locally, gun shops and diving supply shops remain excellent resources. While available on-line, shipping is expensive.

Grommet kit

- Search "grommet kit" on-line or check your favorite hardware supplier to get your own reasonably priced grommet kit and supply of rings.

ACKNOWLEDGEMENTS

The snakes were developed and modified over the years since 1977 by many, if not all, of WACC's paintings conservators including Sandra Webber and Thomas Branchick.

AUTHORS

Montserrat Le Mense
Conservator
Williamstown Art Conservation Center
227 South Street Williamstown, MA 01267
E-mail: mlemense@williamstownart.org

Gabriel Dunn
Paintings Conservator
E-mail: dunngs3@hotmail.com

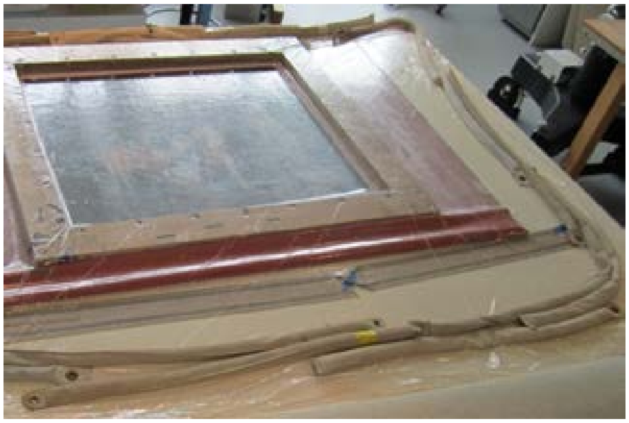

Figure 2. Snakes hold the vacuum envelope for a lining.

Figure 3. Versatile snakes are used throughout the lab.

Figure 4. Snakes begin to fall apart and leak lead pellets.

Figure 5. Leave about 3”of tab.

Figure 6. Sew at bottom.

Figure 7. Do not overfill: the snake approximately. ¾ full.

Figure 8. Lead shot.

Figure 9. The essential grommet..

Figure 10. Snakes store neatly and out of the way against the wall.

Figure 11. Grommet kit: hole cutter, punch and base.

Figure 12. A simple manual process.

Studio Tip: Rottenstone for In-Painting

The addition of rottenstone to in-painting media to alter the color, sheen and gloss of retouch is a useful technique for the paintings conservator.

No news to furniture and frame conservators, rottenstone makes a fantastic in-painting addition. Rottenstone is a fine, silky powder used as a light abrasive or polish and for matching lost toning, dirt or patina on frames (fig.1). Rottenstone, or rotten stone, is also known as tripoli.

Typical rottenstone has a color somewhere between gray, silver, and raw umber—in other words, it is often just exactly the color needed for in-painting losses in an aged surface (figs. 2, 3).

As important as the color, rottenstone imparts an interesting surface sheen.

There are two basic ways rottenstone can be used for in-painting. It can be mixed with your in-painting medium to shift color and reflectance or it can be applied lightly over your finished in-painting to mimic an aged dirt layer.

It is particularly successful mixed with watercolors; simply add a small amount into the color mixture with a dampened watercolor brush.

For resin in-painting, it seems to work best as a top glaze layer—either by wet or dry application. For the first, modify the in-painted fill with a glaze of rottenstone mixed into mineral spirits and stroked onto the surface with a fine watercolor brush; for 'dry' application the rottenstone can be rubbed on, blown on or brushed dry onto the surface; it is especially effective when the in-painted area is still just slightly tacky. The

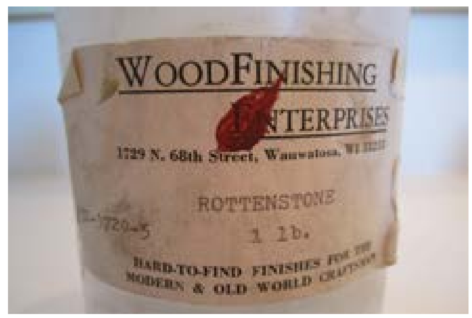

Figure 1. Rottenstone, no secret to the furniture conservator.

rottenstone will veil new colors to look like they have 60 years of light surface wear.

It is especially useful when…

the loss occurs within an aged surface, possibly unvarnished, where the new colors must match an age mellowed white or light color;

a dark color has developed a grayed appearance, scuffs, or burnished spots. The fine rottenstone, in whatever media you are using for in-painting, can be applied in small strokes to mimic a scuff line or rub;

a lively, textured surface has grayed or grimed – where low points, high points, heavy impasto, have attracted and attached surface dust and grime before they dried completely. That effect can be duplicated with rottenstone ghosted over textured fills or applied in a water wash so that it settles into the low points.

working in resins, rottenstone can be added into the media for the last glaze layer giving a slightly silvered ghost layer over the color; or (when the resin in-painting is not entirely dry) it can be applied with a dry brush or rubbed onto the surface, dulling gloss and shifting the color slightly.

Think of it as a tinting raw umber with special surface properties. Tuck a small jar away in your workstation, and when the right in-painting problem comes along, rottenstone may be the answer.

Figure 2. The fine powder against a white board

Figure 3. The fine powder against a black board

ACKNOWLEDGEMENTS

Thanks to Hugh Glover and Kate Payne de Chavez for allowing me to play with their materials. Thanks to Joyce Hill Stoner for rescuing the stranded tips and getting them to Philadelphia.

MATERIALS

Rottenstone is available from several frame and furniture suppliers including:
WoodFinishing Enterprises
1729 North 68th Street
Wauwatosa, WI 53213
Phone and Fax#: (414) 774-1724
E-mail: woodfin@woodfinishingenterprises.com

AUTHORS
Montserrat Le Mense
Conservator
Williamstown Art Conservation Center
227 South Street Williamstown, MA 01267
E-mail: mlemense@williamstownart.org

Gabriel Dunn
Paintings Conservator
E-mail: dunngs3@hotmail.com

ERIN L. KELLY

Studio Tip: Don't Panic: Use HITS: K-12 Conservation Outreach

ABSTRACT

High Impact Teaching Strategies, or HITS, are used by teachers in today's K-12 classrooms to boost student engagement in learning, with resulting improvements in student attitudes and achievement. Based on three years of action research in both the traditional classroom and in museum environments, HITS are equally effective when used to engage K-12 students in learning about museum collections and conservation. The author selects three strategies that are especially suitable for learning events in the conservation and collections arena and offers practical, low-cost applications of each, including a simulation of the cleaning process in painting conservation.

INTRODUCTION

Conservators today frequently are called upon to cooperate with museum education departments in community and student outreach endeavors. With the increasing importance of general outreach in recent years, labs, too, are frequently the subject of visits and special tours. Conservators with busy daily agendas centered around the preparation of objects for exhibition and travel often express uncertainty and stress when faced with often impromptu lab and museum visit requests. K-12 students, particularly those who are inexperienced with museum visits or who have had negative past experiences, also commonly express uncertain attitudes about their museum experiences. The present discussion proposes solutions that improve conservators' ability to manage outreach responsibilities among their other myriad duties and increase student engagement, thus improving learning outcomes from their conservation experiences.

HITS: TIPS FOR USE IN K-12 OUTREACH

High Impact Teaching Strategies, or HITS (Marzano et.al 2001), are used widely by teachers in today's K-12 classrooms to boost student engagement in learning, with resulting improvements in student attitudes and achievement. Based on three years of action research conducted in both traditional classroom and museum environments, HITS are equally effective when used to engage K-12 students in learning about museum collections and conservation. Additionally, the use of HITS facilitates hands-on student learning experiences and complements some of the most innovative and currently favored strategies for teaching students critical and creative thinking skills through the arts.

Three of the most versatile and easily implemented HITS include Asking Questions, Cooperative Learning, and Non-Linguistic Representation. The present discussion explains these, along with specific strategies for implementation.

Asking Questions, familiar to most who have been students themselves, focuses on the development of creative and analytical thinking skills and processes. Implementing this strategy shifts the responsibility for the thinking and speaking roles in a learning event to the students, while the teacher assumes the role of a facilitator or guide. Strategies for successful questioning include implementation of the time-tested "5Ws plus H: Who, what, when, where, why, and how", as well as two routines that are part of Harvard University's Artful Thinking Program (http://www.pz.harvard.edu/at/routines.cfm): "I See / I Think / I Wonder" and "What makes you say that?" These are best implemented, within a conservation lab or museum setting, in exploration and discussion of a particular object or procedure.

"5Ws plus H"

Asking the familiar "5Ws plus H" question encourages students to progress from answers that include basic facts and information (who, what, when, where) to in-depth analysis, synthesis, and personal associations (why, how). Since these questions have likely become "habit" with most students, this questioning routine often works well even with new student groups.

"I See / I Think / I Wonder"

With the teacher-conservator as a guide, students again progress from concrete observations to abstract concepts as they interact with an object or process. The routine includes three rounds of observation and discussion. Students first observe and share only what they see. They then study the object or process again, observing and sharing their thoughts about it. Finally, they study the object or process a final time, observing and sharing what they wonder, or their questions.

"What makes you say that?"

With the teacher-conservator as a guide, students are prompted to study an object or process carefully. After offering their observations, they are asked, "What makes you say that?" The students and teacher then participate together in a dialogue based on students' explanations.

Cooperative Learning organizes the students into collaborative pairs or small groups, as they experience an object or process together. The teacher functions as a "guide on the side" rather than a "sage on the stage." Two common ways to organize collaborative learning experiences include "Think-Pair-Share" and "Gallery Walk" procedures.

"Think-Pair-Share"

This technique particularly encourages collaboration, cooperative dialogue, analysis, and active listening skills. Students, after encountering an object, procedure, or demonstration, are encouraged first to consider their own impressions and ideas about it. Next, students are paired and take turns sharing their observations and ideas in the pair setting. Finally, each student pair shares its key observations and ideas with the group.

"Gallery Walk"

A gallery walk provides a casual occasion for observations, particularly in written format. Although the teacher may lead the experience, students typically are partnered and share a graphic organizer or list of questions concerning a "gallery" of objects or a particular setting. After rehearsing the procedures for conduct within the exhibition space, each pair works together to discuss question responses. The teacher facilitates participation and response-sharing.

Non-linguistic representation, which refers to the use of visual media, acting, movement, or other nonverbal teaching and learning methods, is the technique perhaps best suited to the museum and conservation lab environments. Particularly in the context of learning about conservation, students respond positively to hands-on opportunities. When introducing K-12 students to the concept of paintings conservation, they, like adult learners, are typically fascinated by the concept of "cleaning" a painting and often express confusion about the concept of removing soiling materials and reducing surface coatings.

Particularly when visiting a school or when teaching outside a lab environment is required, creating a hands-on mock cleaning experience, in addition to explanation and images of conservation treatment, can help students understand the concept. The technique is both inexpensive and easy to prepare and align with any painting conservation treatment subject.

Mock Painting "Cleaning"

1. Decide whether students will work alone or in pairs.
2. Place color photocopies or prints of the "after treatment" painting image in inexpensive clear plastic sleeves made to fit three-ring binders.
3. Use non-toxic watercolor or tempera to create a "discolored coating" on the surface of each sleeve.
4. Prepare small water containers. You may choose to have students "label" the "solvent" while explaining the rationale for this procedure.
5. Discuss the reasons for cleaning a painting, for hiring a trained conservator, and reinforce the "pretend" or learning-only purpose of the upcoming experience.
6. Use prepared swabs, or model and guide students to prepare their own.
7. Model the "cleaning technique" and allow students to use their mock-ups to practice and observe the way the appearance of a painting changes during cleaning.
8. Use one of the previously described learning strategies to organize the communication of student observations and experiences.

CONCLUSION

Given the conservation field's increased focus on public outreach efforts, it is reasonable to expect that many, if not most, conservators will occasionally perform in teaching roles. The strategies outlined in the present study offer tips that both encourage effective teaching and learning experiences and simplify the process of outreach participation for all concerned.

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AUTHOR

Erin Kelly
M.A., C.A.S, Painting Conservation
M.Ed Secondary Education, Art Education,
Conservator and Educator in private practice
446 Seminole Avenue, NE #4,
Atlanta, Georgia 30307
E-mail: erin_LK@hotmail.com

Studio Tip: How to Make an iphone Microscope Camera

A video on how to make a microscope camera out of your iPhone recently popped up in tech blog Crabfu Artworks (http://crabfuartworks.blogspot.com/2010/09/crabfu-5-iphone-microscope-mod.html) and is also detailed at (http://gizmodo.com/5629880/how-to-turn-your-iphone-into-a-microscope-for-10).

Aside from the phone itself, the microscope is built by purchasing three things: the SE Mini 45X Microscope w/ Illuminator (http://www.amazon.com/gp/product/B002E0MU70/?ref=oss_product&tag=gmgamzn-20), any compatible iPhone slipcase, and superglue. To build the microscope camera, the microscope is carefully attached to the iPhone slipcase using superglue. It is helpful to have the camera on to find the best position for the microscope over the viewfinder. Protect your phone with Mylar while gluing the microscope on the slipcase. The eyepiece on the SE Mini is detachable, allowing for the body of the microscope to be removed from the slipcase during travel.

There is also an adapter compatible with the iPhone 4 that combines an already attached microscope to a custom slipcase (http://www.geeky-gadgets.com/iphone-4-microscope-adapter).

The microscope camera can only be used on iPhone models with perfectly flat backsides. For example, the iPhone 3GS has a rounded back and the microscope is unable to be attached flush to the camera viewfinder on the slipcase.

AUTHOR

Ana Alba
William R. Leisher Fellow in the Research,
and Treatment of Modern Paintings,
Painting Conservation
The National Gallery of Art
Washington, DC
Tel: 202-789-3046
E-mail: a-alba@nga.gov

Studio Tip: Customized Fume Extraction Hoods

Many institutions use Nederman fume extraction arms to remove solvent fumes. While the arms offer good mobility, the extraction nozzles are bulky and cumbersome when used over or around paintings. A simple solution was found by fabricating cone-shaped extraction hoods with clear 10 mil Mylar and ½" plastic tubing. The Mylar film is rolled into the appropriate diameter to meet the extractor nozzle that comes with the Nederman nozzle. Tubing is shaped in circles and hot-glued inside to reinforce the Mylar, producing a clear rigid form. A cushioning piece of Volara can also be attached to the end of the nozzle to protect artwork located beneath the extraction hood. In this case, Velcro was used to attach the customized hoods to Nederman extraction nozzle so different shaped hoods can be interchanged. See illustration below.

AUTHOR

Dean Yoder
Conservator of Paintings
Cleveland Museum of Art