The AIC Paintings Specialty Group

POSTPRINTS

VOLUME TWENTY-SEVEN 2014

Papers Presented at the 42nd Annual Meeting of the American Institute for Conservation of Historic and Artistic Works
San Francisco, California, May 28–31, 2014

Compiled by Barbara Buckley
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of the
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Compiled by Barbara Buckley
Thursday, May 29, 2014

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Notes on the Treatment of Cracks in Canvas Paintings

ABSTRACT

The paper describes a method of treating cracks and cupping in canvas paintings through localized exposure on the verso to moisture and alcohol and stiffening of the fabric with gelatin. The method is particularly suited to Modern and Contemporary paintings with large expanses of unbroken color. After an overview of past methods of treating cracks, the localized method is explained, with instructions, examples, and cautions. The paper concludes with observations on tolerance for damages of this sort.

1. INTRODUCTION

One of the most common and most frustrating conditions of many Modern and Contemporary paintings are the large, small or even nascent breaks in the paint film caused by handling, poor environmental conditions, and the general transfer of stiffness from the continually creeping fabric support to the hardening paint film over the course of time. In paintings where the surface is the art, and there is no swirling paintwork or imagery to occupy or distract the eye, these cracks assume an importance out of proportion to their size. Their presence stops the viewer from contemplating the scale, color, and surface nuances of the artwork (fig. 1).

Little research or practical treatises have been published about treating cupping and cracks as a stand-alone problem. They have traditionally been dealt with as a part of a comprehensive lining process; however, lining paintings is no longer seen as the default structural treatment for canvas paintings. Ongoing research into the effect of moisture and solvents on paint films, as well as the prevalence of acrylic ground layers in the last 50 years, has created new opportunities to explore localized treatment options, one of which is described in detail later.

Our tolerance, collectively, for this type of damage occupies a sliding scale, with factors such as context, age of the artwork, and viewer expectations informing our perceptions.

2. HISTORY OF TREATING CRACKS

2.1 Lining

The traditional treatment for eliminating cupping and other brittle distortions in paintings has generally been lining, a procedure which not only reduces these distortions, but also
addresses the concomitant loss of stiffness in the aging fabric supports. Although in the literature, descriptions of lining procedures usually mention humidification of the paint and ground layers as a pre-treatment for distortions, it is only one step in the larger process of facing, impregnation, and lining, the goal being to return the entire painting to plane, shore up the weak parts, and end up with a more stable structure so that the imagery may be enjoyed (Phenix 1995).

The most effective linings for reducing planar distortions are glue–paste combinations. In the last 50 years, there have been numerous studies detailing the effects of moisture on different layers in a painting, which prove what early liners knew empirically. Exposing the paint and ground films to moisture is an excellent way to plasticize and deform them. This temporary deformation, when combined with the stiffness of a dried glue–paste layer and a new, taut canvas support, makes a glue–paste lining very successful at getting a painting flat and keeping it that way for a relatively long period of time.

The other traditional method of lining is with wax–resin. In this method, heat and solvents—rather than moisture—are the critical elements in plasticizing the paint. Once returned to plane, the cracks are held in place by the completely uniform adhesive, which immobilizes every layer of the painting. The hydrophobia of the final product is a real benefit, protecting the painting from the deleterious effects of RH fluctuations. So wax–resin linings address not only existing damage but also offer a prophylactic against future or continuing damages caused by varying ambient humidity.

But both of these systems have side effects that came to be considered undesirable or harmful, such as weave interference, flattening of impasto, darkening or deterioration of the lining adhesive, and long exposures to heat and/or solvents. Beginning in the 1960s, new lining adhesives were under investigation, ones that could be activated at lower temperatures, or with less solvent. This coincided with the rise of Minimalism in painting, in which many artists abandoned imagery altogether, creating works with expanses of flat color. Since even small blemishes on paintings of this sort interrupted the viewing experience, the conservation needs of these easily damaged paintings forced conservators to rethink treatments that altered—even subtly—the surface. So there was a real imperative to find structural treatments that worked for these new paintings. In 1974, an internationally attended conference was convened in Greenwich, England, which was planned as a forum for discussion of lining practices, and included demonstrations of new materials, equipment and lining methods which were being developed to address these various issues (Villers 2004).

This conference proved to be an unexpected watershed. Instead of encouraging better lining, it sowed seeds of doubt about the entire procedure. Gradually, lining, which had always been an acceptable, traditional method of preserving canvas paintings, and which had been a large focus of research and treatment in the years leading up to 1974, began to lose favor as a treatment. A few important factors seem to have contributed to its decline in popularity.

The first was a growing body of research on how materials aged, how they reacted to heat, water, solvents, and the stress imposed on the paintings’ structure by some treatments. In addition, scientists entering the field of conservation brought with them a disciplined methodology which practicing conservators began to emulate; that of isolating variables and treating them separately. Because the research coming out of the laboratories tended to focus on one layer or aspect at a time, practicing conservators began to think of them quite separately. In this mind-set, performing a single complex treatment with so many objectives began to feel naïve or presumptuous.

A second trend was a pendulum shift in ethical and practical behavior toward minimal intervention, which was considered safer for the artwork and theoretically easier for a future conservator to reverse, should a better treatment be developed. New technologies, such as scanning electron microscopy (SEM) for instance, showed in shocking detail the complexities of what was happening to the surface of paintings during treatment. Most conservators had thought common treatments had acceptable risks, but this new information was paralyzing. In response, practitioners developed a kind of “fear of treatment,” which in many quarters led to a general movement away from comprehensive treatments and towards more limited interventions.

And third was the growing philosophical notion about paintings as three-dimensional objects, with history and information embedded in their backs as well as their fronts. Painting conservators, who had traditionally walked in lockstep with art historians by favoring the thin layer carrying the image over all other aspects of the painting composite, began to think more carefully about treatments that obscured or sacrificed unseen elements such as such as tacking edges, the canvas reverse, or the original sub-support.

All of these trends contributed to a growing reluctance to line (or at least to a desire to postpone lining), but without generating many practical procedures to replace it. The current popularity of nap bond lining adhesives, such as BEVA film and acrylic dispersions, is due largely to their relatively gentle interaction with the painting; however, while strong enough to hold an auxiliary canvas to the original support of a painting, these adhesive films generally lack the stiffness to hold a cupped paint layer in plane on their own.

1.2 Local Treatments
Very little work has been published in English on treating cracks and cupped paint locally. In the late 1990s, a series of tests were carried out at Queens University and the Canadian
Conservation Institute, in which various adhesives and thin reinforcing materials were compared for their efficacy in holding cupped paint in plane without "surfacing" (the appearance on the face of the painting of the shape of the repairing material applied to the reverse). This approach is conceptually similar to thread-by-thread tear mending, in that the main goal was to scale down the additives and area of intervention to a highly localized level. Although some results were promising, additional research has yet to be carried out (Hough and Michalski 1999).

In a project undertaken in 2003 in England, the researchers sought to take what was known about the stress loads of the various layers in the cracked painting composite and try to realign the stress so as to allow the cupped paint films to return to plane. The experimental method involved applying a coating to the reverse of the canvas and then cutting that coating in a mirror image of the broken paint layer on the face. Although testing showed the cracks were significantly reduced by this method, it was exceedingly difficult to perform accurately (Dimond and Young 2003).

Instead, the problem was addressed from a different angle—prevention rather than treatment. A lot of valuable work has been done on environmental management, improvements in packing and transport, and sympathetic passive, reversible solutions to prevent damages from environmental stress or handling.

3. THE IMPORTANCE OF THE GROUND AND FABRIC LAYERS

But cracked paint films remain a problem, particularly for modern paintings, where we have little tolerance for them. Happily, there are two important physical characteristics of younger paintings that can be exploited in the localized treatment outlined subsequently.

The first is the priming layer. Since its introduction in the mid-1960s, acrylic gesso has been widely used by artists. It is cheap, easy to apply, water based, and gives a great surface on which to paint. Since 1965, artists using commercially primed canvas as a support have been overwhelmingly painting on acrylic gesso, regardless of whether the paint layer is oil, acrylic, or something else.

And the existence of this acrylic layer has given new life to the moisture, heat, and pressure trio that enables cracks to go flat. Whereas on older paintings with oil grounds, any moisture introduced to the composite presents dangers to the fabric and sizing long before it plasticizes the paint and ground, in a modern painting there is an intermediate acrylic layer that deforms relatively quickly on exposure to moisture, and even more so to solvents (fig. 2).

The second advantage is that the fabric supports of these paintings are not as deteriorated as those of older works. They have grown up in environments with fewer pollutants and better temperature and humidity control. Success in treating cracks locally is definitely facilitated by strong, stiff fabric supports that retain their tension.

4. TREATING CRACKS: A LOW-TECH METHOD

Given that cracked and cupped paint films remain a challenge, and that the implementation of wholesale treatments has declined, as our knowledge of the complexity of the layer...
structure has increased, the treatment method described subsequently is an option that has proved to be successful in reducing or eliminating cracks. This procedure has been used in the Cranmer Art Group studio, for the last 12 years and has been taken up by some of the author’s colleagues in New York, with results that have varied from spectacular to only slightly improved. In a professional environment where minimal intervention is considered a positive ethical approach, re-treatability is the gold standard, and the aging characteristics of the materials introduced into the painting during treatment should be well understood, this method offers some distinct advantages.

While the treatment method described below exploits the relative malleability of acrylic films (figs. 3a-b, 4a-b), it has also worked well on paintings with oil or alkyd grounds. The general goal of this treatment is to locally reform the acrylic ground layer and stiffen the fabric so that when the moisture and solvent evaporate, the painting has returned to plane, and there are no patches or auxiliary attachments to the reverse of the canvas. Ideally, the crack closes significantly, and retouching is not necessary. In addition, there is the option of retreatability—either the next day or sometime down the road.

Initially this treatment was performed from the face of the painting (Gridley and Cranmer 2006), but it could be very time-consuming and awkward in terms of handling, particularly with large paintings, so with some alterations to the technique, this treatment is performed from the back, with the painting face down on a table. The method is very low-tech and doesn’t require much in the way of equipment.
There are a few optional steps that may make handling easier, particularly for large paintings. If there are cracks under the stretcher bars or rails, strip lining may help protect the turnover edges during handling as you take the painting on and off the stretcher to treat hard-to-reach areas. Also, numerous temporary handles attached to the stretcher will make it easier to manipulate the painting from wall to table and back (fig. 5).

In order to get the best results with this treatment, the painting needs to be free of varnish (should there be any), surface dirt, and any old fills and in-painting in the cracks. This is because the alcohol component in this system may partially and locally solubilize the varnish, while fill and retouch materials left in the cracks will prevent them from closing completely (figs. 6 a,b).

4.1 Required Materials

1. A flat, stiff surface on which to lay the painting face down.
2. Weights
3. Silicone release paper
4. Small stiff boards or metal plates
5. 10% gelatin mixture
6. Hot plate
7. Stiff-bristle brush
8. 80/20 mixture water/alcohol
9. Tacking iron
10. Mylar
The painting must be able to be wet cleaned. Occasionally, the adhesive moves through to the face of the painting, and one needs to be able to remove that adhesive residue without leaving a clean, shiny area (figs. 7a, b).

### 4.2 Procedure

1. First, make a template of the cracks with Mylar® and a Sharpie®. This becomes a road map of the cracks when you lay the painting face down, and can also serve as a sheet for notations and locations of tests (figs. 8a, 8b).

2. The horizontal surface beneath the painting must be very hard and smooth. Fome-Cor® is not stiff enough. Wood, Gatorfoam®, metal, or high-density polyethylene cutting mats all provide adequate stiffness (fig. 9).

3. Lay silicon release paper on the surface. Glassine, Pellon® or Hollytex® can be substituted if tests demonstrate that no gelatin will seep through to the face, causing adhesion of the paper or fabric to the paint layer. Blotter paper is too thick and cushy to use in this application, particularly for cracks that are only slightly raised. The silicon paper to some degree acts as a moisture wick, helping in the drying phase.

4. Place the painting face down, and flip the Mylar template, using it to locate the cracks to be treated (fig. 10).
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Figure 8. (a, b) Mylar templates with notations

Figure 9. Heavy polyethylene cutting mat used as a work surface
5. If the painting has pronounced impasto you can create a custom flattening board by creating a Mylar template of both the cracks and the impasto. Transfer the notations of impasto to Gatorfoam, and using carving tools or a Dremel sander, carve out a mirror image of the impasto (figs. 11a, 11b, 12a, 12d). This will enable you to use adequate pressure without fear of flattening the impasto or of moating.

6. Once you have your painting face down, paint a mixture of 20% isopropanol or ethanol in water directly behind the crack. Allow it to evaporate. If any of the layers seem too sensitive, omit the alcohol. This is a wetting phase. Some fabrics soak the mixture right up while others may be initially resistant. When this has visually evaporated, paint it on a second time, and follow this with a painted line of warm 8–10% gelatin (fig. 13).

7. The edges of this are then feathered, rather aggressively, with a stiff, slightly moist brush to avoid a hard edge to the drying gelatin (fig. 14).

8. Place a scrap of silicone release paper on the area and pass a warm iron over it. A tacking iron at its lowest setting is adequate. The heat is to encourage evaporation from the canvas, and to approach the glass transition temperature of the layers, allowing them to deform sufficiently to return to plane (fig. 15).

9. Place a stiff board or similar on the area and pile with weights. In our studio, we use three pound cold rolled steel weights, covered in blotter paper (fig. 16). The amount of pressure used is approximately 1.5 psi.

10. Replace the silicon paper 1–4 times over the next several hours as necessary to gradually reduce the moisture content.

11. Let dry under weights for 24 h and check the results.

Essentially this method replicates the successful aspects of flattening during a lining procedure, but reduces them to a local scale, and finishes without the final step of canvas.
Figure 11. (a) Oil paint on oil ground, 1953; detail of a crack with nearby impasto before treatment in normal light; (b) same detail after treatment in raking light

Figure 12. (a) Mylar template on a painting, showing cracks (black ink) and impasto (red ink); (b) the marked up Mylar notations transferred to Gatorfoam; (c) carving the Gatorfoam; (d) completed custom flattening board layered with silicon paper
Figure 13. Painting on the alcohol and water mixture

Figure 14. Feathering the gelatin
re-enforcement. The alcohol and water are acting as plasticizers for the ground and paint, and to some degree reactivating the sizing. The gelatin, which shrinks and stiffens as it dries, provides localized stiffness.

4.3 Successes and Failures
In general, this method has a lot to recommend it. Because it is localized, a small test will enable one to gauge the degree of success one can anticipate. The only thing being added permanently to the painting is gelatin, a sympathetic and resolvable adhesive with known aging properties. And often the surface integrity regained in the procedure makes retouching unnecessary. The method has worked well on many different combinations of ground and paint (figs. 17a–23b); however, some paintings do not respond to this treatment, or respond in unexpected or undesirable ways.

This can be because there is old varnish, fill, or adhesive in a previously treated painting that takes up space between the edges of the crack, preventing it from completely closing, or original paint that has moved into the crack from damage (fig. 24). It can also be the result of a previous treatment to the reverse, such as impregnation with a hydrophobic adhesive, or even a nap bond adhesive that is so thick or impervious to solvent action that the moisture and solvent cannot reach the ground layer.
Figure 17. (a, b) Oil paint on oil ground, 1960; (a) detail in raking light before treatment; (b) same detail after treatment

Figure 18. (a, b) Oil paint on alkyd ground, 1958; (a) detail in normal light before treatment; (b) same detail in raking light after treatment

Figure 19. (a, b) Oil paint on acrylic ground, 1968; (a) detail in raking light before treatment; (b) same detail after treatment
Notes on the Treatment of Cracks in Canvas Paintings

Figure 20. (a, b) Oil paint on acrylic ground, 1994; (a) detail in raking light before treatment; (b) same detail after treatment

Figure 21. (a, b) Oil paint on acrylic ground, 1973; (a) detail in raking light before treatment; (b) same detail after treatment
Then there are the cracks that respond too well. This has occurred when the paint film is highly sensitive to moisture and/or alcohol. In that case weave enhancement, darkening or blanching, or a transfer image or impression of the wrinkled silicone paper to the face of the painting have been seen (figs. 25–28).

Incomplete drying can lead to cracks that disappear but are replaced by rounded deformations that correspond to the area of gelatin on the reverse (fig. 29). (This is the reason for the stiff brush and feathering out of the adhesive.) Occasionally the procedure induces large scale distortions as the gelatin shrinks locally (fig. 30). Both of these conditions can be corrected by traditional overall or local flattening with a moist blower or by keeping the painting under tension.

Evidence of this treatment is often visible on the reverse of the artwork where the moisture and adhesive were applied. The
Figure 25. (a, b) Oil on acrylic ground, 1998; (a) detail of crack before treatment in raking light; (b) same detail after treatment, showing weave enhancement

Figure 26. Acrylic paint on acrylic ground, 1981; detail showing darkening of paint after treatment

Figure 27. Oil paint on oil ground, 1957; detail showing blanching of paint after treatment

Figure 28. Oil and wax paint on acrylic ground, 1981–1982; detail showing transfer of wrinkle pattern from wet silicon paper to paint surface
localized use of moisture can cause varying degrees of staining as the solubilized degradation products mobilize (figs. 31a, 31b). It has been observed that older canvases tend to stain more than younger ones and that linen seems to stain more than cotton.

As with all treatments, these drawbacks can be mitigated by experience and by careful testing. Moderating the amount of moisture used, allowing it to evaporate more fully before putting on weights, frequent changes of silicone paper on the reverse or even shifting the painting on the table mid-drying to get the area under treatment to a drier spot can help. And different paintings have different tolerances. Some cracks go flat with one treatment, whereas others may require multiple attempts. The two most important aspects in a successful treatment are adequate pressure and sufficient drying time.

Although the longevity of this treatment is undetermined as yet, it has been performed on hundreds of paintings in our studio over the last 12 years, and only a very few have come back for retreatment (fig. 32). The material left permanently in the painting—gelatin—has a known aging profile, so there is a good understanding of how it is likely to behave. As more of these treated works enter public collections and are monitored by museum staff, a better idea of the life-span of the treatment should emerge.

There are also ways to mitigate future or recurring damages from handling and fluctuations in RH, such as re-stretching the painting onto a keyable fiberglass panel. A panel stretcher isolates the reverse of the canvas from moisture uptake and gives added structural support to the whole laminate. It eliminates stretcher bars, and the resultant stretcher bar marks, and prevents people lifting the painting by its bars or rails—also a persistent source of cracking. If the profile of the painting is too thin for a panel stretcher, or the painting is shaped or huge, or the original stretcher needs to be retained, sanding down the inner edges of the stretcher bars and rails, attaching a loose lining or cami-lining, a backboard, and handles are all sensible methods of protecting the reverse.
5. OBSERVATIONS ON TOLERANCE

The perception of cracks and cupping as unacceptable types of damage is strongly correlated to the age of the painting, its imagery (if any), its context, and viewer expectations. The collective tolerance for damage in modern paintings lies along a spectrum. Often the people most insistent on surface perfection are the artists themselves, because they have an enormous stake in the aesthetics. The artists are followed closely by dealers and collectors, who have a big financial stake in condition issues.

But as the artists die, their voices become fainter, and other value systems start to vie for attention. As the paintings enter public collections, the tolerance for damage seems to ease a bit. In museums, these paintings now exist in company with many other artworks, all of which exhibit their own signs of aging. The context for experiencing them becomes more historical, didactic, and conceptual. While a collector has the option to treat each work as a singular, coddled object, a museum’s resources may be allocated so as to achieve collection-wide goals rather than provide star treatment for individual objects.

Philosophically, as well, the primacy of the top layer, the image, has been challenged, and that has influenced the way conservation professionals frame treatment protocols. No longer are unseen elements of the artwork unthinkingly sacrificed to preserve the surface, instead efforts are made to imagine and carry out treatments that honor the entirety of the painting.
which can mean acceptance of certain surface damages. That is one of the things conservation as a profession has brought to the art historical table—wittingly or not—an awareness of an artwork as a whole entity, with many different stories to tell.

The final component is viewer expectation. No one is shocked at seeing only the surviving 60% of a medieval wall painting, but one would be suspicious and perhaps even outraged if one were asked to accept that amount of damage in a modern work. As viewers, the expectation is that new things should look new.

In the contemporary art world, a painting with damage is a problem painting. But at 100 years old or more, a painting without damage is a problem painting. Expectations of appropriate wear and tear, damage, or patina are informed by the collective experience of comparable examples.

ACKNOWLEDGMENTS

The author would like to thank her colleagues—past and present—who have practiced and refined this treatment protocol over the years: Dana Cranmer, Daisy Craddock, Christine Frohnert, and Kristin Robinson.

REFERENCES


FURTHER READING


SUPPLIERS

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THIS ARTICLE HAS NOT UNDERGONE A FORMAL PROCESS OF PEER REVIEW.
1. INTRODUCTION

Pencil marks present a great challenge to removal when applied, purposefully or otherwise, to textiles such as unprimed cotton canvas. This problem is relevant to textile conservation as well as to the conservation of contemporary paintings, where unprimed canvas is frequently left exposed. Errant, accidental marks and those applied intentionally as acts of vandalism are equally problematic. Pencils generally comprise low-quality amorphous graphite; when used to write, the powdered crystalline flakes of graphite break off, but when this occurs on canvas, these powdery flakes are difficult to remove without compromising the structure of the fabric. Methods of safe removal were tested, including laser ablation, mechanical removal methods, and reversed microemulsion cleaning agents including siloxane systems. The effectiveness of the method of removal was determined by visual results, the hand of the fabric, and microscopic examination to check for fiber damage and discoloration. Mechanical removal proved ineffective and impractical, and an appropriate microemulsion system could not be found that would not compromise both the aesthetic and the hand of the canvas. Successful results were only obtained with laser ablation at 532 nm; other wavelengths tested (266 nm, 355 nm, and 1064 nm) did not give satisfactory results. Aging tests on the ablated canvas samples showed no significant changes to ablated areas.

Figure 1. Beta Upsilon by Morris Louis, 1960, acrylic on canvas, 102.5 × 243.5 in. (260.4 × 618.5 cm), Smithsonian American Art Museum 1980.5.6
dry cleaning, is now known to be harmful to humans and the environment and is being phased out of commercial use. The various laser tests done at that time were all either unsuccessful or damaging, and were deemed inappropriate; however, laser technology has evolved significantly since that time, as has our arsenal of solvent and aqueous cleaning techniques.

Modern pencils are generally composed of low-quality amorphous graphite, an electrically and thermally conductive semi-metal allotrope of carbon, pressed together with clay. When used to write, the powdered flakes of graphite break off; when this occurs on canvas, these powdery flakes become trapped in the fibers and threads, and are difficult to remove without compromising the structure of the fabric (figs. 4, 5). Little published research has been found on this topic; in consultation with Tiarna Doherty, chief conservator at SAAM, it was determined that the methods of removal to be tested during this study would include laser ablation, mechanical removal methods, and reversed microemulsion cleaning agents including siloxane systems.

Reversed microemulsions are typically made up of a high percentage of solvent with a small aqueous constituent, along with a large addition of surfactant and cosurfactant to reduce the size of the micelles. Their use in conservation has increased significantly in the last decade, and they have been applied to cleaning problems in every category from textiles to contemporary paint films. Their effectiveness lies in the fact that the aqueous component can hold any number of useful cleaning agents, including salts, chelators, and pH buffers, while the

Figures 2 and 3. Details of pencil mark graffiti on Beta Upsilon. Courtesy of Tatiana Ausema.

Figures 4, 5. Graphite embedded in the fibers of a sample of cotton canvas, at 150X (left) and 350X (right), Hirox KH 8700 3D Microscope. Courtesy of Bartosz Dajnowski.
solvent-carrier system avoids exposing a sensitive surface to too much water. The solution can be used to effectively “roll up” dirt, trapping it within the micelle and carrying it away. The reduced size of the micelles means that the aqueous component is more accessible, and therefore more effective. Siloxane microemulsion systems, based on solvents comprising silicon, oxygen, and methyl groups, have become more prevalent recently because of their extremely low polarity and the controlled volatility available by choosing the number of Si–O units.

The use of lasers in conservation has steadily increased since the 1970s, along with advances in the technology and application of the technique, which have made it a viable option for many subspecialties within the field. Laser ablation relies on light with high spatial and temporal coherence applied at specific wavelengths, pulse durations, beam profiles, and energy densities to target materials that absorb radiation at these specific parameters. The atoms and molecules of the contaminant absorb the laser energy and expand so quickly that their center of gravity is instantly displaced, causing them to ablate; that is, to be vaporized or ejected from the surface. Successful laser ablation relies on finding laser parameters that absorb into the layer one wants to remove from a surface, such as a contaminant or graffito, without absorbing into and damaging the original substrate material. Depending on the parameters chosen, a range of photomechanical, photothermal, and photochemical effects can be observed. Laser cleaning is commonly used in sculpture and architectural conservation in the United States, but it has also been explored for paper, parchment, textiles, painted surfaces, and paintings worldwide. Laser cleaning on cotton was explored by Sutcliffe, Cooper, and Farnsworth in 2000; they used carbon-and-oil-soiled cotton fabric to imitate a sort of greasy soot and tested the efficacy of laser cleaning at 266, 532, and 1064 nm with a pulse duration of 5–10 ns. At 266 nm, they found that there was no damage to the canvas, but a small amount of soil remained. At 532 and 1064 nm, the canvas became slightly to greatly discolored. In separate tests, they determined that aged fabric, whose cellulose has already undergone years of hydrolysis and oxidation through natural degradation processes, is more susceptible to damage from laser ablation.

2. EXPERIMENTAL CONDITIONS

Samples were prepared for testing various microemulsion solutions by drawing on Winsor Newton unprimed plain weave cotton canvas with a common no. 2 pencil. It is unknown what sort of fiber finishes may have been applied to the canvas, and it is also important to note that the samples were not aged before testing; therefore, the results of these experiments should be taken as preliminary findings that give insight into the physical and morphological challenges of this treatment problem, and ideally these tests will be repeated on appropriate and accurate mock-ups before being applied to any historical objects. Further, while most pencils typically comprise the same materials, elemental analysis of the pencil marks on Beta Upsilon may give some insight into the appropriate types of pencil to apply to canvases for removal testing. Barring that additional analysis, several different types of pencil with various levels of hardness could be applied in future tests.

The first set of canvas samples were sent to Chicago to be laser tested by Dr. Andrzej Dajnowski at the Conservation of Sculpture and Objects Studio. To establish safe working parameters for laser treatment, the damage thresholds first need to be identified on mock-ups. Three critical laser parameters need to be identified for successful cleaning: wavelength, pulse duration, and fluence. Diagonal pencil lines of various widths and strength were applied to a stretched sample of cotton canvas. A El En laser LQS 1000 and a Clean Laser CO-120, both 1064 nm lasers, were tested with various parameters, as well as comparing dry and wet ablation.

A second set of samples was prepared for laser testing in Warsaw, Poland, at the Military University of Technology, Institute of Optoelectronics, Laser Applications Lab. Plain weave cotton canvas was purchased from an art supply store in Warsaw, though it was of a different type (much finer and more open weave) than the first canvas sample. This was drawn on with a common pencil, and cleaning tests were performed with 2-ns lasers, a Renova at 1064 nm, and a Lotis TII at 532 nm, as well as a Ekspal picosecond laser at 1064, 532, 355, and 266 nm, all tested at various fluences, focal ranges, and pulse durations. This sample was artificially aged at Villanova University in a QUV-Accelerated Weathering Tester over a three-week period, receiving a total light exposure of 30 kJ, while normal exposure under museum lighting over the same period is about 0.003 kJ.

A microemulsion of 70% Laureth-3, 20% D5 decamethylcyclopentasiloxane, and 10% water with 0.5% citrate at a pH of 6.5 was applied with a soft brush to a pencil-marked sample of cotton canvas after first flooding with petroleum ether to help swell the fibers and make the graphite more accessible. Some light mechanical action with the application brush was also employed. After application, the sample was again flooded with petroleum ether and allowed to dry. The same procedure was also performed with an identical microemulsion with the aqueous component at pH 8.5. A second round of testing was performed with a proprietary commercial microemulsion still in testing and development, applied in the same manner. Mechanical removal methods, including vinyl block eraser, eraser crumbs, polyvinyl alcohol sponges, and latex cosmetic sponges, were tested in a preliminary fashion.
3. RESULTS

Table 1. Laser ablation results from the Military University of Technology, Institute of Optoelectronics

<table>
<thead>
<tr>
<th>Laser</th>
<th>Wavelength (nm)</th>
<th>Pulse Duration</th>
<th>Beam Diameter</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1064 (near infrared)</td>
<td>10 ns</td>
<td>2.48 mm</td>
<td>Canvas discoloration</td>
<td></td>
</tr>
<tr>
<td>1064</td>
<td>30 ps</td>
<td>0.522 mm (in focus), 0.879 mm (out of focus)</td>
<td>Canvas discoloration, some fiber damage when used at higher power</td>
<td></td>
</tr>
<tr>
<td>532 (green)</td>
<td>10 ns</td>
<td>9.35 mm</td>
<td>Slight canvas discoloration in some areas, other areas effectively cleaned</td>
<td></td>
</tr>
<tr>
<td>532</td>
<td>30 ps</td>
<td>0.483 mm (in focus), 1.03 mm (out of focus)</td>
<td>In focus: slight lightening of the canvas, full graphite removal, some fiber disturbance</td>
<td>Out of focus: full graphite removal, no canvas disruption, lightening, or discoloration</td>
</tr>
<tr>
<td>355 (UV-A)</td>
<td>30 ps</td>
<td>0.339 mm</td>
<td>In focus, slight lightening of canvas from fiber disruption</td>
<td></td>
</tr>
<tr>
<td>266 (UV-C)</td>
<td>30 ps</td>
<td>n/a</td>
<td>No visible effect on graphite or canvas</td>
<td></td>
</tr>
</tbody>
</table>
4. DISCUSSION

Microemulsion cleaning gave poor results during this study. Although the pencil marks were lightened with these methods, more than enough remained to be visually disruptive, especially in the interstices of the fabric. The proprietary microemulsion, while slightly more effective at graphite removal, caused some lightening of the canvas, as well as a stiffening and a change to the hand of the fabric, which could become exacerbated with age and which, because localized treatment is necessary, could cause future problems of differential stress and strain between treated and nontreated areas. Additionally, the siloxane solvent required an inordinate amount of time to evaporate—nearly three weeks—which could be a problem considering the logistics of treating such a large painting. Testing with smaller chain, lower-molecular-weight siloxanes was not feasible in the time remaining for this study, but may be desirable in the future, as straight-chain siloxanes, such as hexamethyldisiloxane, evaporate much faster than cyclic siloxanes like D5. Microemulsions have proven infinitely useful in other situations, overcoming some of the most difficult cleaning challenges, but the unique morphology of graphite trapped in canvas fibers seems to have defeated them in this particular situation.

Mechanical removal methods, including vinyl block eraser, eraser crumbs, polyvinyl alcohol sponges, and latex cosmetic sponges, were tested in a preliminary fashion but quickly gave poor results. With the exception of the eraser crumbs, all of these methods disrupted the fibers too much, even with extremely gentle application, and all methods were ineffective in the interstices of the weave. With most of the mechanical removal attempts, the graphite seemed to become more spread out but was not actually removed, though the cosmetic sponge and eraser crumbs were both slightly more effective at actually picking up the graphite. Additional means of mechanical removal were suggested, such as using a small straight pin and a nearby vacuum and working microscopically to pick off the small flakes of graphite; however, after studying the microscopic appearance of the graphite, it became clear that, in addition to being impractical, this would not be effective considering the extent of infiltration into the fibers the graphite had achieved.

The graphite was successfully ablated through a wide range of wavelengths and settings, but finding a set of parameters that did so with no damage to the canvas was more elusive. In the Chicago tests, which were all at a 1064-nm wavelength with nanosecond pulse durations, the pencil marks were removed, but the canvas was discolored wherever graphite had been present. When directed at clean canvas, no damage was observed. This was again the case with the Polish tests at 1064 nm. This discoloration appears to be caused by photothermal damage due to both the infrared absorption of carbon as well as the conductivity of graphite, which enhances the transfer of energy from the laser to the canvas, locally dehydrating the fibers and causing them to brown and visually appear as a burn.

As one moves away from the infrared and toward shorter wavelengths, the risk of photothermal damage decreases but the risk of photochemical damage becomes more likely, with the worst occurring with the 355-nm laser in the UVA region of the spectrum. This high-energy burst of UV radiation initiates free radical chain processes in the cellulose resulting in photolysis, the breaking of bonds due to photon energy. Visually this appears as mechanical damage to the fibers.

The best results obtained during this study came from the 532-nm wavelength lasers—not surprising, as this wavelength has a long history of successful use on organic materials such as paper and bone. This method allowed for complete graphite removal without disrupting the fiber bundles or weave structure, and with no apparent discoloration or damage; however, several important factors were noted. At 532 nm with a nanosecond laser, there is a slight amount of discoloration due to photothermal reactions, as was seen in the 2000 study mentioned earlier. With the picosecond laser at the same wavelength, this discoloration was avoided, as the canvas is exposed to far less energy overall. Next, the beam size and focal range of the laser made a significant difference to avoiding damage to the canvas fibers. At the ideal wavelength and pulse duration mentioned earlier, with the beam in focus, mechanical damage occurs, but an out-of-focus beam removes the graphite with no damage to the fibers or disturbance to the weave structure at all. This is due to the fluence or energy density of the beam—an out-of-focus beam spreads the same amount of energy over a larger area. Controlling the fluence of a laser beam is a matter of selecting appropriate optics as well as the skill of the conservator in maintaining a desired focal distance from the surface.

Finally, it should be noted that because of the high texture of the canvas weave, it may be optimal for laser light to be applied from more than one angle. When applied perpendicular to the thread incomplete ablation could occur. Instead, the graphite flakes may need to be addressed on each side of the thread.

No visible differences between the areas treated with the recommended laser parameters and the untreated areas of the canvas sample were noted after artificial aging, suggesting that this laser treatment is safe for the long-term preservation of the canvas, but further study of this artificially aged sample is ongoing.
5. CONCLUSIONS

Methods for removing graphite from cotton canvas were tested, including microemulsion cleaning, mechanical removal, and laser ablation, with an aim toward finding the most appropriate method of treatment for removing pencil graffiti from the Morris Louis painting *Beta Upsilon*. The most appropriate, effective and non-damaging method found during this study was the use of dry laser ablation at 532 nm with picosecond pulses and a large, out-of-focus beam that amounts to a low energy density. The specific absorption of graphite at longer wavelengths and the susceptibility of cotton cellulose to UV exposure made other laser frequencies unsuitable for treating this problem. Microemulsion and mechanical cleaning attempts were unsuccessful at completely removing the graphite, especially from the interstices of the weave, and in some cases caused damage or changes to the canvas.

It is recommended that, before being applied to any historical objects, testing is repeated on accurate and appropriate mock-ups to understand the exact laser parameters applicable to the specific substrate being treated. For *Beta Upsilon*, the most effective tests from this study will be repeated on samples of Louis’s own aged cotton duck canvas scraps before a treatment plan is finalized. If laser ablation is found to be incompatible with the aged and degraded canvas, further testing with mechanical removal and microemulsions (especially with lower-molecular-weight siloxanes) may be desirable.

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ABSTRACT

It has proven challenging to document, via written sources, the variety of materials and techniques used by American painters from about 1860 to 1910. The authors discovered a number of useful sources of information from this period heretofore little known to conservators, including artists’ advice columns in the periodical Art Amateur and a series of detailed technical interviews by DeWitt McClellan Lockman. These sources are interpreted by comparing them to other publications and manuscripts of the time.

1. INTRODUCTION

During the course of writing two books on American painters’ techniques (Mayer and Myers 2011, Mayer and Myers 2013), the authors compiled first-hand descriptions of techniques from written sources including artists’ notebooks, painting manuals, periodicals, suppliers’ catalogs, letters, diaries, and interviews. The period between 1860 and 1910 is an extremely interesting time, when more Americans than ever before traveled to Europe and brought back many new ideas about materials and techniques. But it is difficult to document these methods because painters could easily buy materials readymade, and there are therefore fewer recipe books and intense discussions about materials made “from scratch” than are found in earlier periods. After 1910, many painters became dissatisfied with store-bought supplies and began to make their own, and the volume of discussion went up again. The years between 1860 and 1910 seemed, at first, like a blank spot in between; however, the authors eventually found some sources for this period that are not very well known to conservators, and were able to compare and interpret them with the aid of a limited number of other written sources.

2. PUBLISHED SOURCES

It should be said that many art supply catalogs survive from this period, which provide lists of materials that were available to artists; however, these do not tell us exactly how painters used those materials. There were relatively few instruction books until the end of the century, but one book that does give some information about how Americans were interpreting what they were learning in Europe is an 1878 republication of an earlier British text that was edited for an American audience by Susan Nichols Carter, who was Principal of the Women’s Art Schools at Cooper Union in New York (Williams 1878; see also Carlyle 2001, 330).¹

One of the most pointed editorial comments that Carter made concerned the pigment chrome yellow. The British author did not question its permanence, but Carter added a note at the bottom of the page for American readers: “Chrome yellow is very liable to turn black, and consequently its use is disapproved by painters.—EDITOR.” (Williams 1878, 21)

Chrome yellow had a complicated history in America. Around 1810, Rubens Peale had developed a plan to manufacture it in Maryland, which was one of the few places in the world where chromium ore was found at the time. This predates the earliest known mention of the color in the European artists’ literature. The Peale family, however, gave up the scheme after they found that the color darkened on exposure to light. Chrome yellow was, soon afterwards, manufactured in Europe, and it was available all through the rest of the 19th century (Mayer and Myers 2011, 131, 156–157; Mayer and Myers 2013, 50–52). But, as Carter reminds us, at least some Americans knew that it was not quite right.

Carter’s editorial remarks shed light on some other trends of the time. The British author was enthusiastic about megilps and other added vehicles that would give oil paint better handling properties or greater transparency and gloss. Carter, however, made an annotation that gave the authority of Thomas Couture to the more cautious approach to adding media that some other Americans had arrived at by the 1870s: “Couture recommends as little vehicle as possible, and himself uses turpentine and drying oil mixed” (Williams 1878, 34; Mayer and Myers 2013, 54–58).²
Thomas Couture seems to have developed a special relationship with the many Americans who traveled to Paris to study with him. He painted a striking sketch of one of his American pupils at her easel (fig. 1). Couture’s method, which involved painting thinly over brown underlayers that remained partly visible in the finished composition, sometimes produced problems when paint became more transparent over time. Dark underlayers that have become more prominent over time can be seen in the works of many Americans who were influenced by French technique, including Winslow Homer, Eastman Johnson, and Thomas Eakins (Mayer and Myers 2013, 34–37).

A pigment that played an important role in these brown underlayers was brun rouge or brown red. This pigment was referred to in French sources, but only rarely in British ones, and in fact was not sold under that name by the major British colormen during the 19th century. Brun rouge was available in America at this time, initially imported by American firms with French origins such as Dechaux and Goupil (Mayer and Myers 2013, 47–48). As is the case with some other materials such as Soehnée’s Retouching Varnish and dammar resin, brun rouge seems to have come to America from continental Europe independently of British colormen.

4. ELIZABETH BOOTT

It is somewhat surprising that Americans wrote so little about the technical side of their experiences studying art in Europe in the second half of the 19th century. They did write about the scenery, the people, and the food, and not very much about technique. But a few did, including the painter Elizabeth Boott (fig. 2), some of whose letters have been published, while others are available only in manuscript form.

Elizabeth Boott studied with Couture, and she wrote in a letter about the “many technical things…which are most helpful & which he is always ready to tell us. ‘I will do this for Americans but not for French people’ he says.” (Duveneck Papers, frame 271) It is not clear exactly why Couture was so taken by Americans, but when he wrote a book on technique in 1867, he dedicated it: “À l’Amérique” (Couture 1867).
Boott also wrote letters that describe William Morris Hunt’s class in Boston, and the methods that Frank Duveneck was using when she first met him in Munich in the 1870s. Booth wrote back to the members of the Hunt class that Duveneck “uses his paint very oily….The dragging of dry color so much done in the French school, he does not seem to practice at all. Everything is moist, he paints in a puddle in fact, as one guesses from the looks of his things…he used linseed oil and no turpentine” (Duveneck 1970, 77–79). This would result in a paint film much richer in medium than if turpentine had been added to help make the paint more liquid. Booth wrote that using large amounts of oil allowed Duveneck to “sling” the paint freely with his brush so that—as she described it—“The paint seems to squirm round at his bidding in the most extraordinary manner and model itself” (Duveneck 1970, 78). When a friend wrote and asked if Duveneck still painted in that “buttery” manner, Boott told her: “We called it juicy” (Duveneck Papers, frame 379).

Other artists—William Morris Hunt was one—knew that adding large amounts of oil could eventually produce discoloration. Hunt had criticized William Page for precisely this: “He uses a great deal of oil with it [his paint], and that’s what makes his paintings so brown” (Hunt 1976, 113). Duveneck was apparently willing to take that risk.

Artists also had differing opinions about varnishing at this time. Elizabeth Boott wrote that Duveneck varnished his paintings with coach varnish, which made them, in her words, “shine like mirrors,” and was so glossy that Duveneck’s dealer in Boston hated the varnish and tried to take it off (Duveneck 1970, 78). This reinforces another piece of evidence in a letter from John Singer Sargent, who had crossed paths with Duveneck in Venice in 1881. Sargent apparently took a dislike to the heavy varnishes that Duveneck and his pupils—nicknamed the “Duveneck boys”—were using. Sargent advised a client: “Don’t let D or any of his boys varnish it; they have some wondrous prescription for making a picture blaze under a thick coat of enamel like a panel of a new carriage” (Charteris 1927, 55). Sargent suggested, instead, a “light” varnish, like Soehnée’s Retouching Varnish, which was a thin solution of bleached shellac in alcohol (Charteris 1927, 55; Sutherland 2010; Mayer and Myers 2013, 76–77).

5. HELEN KNOWLTON

William Morris Hunt taught, in Boston, methods he had learned from Couture and from Jean-François Millet, and Helen Knowlton is probably best known for compiling some of Hunt’s sayings and publishing them in two books. But in 1879 she also wrote a slim volume on her own. Knowlton believed, as many painters were coming to believe in the last quarter of the nineteenth century, that caring too much about technique was stifling and “academic”—the opposite of progressive painting. She wrote: “As a general rule, avoid METHOD! It is the bane of art to-day—this seeking for a way. It makes the student self-conscious and pedantic, thinking less of the song than of how to sing it” (Knowlton 1879, 22). William Morris Hunt made one of the most extreme statements in this regard: “Won’t that picture crack? I don’t care if it does! It would be better if more pictures cracked!” (Hunt 1976, 24). This kind of attitude on the part of Knowlton and Hunt can help explain the technical deficiencies of painters like Albert Pinkham Ryder and Ralph Blakelock in spite of the increasing availability of (mostly good) advice about technique at that time.

6. MONTAGUE MARKS AND ART AMATEUR

Montague Marks is still not very well known, but he turned out to be very important to our research. He had a life that sounds like it should be turned into a novel—he was born to a Jewish family in London, and first came to America to become a cowboy(!) in the Far West. When this did not work out, he moved to New York and married the sister of Emma Lazarus, the author of the famous poem on the base of the Statue of Liberty that begins: “Give me your tired, your poor.” Marks reinvented himself as an art expert, with a foot in both New York and London, sometimes writing under the pen name “Montezuma.” He edited and wrote many of the articles in the magazine Art Amateur in the late 1870s, 1880s, and 1890s (fig. 3), in which some of the very first artists’ advice columns appeared.

These articles were extremely useful in giving particulars about how painters used materials. They documented, for instance, the growing popularity, beginning in the 1880s, of Soehnée’s Retouching Varnish as both a retouching varnish and a final varnish (Mayer and Myers 2013, 76–77). This means that shellac is present (sometimes in multiple layers) within the structure and on the surfaces of American paintings to a greater degree than conservators might have thought.

Art Amateur also tested petroleum solvents and compared them to turpentine, tested American paints and compared them to French and German ones, and tested the new so-called “Petroleum Colors” from Germany, which contained an extremely slow-evaporating petroleum fraction that served as a plasticizer. These columns also contain many other nuggets of information about pigments, media, driers, and varnishes. For instance, one of Marks’s columns describes Thomas Dewing applying, in 1890, a thin layer of varnish that gave a “dead gloss,” which is the earliest description of a matte picture varnish that the authors know of from any source. The
Varnishes that he had invented, but gave very little information about what they actually contained. Since Vibert’s materials were made and sold commercially, he may have had an interest in keeping his descriptions vague. His inventions included paints that he called “watercolors,” but which must have contained other ingredients, perhaps wax, because they could be “fixed by fire” to a wall or other surface using an alcohol lamp. He also referred to a varnish made with what he called “normal resin,” and it is only with modern analysis that we know that this mysterious “normal resin” was derived from dammar. Vibert was a great advocate of petroleum solvents instead of turpentine, and at exactly this time some Americans began experimenting with benzine and kerosene as diluents. Vibert also believed that white lead was not compatible with vermilion or cadmium colors, and he recommended zinc white instead; Americans soon became aware of this and came to believe it, with consequences that will be discussed subsequently (Vibert 1892; Mayer and Myers 2013, 52–54, 67–69).

8. ALBERT ABENDSCHEIN

A book that was much more sensible than Vibert’s, in spite of its sensational title, was one published in 1906 by the American Albert Abendschein called The Secret of the Old Masters. Even painters of scenes of modern life in America (the so-called “Ashcan school”) were influenced by this book. Abendschein described experiments with exotic media, but he eventually rejected them all in favor of simply painting in oil and allowing pictures to dry in the sun. But his descriptions of some of these experiments—with wax, for instance—remind us that painters like John LaFarge, Thomas Dewing, Dwight Tryon, Charles Platt, and others were all experimenting with wax in the latter part of the 19th century. Abendschein’s book also discussed tempera painting. The tempera revival began earlier than most conservators think. William Merritt Chase and Robert Blum were using some kind of tempera as early as the 1880s and 1890s, although Abendschein was not quite on board yet in 1906; he ended his account of tempera painting with: “The egg, I think, is more useful taken internally, and should be kept out of the studio” (Abendschein 1906; Mayer and Myers 2013, 205–206).

Abendschein was also one of the first Americans to describe what would become one of the great themes of the first half of the 20th century: the division of painting into two stages (in the belief that the old masters had done this)—a detailed, monochrome underpainting or “dead-coloring,” followed by thin, transparent glazes; artists would eventually come to call this process “indirect painting.” Painters would soon discover, as the tempera revival gathered steam, that this was quicker and easier if a medium other than oil was used in the underpainting.

Dewing scholar, Susan Hobbs, believes that Marks almost certainly knew Dewing personally through his wife’s family, so it gives his remarks on Dewing much more authority than simply hearsay. These columns also document the very beginnings of the tempera revival in America, which included commercially made tempera paints and the theories of J. H. Vibert, who recommended adding varnish or wax to egg tempera in the 1890s, a practice that would become much more common in the 20th century (Mayer and Myers 2013, 38–39, 60, 69–71, 75, 205).

7. J. H. VIBERT

Vibert’s book The Science of Painting appeared in French in 1891 and in English in 1892. Many Americans read it, although it was actually one of the least scientific books about technique. Vibert made great claims for the special paints and varnishes that he had invented, but gave very little information about what they actually contained. Since Vibert’s materials were made and sold commercially, he may have had an interest in keeping his descriptions vague. His inventions included paints that he called “watercolors,” but which must have contained other ingredients, perhaps wax, because they could be “fixed by fire” to a wall or other surface using an alcohol lamp. He also referred to a varnish made with what he called “normal resin,” and it is only with modern analysis that we know that this mysterious “normal resin” was derived from dammar. Vibert was a great advocate of petroleum solvents instead of turpentine, and at exactly this time some Americans began experimenting with benzine and kerosene as diluents. Vibert also believed that white lead was not compatible with vermilion or cadmium colors, and he recommended zinc white instead; Americans soon became aware of this and came to believe it, with consequences that will be discussed subsequently (Vibert 1892; Mayer and Myers 2013, 52–54, 67–69).
At the same time that many other painters began to reject store-bought materials and revived the craft of making their own grounds and paint, Dufner had studied with Whistler in Paris, and a practice that Dufner may have picked up from Whistler was using kerosene to dilute his paints instead of turpentine. This was controversial at the time, and some artists thought that it made paintings darken, although in addition to Whistler and Dufner, Albert Pinkham Ryder, Joseph DeCamp, and some of the Ashcan painters used kerosene as well. But Dufner gave more information than any other painter about exactly why he used it. He told Lockman: “For very light pictures I generally use kerosene oil, which dries without gloss and gives a beautiful surface like the bloom on fresh fruit” (Lockman 1926–1927; Mayer and Myers 2013, 34, 70, 165, 216–217)

This leads to the trend toward nonvarnishing and matteness that developed toward the end of the 19th century. In fact, an inscription on a painting by Dufner recently came to light that bears on this. Dufner wrote on the back of the painting “Youth and Sunshine” (1916): “This picture being in a light key is meant to have a matt surface and should never be varnished.” In his interview with Lockman some years later, in 1927, Lockman asked: “Do you varnish?” and Dufner replied: “Sometimes light, but not generally” (Mayer and Myers 2013, 216–217). This implies that at any given moment Dufner varied his varnishing practice from painting to painting, just as the written inscription on the back of the painting spells out: This one should not be varnished because it is in a light key. Dufner was not the only artist who seems to have believed that paintings that were light in value might not want be varnished, whereas darker paintings might need varnish. Both Charles Hawthorne and Henry Prellwitz said essentially the same thing (Mayer and Myers 2013, 216).

The Lockman interviews are rich in details about these sorts of decisions about matteness and varnishing. They also show how Vibert’s ideas about the incompatibility of white lead with vermilion and cadmium pigments had taken hold, and many artists now used zinc white for exactly this reason (Mayer and Myers 2013, 53).

10. MARY LOUISE McLAUGHLIN

Another book that documents the growth of interest in zinc white was written by Mary Louise McLaughlin in 1888, a few years before Vibert’s book was published. McLaughlin was a strong advocate of zinc white, not because of incompatibility with other pigments, but because she knew that white lead was poisonous, and paint made with it could become more transparent or discolor over time. She listed zinc white instead of white lead in all of the sample palettes in her book, and she even put white lead on her list of pigments “to be avoided” (Mayer and Myers 2013, 53–54; McLaughlin 1888).
Views like those of McLaughlin and Vibert would have consequences in terms of the preservation of paintings from the late 19th and early 20th centuries, because conservators now know that zinc white makes a brittle film that is more prone to cracking than one made with white lead (Rogala et al. 2010).

11. CONCLUSIONS

The primary and secondary sources from this period proved much richer than the authors had initially thought. Their two books on American painters’ techniques contain very complete endnotes, so that conservators can follow leads contained in the endnotes and learn still more from these and from other written sources in the future. Further research will become still easier to do as more publications and a higher percentage of the holdings of the Archives of American Art become available and searchable online.

NOTES

2. See Mayer and Myers 2013, 54–58 on differing ideas about how much media should be added to paint.
3. Boott, letter to William Morris Hunt’s class, July 30, 1876.
4. Boott, letters to Hunt’s class, June 27 and July 22, 1879.
5. Boott, letter to Hunt’s class, July 22, 1879.
7. This 1976 edition combines two books compiled by Helen Knowlton and originally published in 1875 and 1883.

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Conserving Spanish Colonial Paintings: Finding the Divine in Conservation

ABSTRACT

This article examines some of the materials and techniques employed in the creation of Spanish Colonial paintings, including support systems, image media, and surface coatings, and the relation of these components to a painting’s condition; and presents some frequently encountered condition issues that are less commonly seen in European and American paintings from similar time periods. Specific examples of the conservation treatment of Spanish Colonial paintings are given, as well as suggestions of their possible relevance to the conservation of paintings in general, especially those that are in poor condition.

The treatment and preservation of Spanish Colonial paintings present interesting and challenging opportunities. Firstly, they are not only created as aesthetic images, but also made for devotional purposes. They frequently incorporate unique subjects and compositional elements, and may vary from their European and American counterparts in materials and structure. Finally, a large number of these paintings are in remarkably poor condition. Relative to their contemporary European and American counterparts, they often exhibit greater extremes of similar condition issues seen in other older paintings, such as more numerous and more severe damages to their supports, greater loss of preparatory and image layers, more layers of surface coatings of diverse composition, and heavier accumulations of dirt, grime, and accretions (fig. 1). Because of this, they can challenge the conservator to more carefully examine the paintings, to spend more time testing them and learning about their history, and to learn as much as possible about relevant treatment related materials and techniques that are available within the field of conservation.

Spanish Colonial paintings often charm the observer with busy compositions, funky images, and amazing details beyond the painting’s central composition. For example, two–headed and five-legged oxen plowing a field, a Holy Family in the Garden that also includes a smaller, crude image (executed in a different artist’s hand) that captures the hesitant, teetering quality of Jesus’ first steps, and a Rest on the Flight into Egypt that incorporates a small scene of the Massacre of the Innocents, clearly depicting emotions of anger, fear, desperation, and determination on the tiny figures’ faces.

Figure 1. Unidentified artist, Visitation of the Blessed Virgin, 18th century. Our Lady of Belen Catholic Church. Detail before cleaning
Uncommon techniques can often be found in Spanish Colonial painting, such as shell inlay incorporated into the image layers in *enconchado* paintings, sometimes used on their frames as well. Cochineal has been positively identified (along with other sources of red color) in the paint layers in Spanish Colonial paintings, including on the Denver Art Museum’s *The Apparition of St. Michael on Mount Gargano* painted ca. 1650 by Sebastian Lopez de Arteaga. It is not uncommon to see very thin preparatory layers or no ground layer at all. And support systems frequently seen include canvas adhered to strainer faces (rather than being tacked onto the edges), unrestrained canvas in scroll form, and leather. Additionally, there are paintings with peculiar subject matter, such as *casta* paintings, and religious subjects that depart from those typically portrayed in European paintings, such as *Our Lady of Pomata*, *Our Lady of Copacabana*, and *Our Lady of La Macana* (fig. 2).

It appears that colonial paintings oftentimes have received no varnish early on, allowing their paint surfaces to accumulate considerable quantities of dirt and accretions before ever receiving surface coatings many years after their creation. Additionally, in many cases it appears that no attempt was made to clean the painting surfaces of accumulated grime prior to later applications varnish, causing dirt and grime to become interlayered between paint and surface coatings. The same often holds true of consolidants used to stabilize severely damaged media, often having been applied over dirty, damaged painting surfaces or penetrating from the verso through degraded canvases and lean paint layers and embedding grime on the paint surface. Upon initial examination, these paintings may have the typical appearance of darkened tree resin varnishes and later grime accumulation, however their solubility, fluorescence, and degradation characteristics oftentimes suggesting much more complex layers of dirt and accretions, collagen glues, waxy materials, and resinous varnishes, either with additives or possibly of resins other than dammar or mastic. An in-depth study of coatings on Spanish Colonial paintings would be useful in determining if local or regional tree resins or shellac coatings were used on these paintings that appear to vary in solubility and fluorescence from their European counterparts. Exploring this possibility and creating a database of spectra for FTIR analysis may be a valuable research subject for a conservation student or post-graduate intern to pursue. In any case, removal of these layers of surface coatings and grime sometimes necessitates the use of a half dozen or more different solvents in varying solutions to work through them, frequently ending (rather than starting) with aqueous cleaning of grime layers that lay directly on the paint surfaces of colonial paintings.

A painting from the Denver Art Museum of Saint Thomas Aquinas is a good example of some of the problematic condition issues found in Spanish Colonial paintings (fig. 3). Because the painting was obscured by heavy grime...
accumulation and significantly darkened natural resin varnish layers, there was some question as to whether the painting was actually by the hand of Gregorio Vasquez, that of an apprentice, or some combination.

The wood panel had warped convex to the painted surface, and split into two pieces. The break had occurred sufficiently long ago that each side additionally deformed separately and differently from each other, preventing them from lining up with each other. Movement of the wood along the vertically oriented grain had also caused scattered “pockets” of delamination of paper and wood panel, and these planar deformations had caused corresponding cracking, cleaving, and loss of varnish and paint layers. The two sides of the panel had been held together with a length of fabric embedded in a thick, pigmented layer of collagen glue adhesive, and there were smaller strips of masking tape added perpendicular to the split at a later date. In spite of these repairs, the two sides of the panel could readily move, necessitating flat storage since the paintings arrival at the Denver Art Museum.

Conservation of the painting began with creating a temporary support for the panel with shaped sandbags, Ethafoam blocks, and Volara. Once supported to prevent movement of the panel, local consolidation of unstable paint and ground was carried out using 3% w/v isinglass under the cleaved paint layers. Local application of dilute BEVA-371 and minor to moderate heat and pressure were used to relax, manipulate, and secure the delaminated paper to the wood panel. The painting surface was carefully cleaned of grime and miscellaneous accretions using 1% ammonium citrate in distilled water, pH adjusted from 7.5 to 8.0 with ammonium hydroxide. Discolored varnish layers were removed or reduced using varying proportions of xylenes, petroleum naphtha, isopropanol, and acetone, to solubilize the varnish layers gradually, following Chris Stavroudis’s suggestion of viewing each layer of varnish as comprising varying solubility characteristics within that layer. Residual grime and accretions that were beneath the varnish were removed using distilled water at lower pH levels, ranging from 6.0 to 7.0.

The painting was then placed face down over a revised temporary support system, and the tape and fabric reinforcement strips were removed mechanically. Reduction of adhesive was effected mechanically, after softening it first with warmed distilled water. The panel verso was cleaned of dust and dirt using brushes and a lint free cloth dampened slightly in a solution of 4 parts distilled water and 1 part ethanol. Paraloid B-72 (10% w/v in xylenes) was brushed onto the edges of the panel along the break and allowed to dry overnight. The panel was rejoined, the alignment following the general overall arc of the initial warp in the panel, using 30% Paraloid B-72 in acetone. Water-based adhesives were avoided, and an adhesive with a quick drying time was desired, allowing the panel sides to be handheld for initial drying, before putting the panel face up onto a padded support, and clamping and weighting in place until the adhesive had thoroughly dried.

A padded backing was made of rigid Ethafoam carved to shape and covered with Volara, mounted to acid-free blue corrugated cardboard. The painting was varnished with MS2A reduced ketone resin varnish, with the addition of 2% Tinuvin and a small amount of micro-crystalline wax. Losses and damages to the paint media were filled with Modostuc and inpainted with Gamblin Conservation Colors, and a final light spray of Regalrez varnish with wax was applied. A balsa wood insert was made for the frame liner, accommodating the curved horizontal edges of the painting, allowing the painting to be securely installed in its frame, using only minimal pressure on the middle portion of the end-grain sides of the panel.

Examination before and after cleaning ruled out any presence of an ink image beneath the paint layers, and paint handling and artist technique visible after treatment allowed for the positive identification of the painting by curators as having been from the hand of Vasquez himself.

The Denver Art Museum’s collection, Virgin and Child in a Garden with Angels, exhibits the condition issue of a painting apparently having received no varnish coating early after its execution, with a lean paint surface which accumulated considerable dirt, grime, and accretions prior to receiving an application of varnish at a much later date, which in turn was covered with more grime and debris. It exemplifies the complex layers of grime, varnish, and consolidants described earlier (fig. 4), as well as numerous fly-speck accretions and extensive paint loss commonly seen with colonial paintings. On this particular painting, an aqueous solution of pH adjusted distilled water removed minimal surface dirt from the painting. Isopropanol was more effective than acetone or ethanol in removing the discolored varnish layer. Then, the dark layers of heavy grime and the considerable quantities of fly-speck accretions residing under the old varnish were removed, using aqueous solutions including ammonium citrate and EDTA solutions in distilled water, both pH adjusted from 6.5 to 7.5, and following with appropriately pH adjusted water. A collagen glue layer that likely had been applied early on to stabilize flaking paint related to moisture damage was reduced using warm distilled water, pH adjusted from 8.0-8.5, and a final cleaning carried out with a 1:1 solution of isopropanol and distilled water.

It should be noted that while there is considerably more information available in recent years related to removal of dirt from unvarnished paintings, to a significant degree, it does not readily apply to the reduction/removal of the extensive accumulation of “aged” grime on already degraded paint layers later covered with consolidants and varnish layers that is seen on Spanish Colonial paintings. Extensive examination and
solubility testing of these paintings is of utmost importance, as well as utilization of different and sometimes more complex approaches pertaining to cleaning. Practical experience indicates that alternating between aqueous and solvent solutions, as well as using multiple aqueous cleaning systems throughout the process can provide good results with the removal of dirt and grime from many of these paintings.

After removing dirt, grime, accretions, and surface coatings from *Virgin and Child in a Garden*, a dilute brush application of Regalrez varnish with Tinuvin and beeswax was used to varnish the painting prior to filling and inpainting, and a light spray application of the same varnish used to achieve the final finish on the painting. The more shallow losses and those along the edges of the painting were not necessarily filled; Gamblin Conservation Colors were used for inpainting. The goal was to integrate the compositional elements of the painting without attempting to completely remove all signs of damage and loss, and to saturate the paint layers without adding an appreciable layer of varnish to the painting’s surface or creating significant gloss.

Gregorio Vasquez’ *St. Anthony in Repose* (Denver Art Museum, fig. 5), is another example of a painting where upper layers of varnish were apparently applied over a dirty paint surface. In this case, unstable paint along movement of the wood panel was stabilized locally using 3% isinglass. A 1% ammonium citrate solution, pH adjusted to 8.5, was used to remove surface dirt and grime. A synthetic varnish (probably an acrylic resin) and retouching was sheared from a thin underlying layer of tree resin varnish that was reduced gradually with xylenes, mineral spirits, isopropanol, and acetone. After varnish removal, dirt and grime were cleaned from the paint surface as safely possible using EDTA in distilled water, pH adjusted to 7.5, followed by several applications of pH 7.5 distilled water.

Complex layers of surface coatings were also a predominant condition issue with an 18th-century Peruvian *Flight into Egypt* painting from the New Mexico History Museum (fig. 6). Starting from the surface, there was a layer of slightly yellowed varnish with the solubility characteristics of a modern acrylic resin that was removed using xylenes. Next a thin layer of apparent PVA varnish was swelled with a solution of xylenes, acetone and mineral spirits and peeled off the underlying surface of a thin or residual layer of tree resin varnish that was removed with acetone. Beneath the varnish layers an aqueous soluble dirt and grime layer was removed, then a darkened, waxy coating removed with xylenes and mineral spirits, and finally, dirt and grime laying directly on the paint surface was removed with additional aqueous solutions. As frequently encountered with colonial paintings, this painting exhibited vertical and horizontal lines of paint and ground loss corresponding to the painting having been removed from its auxiliary support and folded into a smaller rectangle at some point in its history, before being re-stretched onto an auxiliary support. These creases were treated by inpainting the large, shallow areas of loss, but leaving them unfilled, except where they crossed compositional lines or disrupted other compositional details.

*Our Lady of Bethlehem* from the New Mexico History Museum presented an unorthodox auxiliary support: pegboard. Several paintings from the Collier collection were mounted to pegboard, sometimes stapled to the edges to the board, or stretched over the boards with varying pressure-sensitive adhesive tapes. In the case of *Our Lady of Bethlehem*, the painting’s original edges had been cut off and wrapped over...
the pegboard and taped onto the verso, including an additional 3–4 in. of image on the bottom edge. The pegboard fit into an ornately carved and gilded frame which the curator wished to retain with the painting. After removing the painting from its auxiliary support, it was strip lined and mounted to a new, larger stretcher, the size selected to accommodate as much of the image as possible on its face, yet permitting it to fit into the routed out rabbet of the existing frame. This compromise did not allow for any more of the image to be visible when the painting was framed, but preserved the painting image closer to its original size while maintaining it in the desired frame, and allowing for visibility of the full image when unframed.

_Nuestra Senora de los Lagos_ is the final painting presented as a case study. It is the oldest known New Mexican painting, and while the treatment was relatively straightforward, it is noteworthy for the extent of loss to its image layers (fig. 7). The painting appeared to have been executed over an even earlier image, possibly also of the Virgin, on a somewhat coarsely woven linen (est.), the edges glued to the face of a Spanish Colonial strainer. The canvas support was well-adhered to the face of a strainer with glue. The painting exhibited extensive paint loss and moderately cupped, fragile crack edges, the majority which were stable at the time of its examination, due to a heavy application of wax on both the recto and verso of the painting and thoroughly impregnating the canvas itself. This wax was so thick as to add substantial weight to the canvas, appearing to have caused the degraded fabric to stretch.
and sag beyond what would have been expected with the loose tension. In addition to the moderate overall deformation of the support, there was evidence of small holes and tears in the canvas, and loss of portions of the strainer. The painting appeared to have long ago been cleaned to some degree, exhibiting under the waxy layer a residual slightly yellowed varnish layer overall, local evidence of a gray, crusty, paste-like layer, and a heavy but uneven accumulation of dirt and grime.

A treatment was devised to preserve both of the existing image layers, yet improve the presentation of the more recent image sufficiently to allow a viewer to appreciate the aesthetic and devotional qualities of the upper image. Unstable paint and ground were consolidated locally with dilute BEVA-371. Excess wax was reduced on the painting verso by locally softening with heat and then mechanically reducing with microspatulas and wooden spatulas used for clay work. Wax on the recto was reduced using solvent solutions and mechanical manipulation. Tears were rewoven to the extent possible, and repaired using BEVA film and handmade Japanese mulberry tissue. Wax, varnishes, and grime were reduced or removed as safely possible, using mostly aliphatic hydrocarbon solvents, isopropanol, acetone, and ethanol, and the gray, crusty layer was removed mechanically and with aqueous solutions of citric acid and EDTA, followed with pH adjusted distilled water. Losses were not filled, but inpainted using Gamblin Conservation Colors, carried out where the missing upper image could be determined and avoiding areas where the earlier painting was visible. A backing with a padded insert to help support the canvas and improve its plane was made for the painting, and secured to the strainer verso (which was to remain unframed). Thumb tacks were set into gaps in the joints of its members and in existing holes, creating no new holes in the auxiliary support. It was decided that the painting would be displayed in such a way as to avoid the need for any hanging hardware (fig. 8).

Figure 7. Unidentified artist, New Mexican, Nuestra Senora de los Lagos, 17th century. New Mexico History Museum. Before treatment

Figure 8. Unidentified artist, New Mexican, Nuestra Senora de los Lagos, 17th century. New Mexico History Museum. After treatment
It is suggested that Spanish Colonial paintings may well relate to the conservation of paintings in general in future years. It is possible that paintings with extremely poor condition issues may enter conservation studios with greater frequency in coming years, from private collections, as economic conditions lead collectors to pursue art that was previously considered of lesser value, thereby having been exposed to poorer care and handling; and from institutional collections, as the more “important” and valuable paintings having already been properly conserved in the past few decades and benefiting from appropriate housing and environmental conditions, will possibly not require additional treatment for many decades, thus potentially allowing time and funds to be used towards the treatment of paintings that had previously been deemed unexhibitable or relegated to storage.

The treatment of Spanish Colonial paintings poses both challenges and rewards for the art conservator. They serve as reminders of the importance of truly appreciating the object that is entrusted to our care, of the value in perpetually reaching out to professional colleagues for information, opinions, and perspectives, of the need to be creative and open-minded in our efforts to understand a painting’s condition and devise an appropriate treatment strategy, and of the importance of remaining patient and diligent in the search for practical, ethical solutions that are as close-to-perfect as possible for the imperfect objects we treat (fig. 9).

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Figure 9. Unidentified Collao artist, Our Lady of Pomata, late 17th century. New Mexico History Museum. Detail before treatment
Oil Paintings on Metal Supports: Study, Intervention, and Challenges

ABSTRACT

Five paintings on metal support were received by the Paintings Conservation Lab at Chile’s National Center for Conservation and Restoration. One of them was signed by Flemish artist Willem Van Herp. They had several damages, like distortions, losses, abrasions, lack of adherence and corrosion, among others. An initial stage of studies was carried out, including materials’ analysis, historic, esthetic and iconographic research, and specific restoration methods for this kind of support. After this, conservation and restoration treatments were performed, to recover the visual unit of the paintings and reestablish their value.

1. BACKGROUND INFORMATION

In the year 2012, the Paintings Conservation Laboratory belonging to the Chilean National Center for Conservation and Restoration (CNCR), received a group of five paintings on metal supports from the collection of the O’Higgins and Fine Arts Museum, in the city of Talca. This museum is located in the same house where the Chilean Proclamation of Independence took place in 1818. It was recently restored before being reopened to the public in 2009; however, the earthquake of February 27, 2010, nearly destroyed the adobe building, forcing the museum to close and place all collections in storage. In the five years since the earthquake, studies on how to reinforce the structure were undertaken. In 2014 the restoration project was approved and is expected to be complete by 2016. Meanwhile, the Museum is trying to conserve the pieces that were in need of treatment, including their fine collection of European and Chilean paintings. The museum also houses objects related to the history of the city and of General Bernardo O’Higgins, Libertador and first president of the independent country of Chile.

The five paintings were bought in Europe at the end of the 19th century. They were acquired by a prominent man, Eusebio Lillo, a poet, journalist, and politician who was also the author of the words of Chile’s national anthem. Lillo travelled to Europe in 1889 and returned in 1891. In that period, he formed a big collection of paintings and sculptures, and he ordered that after his death, his collection was to be donated to the National Fine Arts Museum in Santiago, the capital of Chile. Lillo died in 1910, and the donation took place in 1911. In 1929, these five paintings, along with other pieces, were transferred to Talca’s Museum.

The number of paintings on metal supports is considerably smaller than the number of paintings on canvas or wood in Chile’s museums, and it was the first time the Paintings Conservation Lab had to face paintings of this kind. These five pieces, therefore, provide an important opportunity to learn about the way in which they were made, their characteristics and their materials.

It is believed that Italian artists started using copper supports for their paintings by the end of the 15th century (Bargellini 1999-1; Bowron 1999), and the practice later became very popular among Flemish, Dutch, and German artists. Copper was more durable and resistant than organic supports and it gave the possibility of smoother surfaces and precise details (Horovitz 1999; Bowron 1999). Copper plates were easily available since they were used for engraving. The medium to small sizes of the paintings also made it possible for owners to carry them when travelling (Bargellini 1999-1; Bowron 1999).

Paintings on copper were much appreciated in Spain and from there many were sent to the new world. In Mexico, Peru, and Colombia this technique was used between the 17th and 19th centuries (Bargellini 1999-1). Around the second half of the 17th century, European artists began using more canvas because it allowed for larger formats and lighter weight.

2. CONDITION

Three of the paintings on metal supports are medium sized (approximately 21 × 29 in., or 55 × 75 cm), while the other two are smaller (approximately 9 in. × 7 in. or 25 × 18 cm). Some of them had been exhibited, and all had been in storage since 2001.
Devastated by Hunger (Devastated) and The Punishment of the Traitor (Punishment) (figs. 1, 2) are very similar in terms of composition, characters’ distribution and type of faces, so we think they may have been painted by the same artist or by someone within his workshop or circle. Both paintings have a wooden cradle in the back, probably to avoid distortions and to give more support to the thin metal plate. Devastated has a stamp with part of the name of a French framing atelier.

Punishment is the only painting signed and dated. It reads “Van Herp 1655” (fig. 3). This date makes it the oldest painting treated in the lab. Willem Van Herp was a Flemish artist born in Antwerp in 1614, and it is believed he was a student of Rubens. Most of Van Herp’s work was in oil on copper. He died in 1677 (Díaz Padrón 1975; Wolfthal 1999).

Both paintings showed lack of adherence to the wooden cradle, which was possibly due to the different mechanical behavior between copper and wood. They also had several areas with loss of paint layer and ground, where the support was visible. Both paintings showed previous interventions recognizable at first sight by differences in color and texture. Varnishes were yellowed. Both paintings showed some corrosion in the form of small dark round stains on the front.

The Disciples of Emmaus (Disciples) had major distortions of the support, large areas of overpainting, and loss of paint layer and ground, especially in the sky (figs. 4, 5). There was lack of adherence of the paint film to the support in different areas, and the varnish was yellowed. In the back it had a wooden support that was apparently applied after the distortions occurred. This element was no longer fulfilling its objective, since it was broken, separated into three parts, and loose. When this wooden element was detached from the metal plate, it was possible to see some writing on the back.

Magdalene in the Desert (Magdalene) (fig. 6) had distortions in the upper section with loss of paint layer and ground, and even a small fracture of the support. There were tiny areas where the paint film was not well adhered to the copper. The varnish was also yellowed. These two paintings also showed some evidence of corrosion, but less than the others.
In *Punishment*, *Devastated*, and *Disciples*, it was possible to see a special feature—fine lines in different directions that seem to have been made by a big brush. We have different theories to explain this: that the solvent of the new varnish applied during the previous interventions might have removed some of the pigment; that they were varnished before the oil was completely dry; or that the fine lines have to do with intrinsic properties of the pigments or binding media.

To know more about the metal support material, x-ray fluorescence was carried out thanks to an agreement made between CNCR and the Analyses and Archeometric Research Lab at the Anthropology Department of Tarapacá University in Arica, Chile. The results showed that *Devastated*, *Punishment*, *Disciples*, and *Magdalene* had a copper support, while *The Hermit* was a tin-plated iron (Sepúlveda et al 2013).

In *Devastated* and *Punishment*, it was possible to see, with the naked eye, the copper plates striated horizontally to provide a grip to the paint layer. On the back, they also had these marks.

Finally, *The Hermit* had distortions, loss of paint layer and ground, abrasions, and yellowed varnish. The main damage, however, was general corrosion that was protruding and pushing the paint layer (figs. 7, 8).

*The Hermit*, *Magdalene*, *Disciples*, and *Punishment* have a small round hole in the upper section, as if they had been nailed to a wall or structure, such as an altarpiece. *Devastated by Hunger* did not have this hole visible, but it showed a previous intervention in the upper section, so it is very likely that it have had a similar hole.
It cannot be said whether the striations on the back are original or were made later to better adhere to the wooden cradle. In the Disciples, the copper plate is also striated in the front, which is visible only under magnification. The Hermit and Magdalene show no striation on their metal supports.

3. ANALYSIS

Research started with the visual documentation process, which was carried out by CNCR’s Visual Documentation Unit. It included photography, UV fluorescence, IR reflectography, and x-rays. At the same time, historic, esthetic, and iconographic research were started. Later, the materials analyses were begun. The following discoveries will highlight the ways in which all of these aspects interrelate.

The Hermit was in a very poor condition, as previously mentioned, and in the right lower section was a dark area. Before the iconographic research began, it was thought this character might be Saint Jerome, because of the book he had on the lap. But when seen with IR reflectography, an animal was visible in the dark area. First it appeared to be a dog, and later a pig. The pig, together with other iconographical attributes, such as the letter “T” on the figure’s habit, the T-shape of the handle of the walking stick, the flying creatures around the figure, the open book, and the rosary, led to the conclusion that it is an image of Saint Anthony Abbot being tempted by demons in his isolation, with the pig or wild boar at his feet (figs. 9, 10).

In Disciples, the title and subject were not in dispute. But while looking for information about Flemish artists, assuming this painting had a similar origin to the one signed by Van Herp, it

Figure 7. Unknown artist. The Hermit, oil on tin-plated iron, Museo O’Higgimano y de Bellas Artes de Talca. Before restoration. ©Archivo CNCR. L. Ormeño, 2012

Figure 8. The Hermit. Detail of corrosion, losses of paint layer and ground, and abrasions on the lower right corner. ©Archivo CNCR. L. Ormeño, 2012

Figure 9. The Hermit. IR Reflectography; an animal can be seen on the lower right corner, which was not identifiable with the naked eye. ©Archivo CNCR. M. Pérez, 2012
came to light that the parrots depicted in the left side (fig. 11) were identical in every way to those seen in Paradise by Jan Brueghel the Younger, probably taken from his father’s work. The enthusiasm was unimaginable—it was possibly a Brueghel! Or a painting by some member of his circle! Or at the very least a very excellent copy!

Every effort was made to find a reference or description of Punishment, even in Dante’s Divine Comedy, until the art historian found that the scene makes reference to “The Parable of the Wedding Banquet” from Matthew 22:1–14 (Sagrada Biblia 1976:1092-1093), specifically verses 11 to 13, where a man who is not properly dressed—he should be wearing fine clothes to attend the banquet—is going to be punished. Verse 13 reads, “So the king said to his servants: ‘Bind his hands and feet and throw him into the dark, where there is weeping and gnashing of teeth.’” (Christian Community Bible 1999).

Figure 10. The Hermit. IR Reflectography; detail of the animal on the lower right corner. ©Archivo CNCR. M. Pérez, 2012

Figure 11. The Disciples of Emmaus. Detail of parrots on the left side, which are the same as in Jan Brueghel’s Paradise. ©Archivo CNCR. M. Pérez, 2014
4. MATERIALS

Cross sections carried out by CNCR's Scientific Lab allowed the observation of some differences between the original paint layers and later interventions on the three medium-size paintings. The original paint was in general very thin and compact, while the nonoriginal paint layers were thicker, more porous, and had less well-defined limits between layers. Devastated, Punishment, Disciples, and Magdalene had a ground formed of lead white, while in The Hermit lead white was mixed with Prussian blue.

In the Disciples and Punishment, a green color was visible under the microscope in the lower section of the ground. According to sources (Horovitz 1986/1996; Pavloupoulou 2006)), this is copper oleate, formed by the interaction between copper and the oil used to clean the plates. Devastated and Magdalene did not have this green color, and nor did The Hermit, which was painted on a tin plated iron, not copper.

Raman spectroscopy showed the presence of lead white, vermilion, azurite, lead yellow and Prussian blue, but also goethite and calcium carbonate in samples taken from previous interventions (Aguayo 2013, 1-2-3-4-5).

All the varnish samples analyzed were identified as triterpenic natural resins, four of them similar to mastic and one similar to dammar. But at least three of them that are known—the Disciples, Punishment, and Devastated—had previous interventions and therefore a protection layer that was not the original one.

Upon UV fluorescence examination, some differences were observed. Devastated and Magdalene seem to have suffered from aggressive cleaning, or in the case of the latter, an irregular application of varnish. In Disciples, results show at least two stages or periods of intervention in the sky (fig. 12). In The Hermit and Punishment, the protection layer looked quite homogeneous. In at least three of the paintings, varnished present was over a loss, where the copper plate was visible. In all cases, UV fluorescence examination confirmed areas of loss and corrosion stains, which appear darker.

5. TREATMENT

Many sources were reviewed, but most treatments were based in Isabel Horovitz's articles “Paintings on Copper Supports: Techniques, Deterioration and Conservation” (1986) and “The Consolidation of Paintings on Copper Supports” (1996), where she spoke specifically about materials and methods to conserve and restore paintings on metal supports. Before the interventions, prototypes were made out of small copper plates to test adhesion, consolidation, fillings, and chromatic reintegration materials. Different concentrations of adhesive to join copper to a wood support were also tested (fig. 13).

Protruding corrosion and dark stains were eliminated by scraping with a scalpel, and then isolating the area with Paraloid B-72 15% in toluene, wearing a respirator mask and under an extraction arm.

The same solution of B-72 was used to consolidate areas of flaking paint. The flakes would not readhere with application of heat alone and were transferred to the Melinex®, so B-72 was carefully applied with a small brush, the flakes pressed with a scalpel, and allowed to dry under light pressure. This procedure was very successful.

Tests were done to determine how to mitigate the distortions of the metal plates. Research suggested that it was not very advisable, since metal would not return to its original straight shape and the paint layer might be affected, but it was necessary to try. So an attempt was made to mitigate distortions on a copper prototype, after consolidation, using a book press. After evaluating the results, distortion corrections were performed on The Hermit, Magdalene, and Disciples, applying very soft pressure that made the distortions less distracting than before. All became flatter, though not as perfect as before the distortions occurred.

Layers of paint were leveled using Paraloid B-72 15% and 10% in toluene, with the addition of microcrystalline wax to give a matte surface. Horovitz’ articles mentioned earlier described the possibility of adding a filler such as Liquitex Gesso®, or chalk to the Paraloid mixture—saying it has its cons—and when it was applied to the latter, the result was coarse and it flaked off when filed or leveled. Thus, it was decided to apply the B-72 mixture without a filler, which worked pretty well. Several layers were needed, and in some cases a warm tacking iron had to be used to level the edges. This was done very carefully, and quickly, so as to not touch any original paint nearby. Since copper is an excellent conductor of heat, care was taken to ensure that the rest of the plate did not become warm.

After leveling the losses, the surface was isolated with an intermedium Talens retouching varnish and the chromatric reintegration was performed with Maimeri pigments. Finally, a
Restoring the paintings to their original states without any distortion would have been impossible without endangering the paint layers. This is a limitation not found in paintings on canvas, which will have to be explained clearly to the museum. In the case of *The Hermit* or *Saint Anthony Abbot*, it is believed that the process of corrosion of the tin-plated iron will continue, unfortunately. But hopefully, the consolidation that was performed, along with appropriate environmental conditions, will keep it to a minimum.

Treatment of losses and abrasions, on the other hand, was extremely successful in allowing a full appreciation of the esthetic aspects of the paintings. Research also helped discover the real story of the scenes depicted. *Punishment of the Traitor* became *The Guest Badly*

6. CONCLUSIONS

During the course of treatment, prototypes had to be developed to test the treatments before performing them on the paintings. The results sometimes didn’t go exactly as expected, but it was possible to correct the treatments to reach a good result.
Dressed at the Wedding Banquet, and Devastated by Hunger became The Seven Works of Mercy, turning the formerly allegoric topics into religious ones. The Hermit or Saint Anthony Abbot also became a well-known character with a history. The Museum has been given a final report with all the information collected, the treatments performed, and the new suggested names, and now they have to evaluate the feasibility of changing them in the formal record. Before this conservation campaign, the only data they had on these five paintings were their provenance.

Finally, recommendations have been made on the need for environmental control, whether the paintings are on display or in storage.

In conclusion, this was a big research project that involved many people within the CNCR and beyond. Since it was the first time a painting on metal supports was treated, a lot
of time was spent researching the history, materials, and iconography. There is still a long way to go to before being able to fully understand the characteristics of metal supports, but a big step has been taken. Art historians, historians, chemists, photographers, conservators, and trainees worked side by side to register, understand, and conserve this group of paintings. Ongoing historic, aesthetic, and iconographic research on these paintings will be aided by the restoration and correction of distortions, which will help to reestablish the value of the paintings.

The whole process of conserving these paintings will be represented in an upcoming book.

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NOTES

1. Museo O’Higginiano y de Bellas Artes de Talca.

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FURTHER READING


Illumination for Inpainting: Selecting an Appropriate Color Temperature

ABSTRACT

Traditionally, many conservators have preferred daylight, and specifically northern daylight, as the preferred source for inpainting. Unfortunately, the availability and control of northern daylight limits the amount of time and the location in which it can be used as the primary source of illumination; therefore, supplementary and alternative sources of illumination for inpainting are necessary. What are the essential characteristics of northern daylight that make it a preferred source? What criteria should be used to select viable alternative sources of illumination?

This presentation analyzes the key components that make daylight a preferred source for inpainting, including such characteristics as color temperature, color rendering, and light distribution. It also takes into account the fact that many artifacts will ultimately be exhibited at a color temperature that is extremely different from northern daylight and how this should influence the selection of an inpainting light source.

A primary focus of the talk is the importance of selecting an appropriate color temperature with adequate color rendering properties. To illustrate the importance of color temperature and how appearance is altered at different color temperatures, a live demonstration of this phenomenon will be presented.

The goal of the presentation is to suggest that there is an underlying technical basis for color temperature selection that takes into account the fact that objects may be exhibited in a variety of different color temperatures. Most importantly, normal conditions of exhibition generally utilize a warm color temperature source whereas inpainting with northern daylight is done at a very cool color temperature. Research published by the author in conjunction with the National Institute for Standards and Technology is described, which provides the basis for a theory regarding color temperature preference and its significance in the selection of an appropriate inpainting source.

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Leonardo’s Obsession: A Workshop Variant of His *Virgin and Child with Saint Anne* from the Hammer Museum at UCLA*

ABSTRACT

The *Virgin and Child with Saint Anne* attributed to Andrea Salai, an associate of Leonardo da Vinci, dated to 1500–1524, is a scale version of the same subject painted by his master now at the Louvre, and was almost certainly created in Leonardo’s studio. This article describes aspects of the painting technique for which analysis of cross sections greatly enhanced the authors’ understanding of it. Some of the interesting findings include a methodical approach to the paint buildup with the occurrence of intermediate varnish layers, and evidence of a textile and the hand used to manipulate blue and red glazes.

1. INTRODUCTION

In the summer of 2010, The Hammer Museum at the University of California, Los Angeles, (UCLA) contacted the department of Paintings Conservation at the J. Paul Getty Museum to look at a copy of Leonardo da Vinci’s *Virgin and Child with St. Anne* in their storage that rarely went on view (fig. 1). The reason for their request was that Vincent Delieuvin, curator of 15th-century Italian paintings at the Musée du Louvre, was organizing an exhibition around their Leonardo *Virgin and Child with St. Anne*, *La sainte Anne: l’ultime chef-d’oeuvre de Léonard de Vinci*, and requested to borrow the Hammer’s painting. But a request was also made to gather as much technical information on the painting as possible, the reason for which is discussed later in this text. As The Hammer Museum does not have paintings conservators the paintings conservation department of the J. Paul Getty Museum was asked if it would be interested in taking on a technical examination of the painting, to which it was agreed.

The goal of the exhibition was to trace the development of Leonardo’s composition of the *Virgin and Child with Saint Anne*, which the artist/scientist/inventor first began sketching around 1500 and continued to rethink and rework for years (Delieuvin 2012). The culmination of at least 15 years of labor resulted in the Louvre panel that was still left unfinished at the time of his death in 1519. While Leonardo’s painting never left his studio, other variants were made of the St. Anne composition by his assistants at different times capturing the state of the composition at a particular stage. The various preparatory studies, painted variants, and documents taken together

revealed for the first time, in the words of the curator, “the slow, complex genesis of this masterpiece” (Delieuvin 2012, 22). The exhibition also debuted the newly restored Leonardo painting which was not without controversy (Alberge 2011).

The Virgin and Child with Saint Anne from UCLA has often been referred to as a copy of Leonardo da Vinci’s painting of the same subject in the Louvre museum, but it is in fact more aptly described as a “workshop variant” of Leonardo’s painting, with elaborations to the background and changes in the figures’ clothing. In a wooded landscape perched on a rocky edge with blue mountains in the distance, the Virgin sits on Saint Anne’s lap as she bends down to hold the Christ child who grasps a lamb by the ears. There are no exact contemporary copies of the Leonardo painting, only variants of it. One list includes 27 variants; among them is the UCLA painting, considered the most important and closest variant of Leonardo’s work (Musée du Louvre 1952, 43–44; Delieuvin 2011). Another important workshop variant of the Virgin and Child with St. Anne is one belonging to a French private collection that had resided in Santa Barbara, California for a time (Delieuvin 2012, 174). It is also dated to the same period as the UCLA painting.

No early copies of the Louvre panel exist, but early copies of the UCLA Saint Anne do. This is probably because of its location from at least 1635 in the sacristy of the church of S. Maria presso San Celso in Milan, an important sanctuary that received many donations. At San Celso, it was first considered to be a work of Leonardo da Vinci, and it remained there until 1810. It then passed into the collection of Prince Eugene Beauharnais, Viceroy of Italy, followed by Prince Leuchtenberg of St. Petersburg. After the Russian Revolution, a Swedish syndicate acquired the painting, and it was brought to New York by Dr. Gregor Paulsson of Stockholm University from whom Willitts J. Hole (Valentiner 1949, 25; Goldblatt 1961, 108–113; Shell and Sironi 1991, 104; Delieuvin 2012, 166), a real estate developer of Southern California, acquired the painting. His daughter Agnes, in turn, bequeathed the Virgin and Child with Saint Anne to UCLA in 1938 (Wikipedia 2014).

Until recently, the painting was attributed to Salaì, whose given name was Gian Giacomo Caprotti di Oreno. Salaì entered Leonardo’s studio as an apprentice in 1490 when he was just 10 years old (Leonardo da Vinci 1989, 266), and remained in the service of his master until Leonardo’s death in 1519 in France. Salaì himself died in 1524. His name was first suggested in 1671, but the attribution shifted between Leonardo and Salaì up until the 19th century. Another studio assistant, Francesco Melzi, who joined the workshop in 1508, can also be considered to be a potential author of the UCLA painting. Because so little is known about either artist—between the two, there is only one autograph painting by Salaì, a Head of Christ that appeared on the market in 2007—the latest attribution is left at “Workshop of Leonardo da Vinci” (Delieuvin 2012, 166).

2. SUPPORT

From a conservation point of view, one of the most remarkable features of the UCLA painting is that the wooden support is remarkably close to original condition (fig. 2). On the reverse, well-preserved tool marks that are long and narrow, 0.5–1.5 cm wide, better appreciated in raking light, run diagonally and parallel to each other, crossing the joins and spanning the width of the panel. These slightly furrowed marks were probably made with a narrow plane with a curved blade and sole, bastone in Italian (Bisacca 2011). The support has not been thinned and has undergone only a few conservative repairs.

Because the support of the Leonardo *St. Anne* has also miraculously survived without major alterations, intriguing technical comparisons can be made between the two paintings.

The panel support is composed of three butt-joined vertical boards, estimated to be poplar, with two cross battens dove-tailed into the structure that appear to be original, but in the past they have been thinned with a saw to about half of their original thicknesses. The cross battens are estimated to be coniferous wood cut near-radially. Both battens taper from right to left. The top batten protrudes on the right side by 1 cm indicating some shrinkage across the width of the panel.

Two wide boards flank a narrower board, all tangentially cut as can be gleaned from the end-grain and x-radiograph. In the x-radiograph, the outer boards, but possibly all three, look as if they were cut from the same tree because of the similarity of the dense grain pattern. The x-radiograph also revealed the presence of four dowels in each join placed symmetrically across from each other (fig. 3). The dowels, which are 8.5–10 cm long, have tapered ends and are shorter than the tapered dowel holes (fig. 4).

In size and orientation the tool marks on both panels are very similar to each other. Although the Louvre panel consists of four planks compared to UCLA's three (Martin 2005, 28), the width of both panels is about the same at 115 cm (not including the later side additions on the Leonardo *St. Anne*). The variant from a French private collection mentioned earlier also shares the same width. Both the Louvre and UCLA paintings also have similar dowel placement in the joins. A significant difference between the UCLA painting and the French paintings is that the UCLA painting is taller than both of these versions by around 10 cm. Bare-wood margins at the top and bottom of the painted side of the UCLA panel indicate the composition has not been cut down. In the Louvre *St. Anne* the position of the bottom dowels very close to the edge as compared to the top dowels, and compared to the dowel placement equidistant from the edges in the UCLA painting, indicate that the bottom of the Louvre panel was trimmed, so it is likely that the French paintings were at one time as tall as the UCLA painting. These three paintings also share a similar panel thickness, ranging from 2 to 2.8 cm, rather thin for an Italian painting of large dimensions on poplar.

The correspondences in the panel construction from the tool marks, dowel placement, to the thickness, all suggest that the UCLA and Louvre panels were made in the same workshop. Similar narrow tool marks have been found on panels by Callisto Piazza in Lodi and on other panels from Northern Italy, which may suggest a Northern Italian manufacture for the panels (Bisacca 2011; Castelli 2011). It
could even be argued that the UCLA panel is of higher quality because it has fewer joins than in the Louvre panel, and the three, individual planks are free of knots unlike the boards in the Leonardo painting and the variant from a French private collection.6

3. PREPARATION AND UNDERDRAWING

To prepare the panel for painting, it appears a conventional calcium sulfate ground bound with animal glue was applied (Mazurek 2011).7 After the gesso ground is a second preparatory layer of imprimatura, filled essentially just with lead white, that seemingly covers the entire panel surface. In the upper central region of the panel, two applications of similar material have been applied. Rather surprisingly, the panel already had cracks in it when the preparation was applied as these were filled in and appear opaque in the x-radiograph.

There are bare-wood margins at the top and bottom of the painting about 1.0–1.5 cm wide. There are no wood margins on the sides, and they do not appear to have been trimmed. A gesso burr sits at the boundaries with the wood margins top and bottom. The blue sky paint spills over the gesso burr in several spots at the top that could serve as evidence of a temporary frame used during the application of the preparation that was removed or shifted during the painting phase. On a manuscript page, a temporary frame for a panel painting may have been sketched by Leonardo, but it holds three sides. In a painting by Maerten van Heemskerck of St. Luke Painting the Virgin an engaged molding on the top edge, likely temporary, is depicted, which allows the artist to handle the panel without disturbing the painted surface.8 It may be that the UCLA St. Anne once also had molding strips at top and bottom of the panel to facilitate handling.

Infrared examination with an Osiris camera9 revealed underdrawing in both liquid and dry media in a few areas of the painting, mostly in the heads and feet of the figures (fig. 5). Some of the underdrawing also shows subtle changes in the composition. In the face of St. Anne lines in the nose, which was originally drawn smaller, and in the lips were applied in a liquid medium with a fine brush, but lines in her brows appear to have been executed with a dry medium such as charcoal (fig. 6). Dry lines in the Virgin’s foot show that the big toe was slightly longer, and the toe next to it was originally drawn higher (fig. 7). It is interesting to note that in the UCLA painting, the one by Leonardo and the one in a French private collection, underdrawing is visible only in the foot of the Virgin and St. Anne’s left foot, but not in her right foot. This suggests that the artists of the three paintings followed a similar approach to the execution of the preparatory drawing though all are different in style.

No underdrawing was found in the Virgin’s face, and no spolvero dots were detected as were observed in the Leonardo St. Anne (Mottin 2011); however, it must be kept in mind that red or brown pigments and iron gall ink, which might have been used in the laying out of the composition either from a cartoon or done freehand, would not be detected with infrared reflectography. The scale of the figures in the UCLA painting is comparable to the two previously mentioned paintings, and some of the composition corresponds precisely within this group, but exactly how the design was transferred remains uncertain.10

The similarities in scale between the three paintings were established through a tracing made of the variant from the French private collection which, when overlaid on the Leonardo painting, shows that the figures coincide.11 The same
Besides the underdrawing, a series of different marks in the x-radiograph—appearing to be short, filled incision lines; dark, empty incision lines; painted x-ray opaque lines; and dark passages where material seems to have been wiped away—give some clues to the artist’s method of laying out the composition done at different times during the painting’s execution. The marks do not appear to be randomly placed, and seem to relate to the composition as they are mostly located in and around the figures. The reason for their presence might be that they were the result of a traced cartoon, registration marks for key points of the composition such as the intersection of the shoulder and neck, or aids in the positioning of single-element cartoons that were combined in the painting.12 Through drawings by Leonardo of single body parts, it can be imagined from where single-element cartoons could have evolved.13

4. PAINTING TECHNIQUE AND PENTIMENTI

The UCLA painting is a highly finished variant of the unfinished Louvre St. Anne. Leonardo’s intentions for the finished St. Anne composition were said to be found in the UCLA painting (Delieuvin 2012, 163, 189). Moreover, the high finish can still be admired because the paint surface and fine details are so well preserved.

The artist used pigments typical of the time: lead white, vermilion, lead–tin yellow, yellow and red iron oxide earths, natural ultramarine (lapis lazuli), and an arsenic sulfide pigment probably orpiment. Other pigments indicated by microscopical and chemical analysis include azurite, a transparent copper green, at least one organic red lake on an alum-derived substrate, and some form of carbon black. The extensive use in this painting of ultramarine is noteworthy. Indeed, the alternative mineral blue pigment, azurite, seems to have been used in a relatively restricted way: It appears mixed mostly with white in the underpainting layers of the distant mountainous background. Despite the slight greenish appearance of the Virgin’s blue robe, azurite has not been used in the painting of that drapery: Ultramarine is the blue pigment present, with some red lake also included. Another distinctive feature of the painting technique is the extensive use of one or more shades of red lake pigment. In some instances, as in the Virgin’s inner red robe, the lake appears remarkably well preserved, with little perceptible fading.

Examination of paint cross sections demonstrated that many passages of painting had surprisingly complex stratigraphies. Mostly, the samples reflected a methodical buildup of the paint layers. A striking feature of some of the samples is the marked difference in color between paints at different levels in
St. Anne’s sleeve, is rather strange and seems counter to painting practice at the time; and the gray layer or layers in the Virgin’s mantle would essentially obliterate the red lake layer, so what would be the function of the crimson red? Interestingly, a red lake layer and gray paint layer has been also found under the blue drapery of the Virgin by Leonardo (Martin et al. 2005). Red lake under blue—without intervening gray paint—has been noted, too, in paintings by Raphael where it clearly serves as intentional underpainting, not connected with a pentimento. Whether the same intention is at work here (in the UCLA painting) remains open to conjecture.

Another notable instance of the phenomenon of complex stratigraphy with strong internal variation in paint color appeared in samples that were obtained from different locations in the purple clothing of St. Anne (figs. 9a, 9b). The deep purplish hue of this drapery is rendered by one or more layers of paint composed of ultramarine and red lake; but in all the samples, beneath the uppermost purple paint, lies a near-consistent sequence of dark red and red-brown paints of varying transparency that in itself appears to represent a quite fully modeled drapery in that color range. In each sample, between the lower strata of red and red-brown paints and the upper one(s) of purple, there is something of a discontinuity, represented by a thin glaze of pure red lake and unpigmented organic material, probably intermediate varnish. In two of the

Figure 8. (a) Cross-section sample from the Virgin’s blue robe, crossed polarizing filters, 30× objective power. The uppermost blue paint, composed of ultramarine with some red lake, is underpainted with a series of dark gray layers and, below that, two layers of transparent crimson. (b) Cross-section sample from the Virgin’s blue robe, UV fluorescence, 30× objective power.
Leonardo’s Obsession: A Workshop Variant of His Virgin and Child with Saint Anne from the hammer Museum At UCLA

Artist’s painting practice. It can be observed that the varnish layer sometimes lies between distinct early and later phases of the painting connected to apparent changes in specific parts of the composition, but more commonly it occurs close to the later stages of painting, in which cases it may represent applications of artist’s “retouching varnish” prior to the final subtle adjustments and additions of detail.

The highly finished nature of the painting technique is reflected in the large areas of extant glazes present in the Virgin’s red sleeve and blue drapery, and St. Anne’s purple sleeve where traces of fingerprints and the imprint of a textile were left behind. Many papillary lines were left in the Virgin’s red sleeve on her proper right shoulder from the use of fingers in the final application of red lake glaze (fig. 10). Before this, the sleeve had already been worked up to a very finished state with red lake on top of a mixture of lead white and red lake, and was then varnished. Traces of fingerprints can be seen in the shadows of St. Anne’s face around her left cheek and chin. Prints from fingers or the palm are found in the Virgin’s blue mantle over her legs, and are especially noticeable in the highlighted area of her thigh. The technique of using the hand to uniformly distribute a glaze layer is described in Armenini’s

three samples from this drapery, the transitional red lake glaze is actually sandwiched between two layers of intermediate varnish. As in the previous case of the Virgin’s blue mantle, this unusual stratigraphy invites the question of whether it represents a deliberate continuous sequence of paint applications for the rendering of this drapery, or whether the internal hue variation indicates a change of color scheme during the course of painting, a pentimento. In the present case of St. Anne’s robe, the weight of evidence might lean more toward a change made by the artist; that is, that St. Anne’s drapery was changed from modulated dark red and red-brown to purple during the course of the painting’s execution. The evidence supporting this hypothesis includes the strong internal boundary in the stratographies of all cross-section samples from St. Anne’s robe indicated by the intermediate varnish layers that are contiguous with the last red glaze. It may not be entirely coincidental that a well worked-up modeled drapery in shades of red to red-brown is seemingly embodied in the lower strata under the purple of St. Anne’s robe of the Hammer painting, and that the same figure’s drapery (or at least the lower part of it) is in the same general color range in the Louvre Leonardo version of the composition. Indeed, the use of intermediate varnish seems a distinctive feature of this

Figure 9. (a) Sample from St. Anne’s purple sleeve, prepared as conventional cross section, viewed under incident UV fluorescence conditions; 50X objective power. The sample shows the complex stratigraphy of this passage of painting: ground and imprimatura superimposed by a series of dark red-brown paints and red glaze; an intermediate varnish followed by a further red glaze; a second intermediate varnish and the final, uppermost layer of purple that renders the drapery. (b) Same sample as in Figure 9a, converted to thin section, viewed in transmitted light. Same scale; 50X objective power. The colors of the glaze layers are clearly evident, as are the intermediate varnishes. The uppermost purple paint is composed of ultramarine, red lake and a little black. The ground and imprimatura layers are not visible here.
16th-century treatise *On the true precepts of the art of painting*. Specifically, for a green “veil” he instructs to pat it with ‘the palm of the hand’ to even out its application; the same procedure is recommended for lake and smalt (Armenini 1977, 194; 1988, 145; Woudhuysen-Keller 1995, 66). A row of fingerprints is also found in the trees on left, but they are located in a lower paint layer.

In St. Anne’s sleeve, instead of papillary lines, a distinctive gridlike pattern of tiny dots appears in the blue glaze, evidence that a piece of textile was used to even out its application (fig. 11). Armenini also states that a “little cotton wool covered with linen” can be tamped on top of the glaze to obtain the same results as with the hand (Armenini 1977: 194; 1988, 145; Woudhuysen-Keller 1995, 66).

The flesh tones, principally in and around the faces, were constructed with many fine, parallel brush strokes, reminiscent of tempera painting (fig. 12). These are the only areas in the painting where this type of brush stroke is found. While the binder was not analyzed in the flesh paint, the rest of the painting was executed more loosely, and analysis strongly indicates walnut oil as the binding medium (Mazurek 2011). Drying cracks typically found in oil paint are present in the Virgin’s thick blue mantle.

Besides the *pentimenti* described earlier, more changes in the paint layers were detected with both IRR and x-radiography, often reflecting Leonardo’s composition in the Musée du Louvre, which had been elaborated upon in the UCLA picture.
Notable mostly in the infrared reflectogram, St. Anne’s sleeve was originally slimmer and had a protruding cuff; the rocks beneath her clearly had a flap of fabric hanging over them that draped laterally on the ground; and the Virgin’s blue mantle over her proper left sleeve, was in its first conception simply draped and continued down to her wrist without the undulating folds of the orange lining. The latter two pentimenti have substance also in paint cross sections. The red paint visible in the rock represents the drapery that was initially planned. In the Virgin’s sleeve, a deep crimson layer followed by an ultramarine blue under the extant orange-brown of the exposed lining is interpreted as representing an earlier state (purplish blue or blue-gray) for that section of drapery. All of these earlier compositional intentions are found in Leonardo’s painting.

5. TREATMENT

After careful examination and study of the UCLA painting, it was decided that the appearance could be improved with treatment in time for the exhibition. The most visually disturbing aspects of the surface were the grayish appearance of blue draperies of St. Anne and the Virgin to the extent there was little contrast between the two areas; and scattered discolored retouching, especially in the sky. It was not until cleaning tests were carried out, that it was discovered the gray appearance of the blue was not due to blanching of the paint film, which had been feared, but rather due to a degraded coating, possibly synthetic in nature. The treatment was relatively straightforward. Little overall paint loss was revealed after cleaning, but most of that was concentrated in the orange lining of the Virgin. An initial layer of 15% Regalrez 1094 varnish in Shellsol D38 was applied by brush, then 30% Laropal A81 in iso-propanol was brushed on locally where a gouache base was to be laid. Final retouching was carried out with Gamblin Conservation Colors. A final varnish of Regalrez 1094 was sprayed on. The treatment was successful in regaining the different hues of the blue draperies, which contain ultramarine as the only blue pigment, but in different mixtures. Overall, the palette has much improved clarity and saturation.

The painting traveled to Paris in a custom-made, in-frame, microclimate box that was fabricated in 1997, the last time the painting went on loan. In the exhibition at the Louvre, the UCLA St. Anne was finally reunited with the Leonardo St. Anne, and the workshop variant from a French private collection.

6. CONCLUSIONS

On the basis of the new information gathered from the collaborative research on Leonardo’s *Virgin and Child with St. Anne* and its workshop variants, our understanding of Leonardo’s workshop and his obsession with the St. Anne composition has notably expanded. Vincent Delieuvin, the Louvre curator, reassessed the attribution of the UCLA painting adjusting it from the singular Salaì to the Workshop of Leonardo da Vinci. Though this may seem like a demotion to take away a definitive name, the attribution to the workshop is more accurate, and opened up the possibility that the master himself intervened in the painting because of the very high quality of its execution, more refined than any known workshop variant. Leonardo was known to involve himself in his assistants’ work as it was reported, “two of his apprentices are making copies and he puts his hand to one of them from time to time.” Indeed, there is possible evidence for the presence of two hands in the painting as there are two different styles of rendering the plants in the landscape. In one style the paint is applied thinly and quickly, while the other method is harder-edged and more heavy-bodied.

After the run of the exhibition, the UCLA St. Anne, fortunately, did not go back into storage where it normally lives. As it was not part of the Hammer bequest, it cannot be displayed in the permanent galleries. Instead, the Hammer Museum has generously allowed the J. Paul Getty Museum to have their *St. Anne* on long-term loan, where it can be enjoyed by the public, perhaps even in a future focus exhibition.

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ENDNOTES

* This paper is a slightly expanded and updated version of essays previously published on the *Virgin and Child with St. Anne*, Hammer Museum, that appear in Delieuvin 2012; Chui and Phenix 2012.
1. “La plus fameuse est celle peinte par Salaì ou Melzi sous les yeux de Léonard et retouché par celui-ci…” (Musée du Louvre 1952, 43).

2. Studio of Leonardo da Vinci, Saint Anne, Virgin and Child playing with a lamb, around 1508–1513; oil on wood (poplar); 160 x 114.5 cm. Paris: private collection. Catalog entry 52.

3. Gian Giacomo Caprotti, called Salaì Head of Christ, signed and dated lower right I RACCHIE[S]OT/ • FE-SALAI/ •1511 • [DN], oil on panel, 21½ × 14¼ in. (55 × 37.5 cm). Sotheby’s Old Master Paintings (N08282) New York 01/25/07 – 01/26/07, Lot 34.

4. Originally, they probably looked like the cross battens on Leonardo’s Saint Anne, Virgin and Child Child in the Louvre which have large marks described as from a chisel and mallet (Marette 1961, 100).

5. These rather narrow tool marks could be characteristic of a Lombard workshop as these are not typical of Florentine panel construction (Bissaca 2011). Similar tool marks might be found on the reverse of paintings by Callisto Piazza (1500–1561 or 1562) in the church of the Tempio Civico della Beata Incoronata, Lodi (Castelli 2011).

6. The presence or absence of knots was observed in the x-ray radiographs. Bruno Mottin and Vincent Delieuvin graciously allowed the author to view images of the Leonardo and French private collection x-radiographs.

7. A fragment of ground from one sample was analyzed using standard protocols for proteins by GC–MS involving ethyl chloroformate derivatization of the constituent amino acids. The ground layer in this sample was found to contain 2% protein, the amino acid profile of which matched animal glue with a correlation coefficient of 0.99. See Schilling and Khanjian 1996.

8. Maerten van Heemskerck, St. Luke Painting the Virgin, c. 1545, oil on panel, 205.5 × 143.5 cm, Rennes, Musée des Beaux Arts.

9. The Osiris camera made by Opus Instruments, UK, has an indium gallium arsenide (InGaAs) sensor and an operational wavelength range of 0.9–1.7 µm.

10. None of the cross-section samples from the painting showed evidence for applied drawing on either the ground or the imprimatura.

11. Bruno Mottin, C2RMF, made the tracing and kindly gave it to the author.

12. For a discussion on single element cartoons see Syson and Billinge 2005, 458–460.

13. For example, Leonardo da Vinci, Study of a sleeve and hand, ca. 1507–510, black chalk, gray wash, heightened with white, red chalk, pen, and brown ink on red prepared paper, 8.4 × 16.7 cm, Royal Library, The Royal Collection, Windsor Castle, 12532.


15. Rather than pure red lake, pink underpainting composed of varying amounts of red lake and lead white can be found for blues in Italian painting as is the case in the Madonna and Child attributed to Giovanni Antonio Boltraffio, Leonardo’s close associate, in the Szépmüvészeti Múzeum, Budapest; in Giotto’s Crucifix in Santa Maria Novella; and in paintings by Fra’ Bartolomeo and Raphael. See Rioux 1990; Buzzegoli et al. 1996; Bracco and Ciappi 2002; Phenix 2009.

16. Seven samples from the painting were analyzed by gas chromatography–mass spectroscopy (GC–MS) for identification of the organic binding media. These analyses were carried out by Joy Mazurek of the Getty Conservation Institute. The samples were analyzed using established protocols for identification of oils, waxes, and resins, which involved preliminary derivatization (methylation/transesterification) using the reagent Meth-Prep II (methyllic [m-trifluoromethyl phenyl] trimethylammonium hydroxide). Oils were identified on the basis peak area ratios for indicative fatty acid methyl esters, using the procedure of Mills from the National Gallery, London. Azelate: palmitate (A:P) ratios indicated the presence in all samples of drying oil; and in all these instances palmitate: stearate ratios were in the range 2.2–3.2, which suggests walnut oil. All the paint samples analyzed were found to contain dehydroabietic acid, from pine resin, in very small amounts as compared to the amount of drying oil present.

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FURTHER READING


SUPPLIERS

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A Hangover Part III: Thomas Couture’s *Supper after the Masked Ball*

ABSTRACT

*Thomas Couture’s Supper after the Masked Ball* (1856) is a large 19th-century French painting (180 × 228 cm) belonging to the Vancouver Art Gallery. Badly damaged and largely forgotten about with the exception of two invasive conservation campaigns, the painting remained in storage for many decades, unsuitable for display. This article provides a brief summary of previous treatments, their effects on the painting’s structural and aesthetic integrity, and discusses the methodology used to confront key structural problems in the painting’s third major structural treatment, completed at the National Gallery of Canada (February 2013–February 2014).

1. INTRODUCTION

*Supper after the Masked Ball* depicts the aftermath of a private party at the luxurious and eccentric Maison D’Or in Paris (fig. 1). In the composition, Couture uses Commedia dell’arte characters Pierrot and Harlequin, a cavalier in Henry III costume, and a famous courtesan, Alice Ozy to comment on the degradation of society and the loss of moral values (Boime, 1980). A contrast to the usual festive nature of such parties, Couture’s composition is melancholic and sad; it takes place in the early morning hours where the party has ended. The figures have all passed out, inebriated, except for the main character who remains awake and alone, surveying his friends and the recent excess of indulgence. Couture identified with the central figure Pierrot, a character he used in seven compositions and is thought to be a self-portrait of the artist (Boime, 1980).

Initially a design for a wallpaper commission for Jules Desfossé, *Supper after the Masked Ball* transformed into a work on its own, as Couture continued to develop the composition. *Supper after the Masked Ball* was important to Couture, who had an expensive custom-made frame built for the painting and displayed it in his studio (Boime, 1980). It was eventually sold to private owners and then to the Vancouver Art Gallery. It was brought to the National Gallery of Canada for treatment and long-term loan. The characters in the painting are no doubt suffering from a hangover, but the painting itself could be described as somewhat hung-over despite two previous invasive conservation campaigns. This would be its third major structural treatment.

2. CONDITION AND PREVIOUS TREATMENTS

*Supper after the Masked Ball* was forgotten about for several decades. In part, this occurred because Couture himself, though celebrated in the 19th century, fell out of favor as tastes changed...
and other artists became popular. Also, the painting was badly damaged, and due to condition issues, remained in storage. At some point, the painting and its original frame became separated and would remain separated for nearly 90 years.

Encountering artwork with previous conservation is not uncommon, and many conservators now find themselves re-treating previously treated works. Such was the case with Couture’s painting. Beyond several partial and selective cleanings, the painting had undergone two linings. First, the painting was lined with a 19th-century traditional glue–paste lining that included a mesh interlayer. Taken off as part of the glue lining, the tacking margins were no longer present. The glue was only partially removed from the back of the canvas (and only from the lower half of the painting) before the second lining was applied. Second, a mid-20th-century wax–resin lining was applied, resulting in a mixture of glue, wax, and mesh on the verso. The cleanings resulted in abraded surface and significant campaigns of overpaint. An important detail was overlooked in the treatments so far: the verso of the canvas was covered in brush marks by Couture, who used the back of the canvas to test out tint combinations and paint consistencies, possibly within a teaching context in his studio. The artist’s brush marks, along with a canvas stamp, are historically important and were components incorporated into the decision making process for the treatment.

Removal of past treatments is not without complications and is often impossible. For example, wax residues and glue residues can never fully be removed and lining adhesives can cause lasting tonal changes in the painting. Altering a painting’s support is more consequential than cleaning it because adding or removing material in a work of art changes the stress dynamics on that work. As such, modifications and additions of materials require careful consideration of the effects of old materials alongside new.

4. TREATMENT

4.1 Varnish Removal, Lining Failure
Carefully considering previous treatments, a plan was developed. Initially, the focus was on the surface of the painting, conducting analysis of the aesthetical issues, while gathering data about the structural condition. As the treatment progressed, it became increasingly apparent that the current structural support would not suffice, because the wax–resin lining had failed.

During the varnish removal, and removal of the brown liner’s tape, a critical observation was made: the lining canvas was actively detaching from the original canvas (fig. 2). Most likely, this occurred because it had been applied unevenly, and the painting was in a less-than-ideal environment. The painting likely responded to moisture causing the original canvas to pull away and creating pockets of delamination throughout the support. Additionally, the back of the canvas was entirely ignored throughout both linings. The only existing treatment report had indicated that paint on the verso was present due to an extremely thin canvas that allowed the paint from the front to press through; however, this rationale was flawed; the paint on the verso did not correspond to the paint on the front—it did not match the color nor the composition, and certainly would not have pressed through the still present ground layer.

3. EFFECTS OF PREVIOUS STRUCTURAL TREATMENTS ON THE ORIGINAL SUPPORT

The first step in treating Couture’s masterpiece was understanding the effects that the wax and glue linings had on the painting’s structural and aesthetic integrity. The irons from both wax and glue linings flattened the impasto, and the painting still responded to humidity (the wax–resin filled gaps in the canvas weave, but moisture inevitably entered). The application process of the glue lining had caused the original canvas to shrink, leaving wrinkle-like compression tenting, which later became the reason for the wax lining. The application process also created a slight weave emphasis. Leaving aside whether the wax–resin darkened the ground and paint layers, it certainly stained the canvas. The accumulation of glue, mesh, wax, and Couture’s brush marks coupled with pressure of the lining irons created a lumpy surface. Although the aforementioned effects are negative, it should be mentioned that both linings also contributed to the painting’s survival by temporarily preventing additional structural damages, including flaking, from occurring, during travel and storage in uncontrolled environments.

Figure 2. Failure of the wax–resin lining at the bottom left corner of the painting. Courtesy of Fiona Beckett
Moreover, the paint was only on the upper half of the painting. The simplest explanation for this is that the painting was in Couture’s studio while he painted. Indeed, a painting in the University of North Carolina at Chapel Hill collection depicts Supper after the Masked Ball testing on the floor of Couture’s studio. Couture was likely working on another painting, or several simultaneously. The top half of the painting is precisely at a height that Couture could easily reach from a standing position and apply his paint. Conversely, applying paint to the lower half would require extra effort to reach down, an inconvenience for simply testing out paints. Considering the failing lining, the paint on the verso and the inconsistency of the previous condition report, a critical decision was made to remove the lining.

4.2 Removal of Lining Adhesives
Several weeks were required to conduct tests and determine the best method to remove the lining. The failure of the wax–resin made the lining easy to separate; however, it was also necessary to keep the painting face up to monitor for any adverse effects and avoid flaking, as well as to ensure minimal bending of the original canvas. After testing several varieties of wires, spatulas, dental floss, and heat, spatulas were found to work most efficiently. Large custom-made spatulas were cut and polished from flexible Vivak acrylic sheeting. These were designed to reach the center of the painting. The lining was carefully removed, and due to the extent of failure in the wax–resin, easily detached with little resistance in 10 min. Next, the majority of the wax was removed with a heat treatment on a large hot table, where the wax was carefully melted from the back of the painting onto a sandwich of absorbent materials (four layers were used: Hollytex, tissue paper, and two layers Hollytex). The process was done inside an envelope with a slight vacuum; the bulk of the wax was removed during the heating process.1

Once the wax was removed, the residues of glue and mesh were clearly visible (fig. 3). To remove the stiff glue with minimal mechanical action, moisture needed to be introduced. Again, after testing, it was determined that Gellan Gum would enable a controlled application of moisture that would soften glue residues. The Gellan Gum was cut into squares and applied to several different areas of the canvas (fig. 4). Once the glue was softened, it was gently scraped off with micro spatulas. The removal of the glue took three to four conservators approximately 2 wk, with very little stress to the painting. It was at this stage that the back of the canvas was cleaner and more exposed than it had been in a long time, and a clear assessment could be made. After the removal of the glue, the canvas was no longer entirely flat; it had responded slightly to the moisture, leaving the edges slightly curved. A gentle flattening treatment was done inside an envelope to prevent moisture loss.

4.3 Reasons for not Re-Lining
In Supper after the Masked Ball, the decision not to re-line was made for several reasons. First, the canvas remained strong, pliable, and in good condition. Second, wax and glue residues from the linings had penetrated the canvas fibers, offering a degree of protection. Third, both the 19th- and 20th-century linings applied to Couture’s painting were arguably unnecessary. Finally, they also concealed the brush marks made by Couture, which are historically significant and give insight into Couture’s artistic technique. It is easy to criticize past treatments; some of these result from misinformed decisions, however, others result from limited equipment and knowledge.

Figure 3. Wax–resin, glue residues, and artist’s brush marks on the verso of the original canvas. Courtesy of Fiona Beckett

Figure 4. Gellan Gum used to remove the glue residues: (a) process of blending the Gellan Gum powder with distilled water; (b) after heating and setting, the Gellan Gum was cut into squares and applied to the verso of canvas for 3–5 min.; (c) glue residues softened and the Gellan gum was easily lifted; (d) glue residues mechanically removed with a micro-spatula, minimal mechanical required. Courtesy of Fiona Beckett
available at the time. Additionally, were it not for the glue and wax residues in Couture’s painting, the damage might have been exaggerated and the canvas not as strong.

Since the painting would not be lined and no tacking margins remained, strip lining was necessary. Before this, the verso was spray-varnished with a nonimpregnating layer of B-72 to potentially create a barrier against environmental changes and also stiffen the canvas, providing additional rigidity and strength. The main objective in applying B-72 was to level out the response and mechanical differences between areas impregnated with glue, wax, combinations of either, as well as areas of bare canvas. As an added benefit, the varnish served to saturate the brush marks and the canvas stamp. There was no risk of color change to the painting, as it had been heavily impregnated with wax and had a lead white ground; any color change would have already occurred.

4.4 Structural Work
The next stage in the treatment was strip lining, and before this step could occur, the front of the painting was brush-varnished with a B-72 and Laropal mixture. Applying the varnish prior to the strip lining prevented the solvent from interfering with the adhesion of the strip lining. Strip lining was done using Lascaux P110 fabric and BEVA film (fig. 5). Lascaux P110 was ideal as it is polyester with a linen appearance and is also extensible. In addition to its tensile qualities, the fabric was chosen for its wide width, allowing a single piece to be employed for the entire painting. The result was no corner joins or discontinuity and therefore less risk of peel of edges. The Lascaux fabric was tested for strength, and the white threads were found to be stronger, so these were kept in the vertical orientation, bearing most of the painting’s weight.2 The warp and weft were matched to that of painting, and the edges of the Lascaux fabric were frayed and pinked to reduce direct transmission of force.

While strip lining can typically be regarded as a more minimal approach compared to lining, mechanically it is thought to be more invasive because it does not spread the load or tension evenly over the painting. To counteract this imbalance, modifications were made to the stretcher. The original beveled stretcher was retained and built up in layers of acid-free matte board, attached to the stretcher with staples (first layer) and glue (subsequent layers), resulting in a flat even surface. Backing board inserts, constructed from foam-core were then used for the six areas between the stretcher bars, also built to the same level as the stretcher bars. A final layer of feltlike nonwoven polyester was added over the entire surface (fig. 6a). The polyester was chosen for its Velcro-like nap bond with the painting’s original linen that would help spread the load of the painting. The goal was to keep the tension low, reduce air movement, keep the painting in plane, and prevent it from flapping around.

Figure 5. Strip lining using Lascaux P110 fabric and BEVA film. Note the continuous corners, pinked and frayed edges. Courtesy of Fiona Beckett

Figure 6. Modification of the stretcher: (a) foam core panels covered in felt-like non-woven polyester; (b) panels are designed to be fully removable thus allowing access to Couture’s brush marks on the verso. Courtesy of Fiona Beckett
The painting was stretched at low tension so that future aging will be much easier on it. Additionally, the backing boards were constructed to be fully removable, providing access to Couture’s brush marks on the verso (fig. 6b). To stretch the painting over the feltlike nonwoven polyester, a sheet of silicone Mylar was used during the stretching process; otherwise the nap bond would have pulled against the canvas and prevented an adequate stretch. The Mylar layer was later removed via one of the removable panels.

4.5 Retouching, Final Stages
With the major structural work complete, retouching was carried out with synthetic resin (AYAA: AYAC, 2:1) and dry pigments. Finally, the painting was spray-varnished with MS2A to adequately saturate and protect the surface. The labels on the stretcher, present from exhibitions and previous restorations, were covered with Mylar for protection. One memorable label indicated information about the painting and in typed lettering that it “was cleaned by me” followed by a scribbled signature. Fortunately, documentation standards have advanced considerably, tempting as it might be to include another such label.

In summary, the methodology employed for confronting the structural problems included a thorough understanding of the previous lining materials and how they altered the current structure of the painting, allowing changes over the course of the treatment to adequately address the structural needs of the painting, having a sound rationale based on artistic and historical decisions as well as considering future treatment options, and finally allowing innovative treatments and flexibility throughout the treatment.

5. CONCLUSIONS
It is hoped that the approach and treatment of Thomas Couture’s Supper after the Masked Ball can provide a general guide for paintings conservators approaching similar structural problems in previously treated paintings. By conscientiously acknowledging previous conservation treatments, their impacts (including advantages), educated decisions can be formed in current treatments. After one year of treatment, Supper after the Masked Ball was once again suitable for display. The painting and frame are now happily reunited after having spent several decades apart; both successfully restored, they were the subject of the Masterpiece in Focus exhibition at the National Gallery of Canada, Thomas Couture: In the Studio, highlighting the conservation process as well as Couture’s painting methods (fig. 1). The painting will also travel to Vancouver in a travelling frame tilted at an angle thereby avoiding oscillation. Now in good health, Supper after the Masked Ball will continue to be monitored in case of any future hangovers.

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NOTES
1. To mobilize the large painting throughout the process, the original stretcher, covered in fresh linen, was employed as a base, and several conservators assisted in moving it. To flip the painting and allow access to the verso, a layer of Dartek was secured over the painting and to the back of the stretcher with staples, essentially wrapping the painting to the stretcher. Rare-earth magnets were also used around the edges.
2. Lascaux P110 fabric was tested before use as a strip lining fabric. This was done simply via hand-strength testing. The white threads were consistently more difficult to break than the colored threads. This may be related to the dyes used, although scientific analysis would be necessary.
3. Additional structural work was carried out, including fills and inserts. Holes were repaired with inserts made from similarly aged canvas with a similar weave that had also experienced a lining. Fills were applied to smaller punc- tures for which inserts were not feasible. The fills were made from BEVA-371, phenolic resin, and pigments.

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The Pied Piper of Hamelin: Maxfield Parrish’s Painting for the Palace Hotel, San Francisco

ABSTRACT

The opportunity to examine and analyze the original varnish of this unlined painting was a rare opportunity. New information about Parrish’s materials and methods were discovered. Comparisons to earlier large-scale paintings by Maxfield Parrish of nursery rhyme imagery are made. In addition, a low-risk method was found for removal of a non-original alkyd layer.

1. INTRODUCTION

The Pied Piper of Hamelin, painted in 1909 by Maxfield Parrish for the Palace Hotel in San Francisco, depicts what happens to the children of Hamelin in the namesake nursery rhyme penned by Victorian poet, Robert Browning, after the Piper has led all of them to the mountain side into a portal that closes forever after the last child has entered (Browning 1842).

As many as 27 children are depicted (fig. 1) in this 5 ft. 4½ in. by 16-ft. painting (many of the reference works on Parrish’s murals referred to for this article misstate the height of the painting as 7 ft.). Parrish’s older son, Dillwyn, posed for the boy climbing across the rocks while looking out at the viewer. The artist’s younger son, Maxfield, Jr, was the model for the boy running slightly in front of the Piper. Parrish’s favorite model, Susan Lewin, was the model for the older children of both genders, and Parrish himself (with prosthetic nose) is depicted as the Piper (fig. 2) looking pleased with himself, having exacted revenge on the greedy Hamelin elders (Gilbert 1995, 120). The group has come over the mountain and is heading downwards toward an idyllic landscape in the distance, seen at the lower left.

Figure 1. Maxfield Parrish, The Pied Piper of Hamelin, 1909, oil on ticking, 5 ft. 4½ in. × 16 ft. (163.83 × 487.68 cm) after 2013 conservation treatment. © Palace Hotel, A Luxury Collection Property, 2013
2. BIOGRAPHICAL SUMMARY

Maxfield Parrish was born in 1870 in Philadelphia and was named Frederick Parrish by his Quaker parents. Parrish later took a family name, Maxfield, as his middle name and then, as a professional artist, dropped Frederick completely and became Maxfield Parrish. Parrish's father, Stephen, exhibited as a landscape painter but was best known for his etchings of seascapes. From an early age, Maxfield was encouraged by his father to develop his artistic abilities. Stephen Parrish tutored his son in drawing, painting, and printmaking. As a teenager, Maxfield Parrish and his parents spent more than a year travelling across Europe. There Parrish was most taken with the architectural wonders of Europe and, as a result, his interests shifted from fine art to architecture. Eventually, determined to become an architect, Parrish entered Haverford College, just outside of Philadelphia, where he studied architecture for three years. During his studies at Haverford, Parrish never stopped painting and drawing, but after three years was compelled to refocus his energies. When Parrish left Haverford it was to return to the study of drawing and painting.

Parrish enrolled at the Pennsylvania Academy of Fine Arts in Philadelphia. At the Academy, Parrish studied under Robert Vonnoh, an artist smitten by Impressionism, and Thomas Anschutz, who usually favored a darker palette and a style heavily influenced by another academy instructor, Thomas Eakins. Perhaps an even greater influence on Parrish during his student years was Howard Pyle, the artist known as “The Father of American Illustration.” While Parrish was a student at the Pennsylvania Academy, he would also sit in on Pyle's lectures at nearby Drexel University. Parrish seems to have learnt a great deal about technique, working from the model, and how to manage a successful career from Pyle (Ludwig 1973, 11–15).

Maxfield Parrish's work is appreciated for many reasons—for the purity and clarity of his colors, for his humor and sly sarcasm, and for his dreamy visions of youthful beauty. Not all of these characteristics were evident from the beginning. Soon after graduating from the Pennsylvania Academy, Parrish travelled again in Europe, this time on his own. There he was captivated by the old master painters, particularly those whose use of glazes heightened the realism of their paintings. Parrish developed his own take on the glazing technique and was able to achieve remarkably luminous colors; however, as has been widely documented, his relatively thin oil glazes are separated from each other by layers of varnish, making removal of a discolored final varnish impossible to accomplish without risk to the glazes below (Bockrath 1999, 140).

To counter balance his time-consuming and meticulous glazing technique, Parrish found other ways of making his studio practice more efficient. Parrish used photography and sometimes detailed maquettes to finalize everything from drapery folds on a figure’s flowing robes to how reflections occur on a placid lake. For both his easel paintings and large murals, Parrish would project lantern slides onto his panels and canvases for murals in order to trace the forms precisely. Parrish would even stand in as model for a female figure when a suitable female model could not be found (Ludwig 1973, 188–200).

3. PROFESSIONAL CAREER AS A MURAL PAINTER

In 1895, while still a student at the Pennsylvania Academy of Fine Arts, Parrish was commissioned to paint his first professional mural as well as other decorations for the Mask and Wig Club of the University of Pennsylvania, in Philadelphia. The mural, measuring 3 ft. 8 in. by 11.5 ft., was Parrish's first rendition of the nursery rhyme, “Old King Cole was a merry old soul, And a merry old soul was he; He called for his pipe, and he called for his fiddlers three” (traditional English nursery rhyme) (“Old King Cole,” Wikipedia: The Free Encyclopedia). The characters of the rhyme are depicted by Parrish as buffoonish caricatures, which was fitting with the comedies and parodies that the Mask and Wig Club continue to be known for (fig. 3). This work's renown eventually led to other mural commissions, particularly of nursery rhyme subjects. The 1895 Old King Cole mural remained in the Mask and Wig Club for 101 years until it was sold at auction in 1996 (Cutler and Cutler 2004, 296–298). It is now in a
private collection in New York City where it was examined and conserved in 2011 at Rustin Levenson Art Conservation Associates by Harriet Irgang Alden, Jean Dommermuth, and Kelly O’Neill.

The next time Parrish painted a mural depicting a nursery rhyme was in 1906 when he received a commission from John Jacob Astor IV. Astor, who was willing to pay the tremendous (at the time) sum of $5000, wanted to be portrayed as Old King Cole in the mural that would decorate the bar of his new hotel, The Knickerbocker, in New York City. The realistically portrayed figures of the Knickerbocker mural (fig. 4) are quite different from Parrish's 1895 Philadelphia mural. The 1906 Old King Cole depicts Astor as the King, sheepishly grinning to having passed wind. His guards respond by wincing or smirking, at the same time his pipe, bowl and fiddlers three come in from the sides. The triptych mural (measuring 7 ft. 4¾ in. by 28 ft. 6 in. overall), being a mix of grand posturing, humor, and innocence presented in Parrish’s uniquely glazed colors, was so successful that other hotels commissioned their own nursery rhyme murals from Parrish (Gilbert 1995, 117–119).

In 1921, The Knickerbocker closed, having been brought low by Prohibition. After that, Parrish's triptych was mostly in storage until, in 1932, Vincent Astor, son of John Jacob IV, found a permanent home for it in another Astor hotel, the St. Regis. Over the years the triptych received several notable restoration and conservation treatments, including the first in 1932 prior to its relocation in the St. Regis. Parrish was brought in to advise the mural artist, William A. Mackay, in the cleaning and re-stretching of the mural panels (Ludwig 1973, 151). Other major treatments occurred in 1957 (James 1957) and sometime...
in the 1970s. Approximately once a decade a conservator would be brought in to surface clean the mural. When smoking was banned in New York City eating and drinking establishments in 2002, Old King Cole would have its last yellowed grime layer removed. The conservators of Rustin Levenson Art Conservation Associates were asked to perform this historic cleaning (Irgang et al. 2008).

In 1906, the same year that Parrish painted Old King Cole for The Knickerbocker in New York City, the Palace Hotel in San Francisco was completely destroyed by fire as a result of that city’s massive earthquake. The owners of the destroyed Palace determined immediately to rebuild and when The New Palace Hotel opened in 1909, The Pied Piper of Hamelin by Maxfield Parrish, greeted its visitors (fig. 1).

The mural has been a beloved resident of the Palace Hotel’s bar for many years. In the spring of 2013 the Parrish mural went missing from the walls of the hotel bar and the public learned that the painting was to be sold at auction in New York. Fortunately, in answer to the heritage community’s organized response, the owners reversed their decision and removed the mural from sale but not before the mural had already begun its travel to New York City (SF Heritage 2013).

In early 2013, shortly before the mural was removed from the bar, Rustin Levenson Art Conservation Associates was contacted about surface cleaning The Pied Piper of Hamelin. This bar mural, like Old King Cole in 2007, was covered with decades of yellow/brown cigarette smoke and grime. Given that Parrish paintings are infamously impossible to devarnish, only surface cleaning was anticipated and planned for by the conservators.

4. COMPARATIVE MATERIALS

The conservation of the Palace Hotel mural presented the conservators with a rare opportunity to examine and analyze a Parrish mural that remains in relatively pristine condition. However, when the mural was first examined its beautiful state of preservation wasn’t obvious because it was buried under an extremely brown and mottled coating of grime as well as a discolored surface coating (figs. 5a, 5b). As the examination and cleaning progressed what was original and what was not became clearer. In addition, it was an occasion to compare Parrish’s materials and techniques in The Pied Piper to the two earlier Old King Cole murals previously examined and treated by the conservators of Rustin Levenson Art Conservation Associates.

The 16-ft. length of The Pied Piper mural made moving it around problematic. At one point, it was possible to examine a single section of the painting reverse (fig. 6). The stretcher members are unusually wide, measuring 8 in. high by 1 1/8 in. deep. The three horizontal members are continuous and not divided into joined sections, each member measuring 16 ft. Parrish painted the mural in his studio in Cornish, New Hampshire, and then shipped the painting to San Francisco. It isn’t known at this point whether the canvas would have been shipped rolled or stretched; nevertheless, the construction of this stretcher from a wood of excellent strength and dimensional stability explains the good condition of the unlined canvas support. Stretcher creases, evident in raking light, correspond to this stretcher’s members. No other marks were found to indicate the canvas had ever been on a different support long enough to create other creases.
Figure 6. Maxfield Parrish, *The Pied Piper of Hamelin*, 1909, oil on ticking, 5 ft. 4½ in. × 16 ft. (163.83 × 487.68 cm), detail of reverse during examination. © ArtCareNYC, a Rustin Levenson Company, 2013
It is a mystery what type of fabric Parrish used in 1906 for his mature version of *Old King Cole*, because it is obscured by a lining fabric (estimated to date from 1957) that remains firmly attached. One can only speculate on Parrish’s choice of ticking. Perhaps he was interested in the strength inherent in its tight weave and/or the particular weave texture that would be visible through his paint. There remains more to learn about the canvases selected by Parrish for his murals.

5. MEDIA, VARNISH, RESTORATION LAYER

Maxfield Parrish is known for the gemlike brilliance of his colors. His technique of layering varnish between applications of unmixed, transparent color has been extensively documented (Ludwig 1973, 195–198) as well as decried by conservators (Bockrath 1999, 140). The technique that resulted in these remarkable colors is also what makes his discolored surface coatings treacherous to remove without dire consequences.

In a 1950 letter to a paint manufacturer who had inquired about his technique (Ludwig 1973, 191–193), Parrish wrote:

"[T]his method is very simple, very ancient, very laborious, and by no means original with me…each artist had his own particular way of going about it: some by starting with a monochrome underpainting, some with a few colors, over which were glazed more or less transparent colors…Colors are applied just as they
cigarette and cigar smoke residues, and food and drink splatters. The initial visual examination provided a glimpse of the difference grime removal might make because a more lively blue color could be seen around the edges of the painting in the sky (fig. 9). At first, this bluer color at the edges was assumed to be where the original varnish had been protected by the frame; however, further examination didn’t confirm this explanation. In specular and UV light, broad brush strokes, and uneven patches were evident (fig. 10) in the surface layer. Where the coating was uneven or had been removed, a lighter brownish yellow could be seen. But, how should one interpret these interruptions in the coating when they didn’t look like cleaning tests or intentional wipes? Could the irregular surface layer be a broken-up grime layer? If so, why were there brush marks? Could this layer be a restoration varnish applied within the frame? Further examination and testing would eventually answer these questions.

come from the tube, the original purity and quality is never lost... I used to begin a painting with a monochrome of raw umber...but now the start is made with a monochrome of blue, right from the tube, not mixed with white or anything. Ultramarine or the Monastral blues, or cobalt for distance and skies. This seems to make a good foundation for shadows and it does take considerable planning ahead, and looks for all the world like a blue dinner plate. The rest is a buildup of glazes until the end. The only time opaque color is used is painting trees.”

Further information about Parrish’s glazing methods can be found in an excerpt of Maxfield Parrish, Jr’s unpublished manuscript about his father’s techniques (Ludwig 1973, 195–200).

The discolored brown film that obscured Parrish’s intended colors in The Pied Piper mural was made up of surface grime,
Figure 10. Maxfield Parrish, *The Pied Piper of Hamelin*, 1909, oil on ticking, 5 ft. 4½ in. × 16 ft. (163.83 × 487.68 cm), detail of figures at lower center under UV light before treatment. © ArtCareNYC, a Rustin Levenson Company, 2013
The Pied Piper of Hamelin: Maxfield Parrish’s Painting for the Palace Hotel, San Francisco

6. ANALYTICAL RESULTS

A few discreet cleaning tests were made with different aqueous mixtures to determine how best to proceed with the surface grime removal. The mixture found to be most effective was a solution of 2% ammonium citrate, dibasic (chelating agent), in water mixed with 1% Ecosurf™ EH-9 (nonionic surfactant manufactured by Dow; Dow 2015). All areas were rinsed of the cleaning solution with distilled water on cotton swabs.

Once the surface cleaning was completed it was possible to determine the reason for the unevenness seen in specular and UV lights: A discolored coating corresponding to the broad brushstrokes had disintegrated in many places. In some areas, tiny air pockets had formed in the film; in other areas, the coating had powdered to such an extent that it had come away with the aqueous cleaning. As seen in figure 11, a detail from the mountains in the upper right of the mural where the deteriorated coating is lost, a brilliant blue color has been revealed. In addition, between the deteriorated brownish layer and the brilliant blue paint was another overall varnish. Unexpectedly this newly uncovered layer was clear, glossy, and apparently well-preserved. Could this clear coating be Parrish’s original varnish? Wanting to know if either or both layers could be original, the client was contacted and permission was received to have the two coatings analyzed before continuing the treatment.

Christopher McGlinchey, conservation scientist at the Museum of Modern Art, was asked to perform media and cross-sectional analysis. During sampling, McGlinchey noted that scrapings of the upper disintegrating layer came off readily as if it had a tendency to stick to itself rather than the surface below. In contrast, the lower, well-preserved coating felt brittle under the scalp. In a way that was consistent with a natural resin. His findings, determined through analysis by FTIR (McGlinchey 2013), indicate that the upper, deteriorated coating is an oil-modified alkyd resin (cameo.mfa.org/wiki/alkyd_resin) while the lower, clear coating is a non-dewaxed and decolorized shellac (figs. 12a, 12b).

Figure 11. Maxfield Parrish, The Pied Piper of Hamelin, 1909, oil on ticking, 5 ft. 4⅜ in. × 16 ft. (163.83 × 487.68 cm), detail of mountain side at upper right during treatment. © ArtCareNYC, a Rustin Levenson Company, 2013.
Sample 1, confirming alkyd Spectra representative of entire sample

Alkyd resins are synthetic polyesters that have been modified with a drying oil (Learner 2004, 185) to create an array of versatile and fast-drying protective coatings and binders. Though alkyd resins were first utilized as plasticizers for automobile finishes in the 1920s, they became widely available only after World War II (Standeven 2011, 69–72). In the 1940s, alkyds were modified with various materials to make the polyester resin less water resistant. The urethane-modified alkyds, for example, continue to be utilized as interior and exterior wood coatings as well as for marine and decorative paints (Standeven 2011, 79).

Since an alkyd clear coating would not have been commercially available earlier than the 1940s, the alkyd coating on The Pied Piper of Hamelin could not have been applied at the completion of the mural in 1909; therefore, the deteriorated alkyd coating is not Parrish’s original presentation coating.

The well-preserved lower coating, visible where the alkyd layer is lost and identified analytically to be shellac, therefore, must be Parrish’s final varnish. In magnified images of the sample of the lower shellac coating (figs. 13a, 13b) parallel lines are visible from the scalpel blade. Whereas the alkyd easily popped off the surface, this natural resin required greater pressure to remove. Except for the ridges made by the scalpel blade, the film is clear and devoid of fissures or discolored material in contrast to the degraded and pitted alkyd sample (fig. 14a, 14b).
Sample 2, confirming shellac

Figure 12b. Maxfield Parrish, *The Pied Piper of Hamelin*, 1909, oil on ticking, 5 ft. 4½ in. × 16 ft. (163.83 × 487.68 cm), Sample 2, Shellac, A.C. Garnet non-dewaxed. Courtesy of Christopher McGlinchey, 2013

Figure 13a. Maxfield Parrish, *The Pied Piper of Hamelin*, 1909, oil on ticking, 5 ft. 4½ in. × 16 ft. (163.83 × 487.68 cm), Sample 4, Shellac, transmitted visible light. Courtesy of Christopher McGlinchey, 2013

Figure 13b. Maxfield Parrish, *The Pied Piper of Hamelin*, 1909, oil on ticking, 5 ft. 4½ in. × 16 ft. (163.83 × 487.68 cm), Sample 4, Shellac, reflected UV. Courtesy of Christopher McGlinchey, 2013
That Parrish’s final varnish had not only remained intact but clear and glossy after 104 years is truly remarkable and may in part be due to the protective characteristics of the alkyd coating as well as the minimal output of UV radiation from incandescent bulbs in the bar. Parrish’s use of shellac for his final varnish would have been in keeping with a common artistic practice in America at the time. Vernis Soehnée was a retouching varnish made from bleached shellac in alcohol. It was sold to artists by New York suppliers in the mid- to late-19th century as early as 1857. Many American artists also preferred this product for use as a thin, not-too-glossy final varnish (Mayer and Myers 2013, 73–78). Parrish diverged from his contemporaries by using a non-dewaxed, decolored shellac rather than a bleached shellac. Parrish’s choice of decolorized rather than bleached shellac may also have played a part in the clarity of the final varnish on The Pied Piper. Shellac bleaching, or oxidation, is a chemical process involving the introduction of chloride atoms and hydroxyl groups in addition to peroxides, hydrogen peroxide, hypochlorites, and chlorites to destroy coloring components. The resulting material contains residues of salts, acids, and water, chemical substances, which, under certain conditions can lead to permanent accelerated aging (Grimmig-Haga, 2005).

Parrish was also known to have used various natural resins in addition to shellac over his long career (Ludwig 1973; Bockrath 1999; Bareis 2002). The analyses performed for the purposes of this conservation treatment appear to be the first to identify the shellac as non-dewaxed and decolorized. Cross sections taken from The Pied Piper samples also suggested that the same shellac was used between the glaze layers (figs. 15a, 15b, 15c).

7. FURTHER TREATMENT OPTIONS

Before contacting the client with the analytical findings, the conservators reviewed possible treatment options in the context of the new information. The appearance of the painting was certainly brighter and more colorful after the removal of the grime and cigarette smoke. The discoloration of the alkyd layer lent a warm glow of patina to the painting that the bar clientele had been familiar with for many decades. The original request to remove the surface grime had been fulfilled. One option would be to preserve what was left of the alkyd coating. The fragmentary alkyd layer could be unified with a saturating coat of a new varnish and the treatment could be declared done. Or, we could find a way of removing the discolored and delaminating alkyd layer to reveal Parrish’s original varnish and true colors.

Solvent cleaning was not an option; however, it was noted that the alkyd layer had been adversely affected by the aqueous cleaning. Water removal methods were investigated by the conservators. The first tests were with moist blotters held on the surface under sheets of transparent, thin (.0005 in.) Mylar and low-tack blue tape for varying amounts of time. This means of applying moisture was eventually rejected because it wasn’t possible to view the effect of the water through the
Once the alkyd softened, various tools were tested for removing the methyl cellulose and alkyd from the surface. Removal with hand tools such as scalpels or spatulas were quickly abandoned since there was a risk of abrading the shellac coating. Next, a technique that has been helpful during removal of other aged coatings from wall and ceiling paintings, was tested. Pieces of clear self-adhesive tape were pressed securely onto the softened alkyd and then gently peeled away taking the alkyd layer with it. In figure 16a, conservator Debra Selden applies a piece of tape; in figure 16b she peels it away taking the alkyd with the tape; and, in figure 16c the original color appears after several square inches of alkyd have been removed. This treatment was repeated in a number of other small areas to determine whether it was repeatable. The results were similar in all of the areas tested.

The client was pleased with our news, but declined to give us permission to remove the alkyd coating citing the extensive time period needed to perform such a delicate cleaning procedure. Though this was not the decision the conservators hoped to hear, they nonetheless carried out the client’s instructions. The cleaning tests were inpainted with Gamblin conservation colors and the alkyd was resaturated with a brush coat of Regalrez mixed with microcrystalline wax as matting agent. The resulting satin finish varnish will remain readily reversible in naphtha should a conservator be given the privilege of removing it and the alkyd one day.

Blotter paper. Instead, a methyl cellulose gel, 5% in water, was applied to the surface, covered with a piece of thin Mylar, and monitored. The alkyd softened with 5 to 10 minutes’ exposure. If left on longer, there was a risk of also softening the shellac layer.
ACKNOWLEDGMENTS

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REFERENCES


FURTHER READING


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THIS ARTICLE HAS NOT UNDERGONE A FORMAL PROCESS OF PEER REVIEW.
Piet Mondrian in the Collection of the Museum of Modern Art

ABSTRACT

With 25 works spanning from 1902 to 1943, the Museum of Modern Art holds the most comprehensive collection of paintings by Mondrian in North America. For the last four years, the conservation department has continued to utilize new technologies to study Mondrian’s 16 oil paintings through examination, documentation, technical analysis, retreatment, and inter-museum collaboration. This paper summarizes the research carried out to date and focuses in particular on the comparative study of three paintings, Tableau no. 2 / Composition V (1914) Composition with Color Planes 5 (1917) and Composition C (1920).

1. INTRODUCTION

Piet Mondrian was born in Amersfoort, Holland, in 1872 and trained at the Rijksacademie. His work of the 1890s was influenced by the contemporary styles of the day: The Hague School, the Amsterdam Impressionists, and Symbolism. By 1911, he had embraced Cubism and soon moved to Paris, immersing himself in the café and salon scene with fellow artists such as Léger, Braque, and Rivera. He traveled back and forth from Holland to Paris over the next few years and exhibited a series of important cubist works at the Walrecht Gallery in The Hague in 1914. The outbreak of World War I forced him to stay in the Netherlands, where from 1917 to 1920 he painted experimental works and wrote for van Doesburg’s De Stijl. In between the two world wars, he was able to travel again, and he returned to Paris in 1919. He continued to write and to paint throughout the 1920s and 1930s and was exhibited in Paris, Germany, the Netherlands, and the United States. As World War II approached, he moved to London in 1938 and finally New York in 1940 (Joosten and Welsh 1998).

In a 1941 autobiographical essay, Mondrian stated, “In my early pictures, space was still a background. I began to determine forms: verticals and horizontals became rectangles. They still appeared as detached forms against a background; their color was still impure. Feeling the lack of unity, I brought the rectangles together: space became white, black or gray; form became red, blue or yellow. Uniting the rectangles was equivalent to continuing the verticals and horizontals of the former period over the entire composition” (Mondrian 1941). Mondrian died on February 1, 1944, at the very height of his career. He had ultimately practiced a deceptively simple theory of art. The essence of his ideas was that painting—composed of the most fundamental aspects of line and color—must set an example to the other arts. Mondrian’s aesthetic influence has been far reaching from the Bauhaus movement to 1960s minimalism to name a few. Brief Pinterest and Instagram searches yield the scope of his mark beyond the gallery walls and into areas including fashion, industrial design, marketing, video games, interior design, and food.

The collection of the Museum of Modern Art (MoMA) presently has 25 works by Mondrian, including paintings, watercolors, drawings, and prints. Of these, 16 are oil paintings. Spanning from 1902 to 1943, they form the most comprehensive collection of Mondrian’s paintings in North America.

Cynthia Albertson began re-examining and documenting MoMA’s collection of works by Mondrian in 2009 with the support of the Samuel H. Kress foundation. Technical examination including imaging, x-ray radiography, reflectance transformation imaging (RTI) and (XRF) has been carried out on the majority of the collection. These studies have helped characterize the artist’s materials and changes in his palette and to provide evidence of a plethora of compositional changes, as well as, through the examination of stratigraphy, the evolution of his paint layering technique. Ultimately, the collective documentation will provide MoMA as well as other institutions and art historians with a more comprehensive understanding of this critically important body of Mondrian’s work. A snapshot of the documentation initially compiled for the 16 Mondrian paintings in the MoMA collection is presented in Table 1, including past treatments and analysis.
Table 1. Summary of Past Treatments and Analysis (prior to 2010) on the Sixteen Mondrian Paintings in the MoMA Collection.

<table>
<thead>
<tr>
<th>Title</th>
<th>Date</th>
<th>Before entering the MoMA collection</th>
<th>Conservation treatments at MoMA</th>
<th>Scientific Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truncated View of the Broekzijder Mill on the Gein, Wings Facing West</td>
<td>c. 1902-03 or earlier</td>
<td>• Canvas mounted on cardboard • The cardboard had been mounted to a wood panel • Layer of dirt and discolored varnish</td>
<td>• Cleaned and spray varnished (no date) • Cleaned and revarnished, losses filled and inpainted in 1981 • Tertiary support and nails removed in 2006</td>
<td></td>
</tr>
<tr>
<td>View from the Dunes with Beach and Piers, Domburg</td>
<td>1909</td>
<td>• Heavily applied varnish that is now discolored and contains embedded detritus</td>
<td>• No treatment records</td>
<td></td>
</tr>
<tr>
<td>Composition in Brown and Gray</td>
<td>1913</td>
<td>• On its original stretcher • A small patch was applied near the center</td>
<td>• Small patch replaced and applied with wax resin on reverse, cleaned and varnished with synthetic resin in 1950 • Cleaned in 1958 • 1950s varnish removed along with an underlayer of natural resin varnish, old tear inpainted in 1993</td>
<td>• Surface cleaning in 1958</td>
</tr>
<tr>
<td>Composition in Oval with Color Planes 1</td>
<td>1914</td>
<td>• Old synthetic overall varnish likely applied in the 1950s</td>
<td>• Wax resin lined and restretched on a Lebron stretcher in 1967, varnish removed and a new varnish applied</td>
<td></td>
</tr>
<tr>
<td>Tableau no. 2 / Composition no. V</td>
<td>Unknown</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Composition with Color Planes 5</td>
<td>1917</td>
<td></td>
<td>• Wax resin lined on a Lebron stretcher and varnished (the original stretcher was retained), cracking at edges infused with PVA in 1967 • Cleaned in 1980</td>
<td></td>
</tr>
<tr>
<td>Composition C</td>
<td>1920</td>
<td>Unknown</td>
<td>• Cleaned, revarnished, lined and put on hollow core panel in the late 1960s • Unlined, placed back on a new stretcher, and the varnish removed in 2004</td>
<td>• Analysis of cross sections and pigment samples by PLM and SEM to understand if the yellow green paint had discolored (1997)</td>
</tr>
<tr>
<td>Composition with Red, Blue, Black, Yellow and Gray</td>
<td>1921</td>
<td>Unknown</td>
<td>• Cleaned, wax resin lined, mounted on a panel, and varnished in the late 1960s</td>
<td>• Analysis of cross sections and pigment samples by PLM and SEM to determine if areas of obvious retouching or reworking were by Mondrian (1995)</td>
</tr>
</tbody>
</table>
| Tableau I: Lozenge with Four Lines and Gray  | 1926 | Unknown | • Lined and restretched, cleaned, and varnished in 1953  
| (Object Number: 179.1953) |  |  | • Cleaned and revarnished in 1978 and 1984  
| Composition No. II, with Red and Blue | 1929 | Unknown | • Cleaned and wax resin lined, mounted on a panel, varnished in 1970  
| (Object Number: 486.1941) |  |  |  
| Composition with Red and Blue | 1933 | Unknown | • Lined on a new stretcher prior to 1968  
| (Object Number: 635.1967) |  |  | • Relined and mounted on a panel in 1977, synthetic varnish applied  
| Composition in White, Black, and Red | 1936 | Unknown | • Wax infused, mounted to a panel, and varnished in 1971  
| (Object Number: 2.1937) |  |  | • Cleaned and revarnished in 1984  
| Composition in Yellow, Blue and White, I | 1937 | Unknown | • Shortly thereafter the painting had to be locally cleaned after incident in the gallery  
| (Object Number: 637.1967) |  |  | • Cleaned in 1996 after a gallery incident  
| Composition in Red, Blue, and Yellow | 1937-42 | Unknown | • Glue lined and restretched sometime prior to 1967  
| (Object Number: 638.1967) |  |  | • By 1978 the lining was failing, the glue was reduced, and then the canvas wax infused, lined, and mounted on a panel; the varnish was removed and a new one applied  
| Trafalgar Square | 1939-43 | Unknown | • PLM analysis on dispersed pigment samples (1997)  
| (Object Number: 510.1964) |  |  |  
| Broadway Boogie Woogie | 1942-43 | Unknown | • PLM analysis on dispersed pigment samples to help understand the cracking and cleaving of the yellow paint (1993)  
| (Object Number: 73.1943) |  |  |  

AIC Paintings Specialty Group Postprints 27 (2014)
Although a review of the existing treatment documentation provided a greater understanding of the current state of these paintings, it was impossible to know exactly how these works appeared before treatment because technical documentation for this collection—particularly for the artist’s earliest works—was sparse, with little or no photographic records and mostly in black and white. Some pigment analysis was also done in the late 1990s on some of the later works, but the goal at the start of this new investigation was to gather as much technical information as possible using nondestructive methods of examination and analysis and to try to address questions such as: Were these pictures supposed to be varnished? Were they supposed to be glossy or matte or combinations of both? Did Mondrian repaint entirely, rework partially, or even retouch selectively several of these pictures or are we seeing the hand of restorers? Why did his earlier paintings appear relatively uncracked and those post 1920 appear more cracked? Was this related to his choice of materials or a combination of layering and material choice?

In some cases, it remained unclear why only some paintings had required treatment and what the long-term effects the treatment had on the paintings’ condition. Discussion with MoMA colleagues familiar with the treatment history of the works led to the formulation of a number of questions: Had some of the surfaces been damaged during prior cleaning, varnish removal, and lining treatments both elsewhere and at MoMA? Although seen as combinations of restoration and preventive care at the time, are the linings, panels, and varnishes really still needed? Are the linings and varnishes compromising the artist’s intended aesthetic? How might they have changed the surface? Are they affecting interpretation of the works for a general audience? Are they obscuring historical information? Did we still have the original stretchers for the works that were lined and restretched at MoMA? And which frames are original, and if not original, are they the most appropriate choices?

2. METHODS

A plan for in-depth technical examination and documentation was devised as well as an intermuseum collaboration with conservation and curatorial colleagues at the Gemeentemuseum Den Haag. Examination and documentation goals included digitization and archiving of any and all previous documentation; creation of current written reports, including annotated condition of images; and photographic documentation including normal, raking, UV-induced visible fluorescence, specular, infrared imaging, multispectral imaging, x-ray radiography, and topography studies with RTI for the entire collection. Scientific analysis was included as well, with an emphasis on noninvasive techniques such as XRF both in spot analysis mode and mapping mode to characterize the materials used by Mondrian and to assess if his choice and use of materials might have impacted the current condition of the artworks.

Initial and ongoing materials-based questions included what white, yellow, red, and blue paints was he using? Could the use of zinc-prepared grounds or paints and/or cadmium-based paints have contributed to present-condition issues?

While working on completing the examination of MoMA’s works, it became clear that the best way to understand what these pictures would have looked like without treatment was to examine as many untreated works as possible. Taking advantage of research funds, courier trips, and traveling exhibition installations, it was possible to view or examine over 200 works with curators and conservators at other institutions and private conservation studios. Although not all of them were untreated, examining them all provided a greater understanding of the artist’s technique as well as a basis to understand and interpret historical conservation-treatment trends. On the basis of these examinations, answers to some of the research questions came to light. Brush-stroke application, direction and thickness are unique from picture to picture. Variation of technique is the result of an evolution of his intentions. Surface matte and gloss variation within the same picture are intentional. Each color area changes, sometimes subtly, other times quite dramatically, as the painting evolves. Black bands are typically glossier than the surrounding paint, and this variation is intentional. An applied varnish may be on top in some instances; in others, it may be varnish/medium within the black paint. Mondrian often scraped out/reworked the surface sometimes to bare canvas in areas. He often retouched or reworked his own paintings, sometimes years later. His original frames are intrinsic to the paintings and like the works themselves, these were often modified by the artist; he changed his style of framing several times (Cooper and Spronk 2001).

The information gleaned through this technical and documentary evaluation will hopefully produce sufficient data to establish a correlation between current- and past-condition issues and the artist’s material choices and application techniques. For example, many of Mondrian’s post-1917 works have exhibited cracking and paint lifting due to intra- and interlayer cleavage of ground and paint, which had warranted lining treatments in the past. This period corresponds to the development of Mondrian’s neoplasticism style and to the use of a large range of techniques; it simultaneously corresponds to an apparent arbitrariness in the choice of materials, sometimes of lower quality possibly for lack of financial means (Blok et al. 2011).

The comparative study of three early abstract paintings discussed in this paper—Tableau no. 2 / Composition V (1914), Composition with Color Planes 5 (1917), and Composition C (1920)—illustrates the range of documentation techniques used for this project and simultaneously provides some re-treatment examples. These three paintings span only six years but illustrate important changes in Mondrian’s technique as his work becomes more and more abstract yet more structured and restrained.
3. RESULTS

In normal illumination, Tableau no. 2 / Composition no.V from 1914 (fig. 1) presented an overall flat, highly glossy surface. The painting’s wax resin lining was restretched on an expansion bolt stretcher. UV-induced visible fluorescence revealed a thick synthetic varnish layer and very little retouching over a few passages of cracking. This thick varnish layer was obscuring brushstrokes and topography that were highlighted in raking light.

According to an earlier treatment report, the work was indeed lined in 1967 and restretched on a thicker stretcher (Volkmer 1967a). The dimensions of the stretcher were slightly bigger than the dimensions of the picture plane, and it was 1½-in. thick, while the actual tacking edges on the painting were just 7/8 in. During examination in the 1990s and in 2011, a green border-like material was seen along the perimeter of the picture plane. It was previously described as a greenish paint or a bronze paint. Under magnification, it appeared like corrosion products and was easily manipulated and moved about when probed. Samples were extracted for analysis to determine if it was a paint or corrosion, and to determine if it should and could be removed. Fourier transform infrared spectroscopy (FTIR) and scanning electron microscopy with x-ray microanalysis (SEM-EDS) revealed that the green substance was an organometallic corrosion product formed most likely from an interaction between the frame bronze paint and the wax resin from the lining or the artist’s paint medium. Consulting with curators at the Gemeentemuseum confirmed that Mondrian had placed a gold-strip frame on this work for an exhibition at The Hague in 1914 and that he most likely painted the frame himself, while it was on the painting (Albertson 2012; Janssen 2012, pers. comm.). This reaction has been observed to a lesser degree, on two other works in MoMA’s collection, as well as several other early works in other collections.

The radiograph (fig. 2) revealed an abundance of lead white within the picture, as well as some fascinating compositional changes.

While there is no pencil drawing visible on the face of the painting, throughout Mondrian’s working and reworking process, nearest to the ground he lays very thin to medium lines no wider than ¼ in., with a fine brush. Here he draws a somewhat regular grid or scaffold of horizontal and vertical lines in black that he will go on to reinforce and bring to the forefront in some areas or push completely to the background in others. Reflected infrared examination reveals many more black grid lines—from an earlier state—near the corners (particularly the top and bottom right corners), which he painted out. These can just be seen in normal light but are more evident when captured with infrared reflectography (IRR). Clearly seen in the IRR is a dark black band that runs throughout the bottom; this seems to mimic the bottom stretcher, which is now part of an underpainting.

Further consultation with colleagues in the Netherlands (Albertson and Janssen, pers. comm.) suggested that this picture was at least partially reworked or repainted by Mondrian just before his 1914 exhibition. A close look at his signature with magnification reveals an earlier iteration of his signature under the present one (fig. 3a).

Looking at this same area with RTI evidences the scraping across the surface (fig. 3b). Examination of the rest of the painting with RTI reveals that the right-of-center exhibits substantial scraping, along with dramatic variation in surface texture and thickness from one shape to another, some pushing and pulling forth of the black grid lines, and the overall absence of cracking in the paint surface.
Figure 3. (a) Detail images acquired under the microscope (×20) of the signature at the bottom left of *Tableau no. 2 / Composition no. V* (1914) showing a half hidden first signature; (b) examination of the lower left area using RTI.

Figure 4. Examples of elemental (Ba, Ca, Fe, Co, Zn, Cu, Pb, and Ti) distribution maps for *Tableau no. 2 / Composition no. V* (1914) based on the XRF mapping analysis.
Elemental distribution maps were obtained by macro-XRF (MA-XRF) mapping. A few representative maps are provided in fig. 4 to illustrate some of the findings, in particular the brushwork and paint layering. Spot analysis with an XRF handheld instrument was used to confirm and complement the list of elements identified by XRF mapping. On the basis of the elements present in the different color fields, a tentative list of inorganic pigments and fillers is proposed in table 2. Further analysis on samples is required for confirmation, but XRF results suggest that the both blue and pink paints contain an organic pigment with a significant amount of barium sulfate (BaSO₄) filler—indicated by the presence of barium (Ba map) and strontium (Sr map), a known impurity in barite—while the yellow or orange are iron oxide (Fe map) or earth pigments. All of them were mixed with or also contain lead (Pb map) white paint. The paint used to create the black lines contains bone black—indicated by the presence of calcium (Ca map) and phosphorous (P map)—the IRR indicates the presence of carbon black paint as well (not detectable by XRF). The lines at the top and bottom in the copper (Cu), zinc (Zn) distribution maps correspond to the green lines observed and identified as a bronze paint. Mondrian also added a few brushstrokes here and there of an expanded palette containing cobalt blue (Co map), cadmium yellow (Cd map), and chrome yellow (Cr map). The titanium (Ti) distribution map indicates areas that have been inpainted during restoration campaigns. The ground is lead white based and appears to also contain a small amount of BaSO₄.

After thorough examination, it was decided to retreat Tableau No. 2/Composition 5 due to a number of factors. The treatment
file mentioned an inscription and canvas-maker stamps on the back that were obscured by a 1967 lining (Volkmer 1967a). The painting was in good condition, aside from the corrosion products along the face of the picture plane. There was very little cracking, and the varnish was obscuring all surface variation and subtlety. Colleagues at the Gemeentemuseum helped identify the appropriate type of stretcher and a new one was made (Hoppe and Speelers, pers. comm.). The lining was slowly and gently rolled off the back with handmade Teflon® spatulas to encourage the release without heat. Lining removal revealed Mondrian’s signature on the reverse, inscriptions, as well as a manufacturer’s stamp. The delicate tacking edges were strip lined. The picture was restretched on its new French style back beveled 7/8-in.-thick stretcher. The surface was cleaned and then left unvarnished (Albertson 2012a).

Mondrian’s *Composition with Color Planes 5* (1917) (fig. 5) has also been lined, applied with a polybutylmethacrylate varnish (Volkmer 1967b), and placed on a Lebron-style.
(Buckley 2013) nonoriginal expansion bolt stretcher, and varnished with a polybutylmethacrylate (Volkmer 1967b).

While the original stretcher has been retained in MoMA’s collection, unlining and restretching has not been done. To date, the surface has been minimally treated, using a pH-appropriate aqueous solution to remove surface dirt (Albertson 2012b).

Unlike in Tableau no. 2 / Composition no. V (1914), cracking is becoming noticeable in a number of passages, but in normal illumination, both paintings revealed an overall flat and highly glossy varnished surface. UV-induced visible fluorescence (fig. 6) shows a confusing assortment of paint layers, many with patchy and different fluorescence, highlighting individual brushstrokes. These fanned-out gestural scribbles make the picture appear unfinished in UV.

Upon initial examination, it was unclear if this was Mondrian or the work of an earlier restorer. Raking light and RTI also highlighted these changes within the paint layers. X-ray (fig. 7) revealed another view of the changes to the composition, with differing densities of paint layers visible across the picture plane.

Although transmitted infrared did not produce any information about an earlier state, reflected infrared revealed an earlier iteration of the artist’s signature. Rather than the initials PM side by side with 17, an earlier signature is visible 3 in. to the left in which he overlaps the M over the P with the 17 adjacent (fig. 8).

This change certainly made the UV examination information more digestible and acceptable as an artist’s change rather than the work of a restorer. Consultation with
Bit of the XRF spot analysis, the priming layer is also lead white based like the 1914 painting, but it contains a calcium-based substance, possibly calcite. The white paint is mostly zinc white, although some areas have been partially painted over and somewhat haphazardly with a lead white paint (as seen under UV illumination). Mondrian was still at this time using a palette composed of natural earth pigments such as yellow ochre. The blue and pink pigments are organic. The list of proposed pigments is presented in table 2.

Three years later Mondrian painted Composition C (1920) (fig. 9).

This painting was previously wax lined and mounted on a hollow core panel in 1964 (Volkmer 1964). The lining and panel were removed, and it was restretched on a new thinner stretcher in 2004 (Skopek 2004). Normal illumination and UV-induced fluorescence now present an unvarnished surface. There is noticeable and expected variation in gloss from one color plane to another. There are some drying cracks in the blues and mechanical cracks in the yellow-greens, although all are stable.

The x-radiograph (fig. 10a) reveals evidence of a grid or earlier state underneath. This grid underlayer is further illustrated in transmitted infrared with the light from the back (fig. 10b), but is most clearly seen with the light...
shining through the front and the camera at the back of the painting (fig. 10c). This earlier state illustrates a very regular arrangement of gridlines roughly 2 in. apart. In some instances, the whole vertical grid shifts over ½ in., and the earlier iteration is obliterated. The vertical lines appear to remain constant through to the finished state except in the red and blue to the far left and through the very center.

Meticulous and thick reapplication of the upper paint is also visible in the RTI images (fig. 11). In the darker blue and in the yellow-green, the cracking is highlighted, and a layer of gray paint applied over the end of the brush stroke in the yellow-green reflects Mondrian’s self-editing.

Examination of the picture in normal light presents it as a departure from Mondrian’s earlier palette of 1914 and 1917.

The XRF spot analysis and mapping identify elements indicative of the presence of vermillion, cadmium red, and cadmium yellow. These results are consistent with the analysis done on dispersed pigment samples in the past (Ordonez 1997), with the exception of that of the identification of cadmium red as well as the presence of a molybdenum-based compound or pigment in the blue fields.

The elemental distribution maps for cadmium (Cd), selenium (Se), and mercury (Hg) are presented in figure 12. Cadmium is present in both the green-yellow and red suggesting the use of both cadmium yellow (cadmium sulfide, CdS) and cadmium red (cadmium sulfide and selenide, CdS.CdSe)—the presence of this last pigment being confirmed by the presence of selenide. Mercury is also present in the red color fields, but the comparison with the selenide map clearly shows that the two elements are not mixed together, hence Mondrian used two different red paints, one containing cadmium red—in an underlayer—and the other vermillion in the top layer (mercury sulfide, HgS), applied in broad brushstrokes. The red paint fields also seem to contain an iron-rich compound or pigment (see the Fe map), but the particles are very coarse, which might be an indication of the use of lower-quality paints.
The zinc map confirms the presence of zinc white in the cadmium yellow based paint as identified in the past (Ordonez 1997). On the other hand, zinc as well as lead are present in the ground (previous analysis only identified calcite in the ground). The blue paint is rich in both cobalt and lead, which suggests the presence of cobalt blue mixed with varying amounts of lead white to produce the three tonalities of blue. Iron is also present in smaller amounts and had not been

Figure 12. Some of the most representative elemental (Ca, Co, Cd K line, Fe, Hg, Se, Pb, Zn) distribution maps obtained by XRF mapping for Mondrian Composition C (1920).
detected in the past suggesting that it is present in an under-layer. The presence of molybdenum (Mo) could be due to the presence of an organic pigment precipitated with a molybdenum complex salt (Herbst 1993). The presence of an organic blue pigment had been detected in the past using the polarized light microscopy, but further analysis is required to identify it. The presence of Ca and P suggest the black paint contains bone black. Results are summarized in table 2.
On combining the ongoing data collection and examination of the Mondrian paintings in the MoMA collection with the earlier studies done in the 1990s and examination of other paintings in other collections, a more detailed description of Mondrian’s early process emerges:

1. **By the early 1900s to 1910**—He preferred a matte surface.
2. **From 1911 through the 1920s**—He tried to achieve variation from textured matte surfaces and contiguous smooth reflective areas in the same picture as seen with Composition V. Charcoal gridlines shift as the composition develops, sometimes obscuring them entirely or reinforcing them at a later or final stage.
3. **From 1917 through 1920s**—His color planes shift several times as seen with Composition with Color Planes 5.

Mondrian often produced a set of intersecting charcoal lines that remained static or shifted slightly acting as registration lines as seen in Composition C.

As we continue to gather information on Mondrian’s selection and use of materials for the other paintings in the collection and other Mondrian’s paintings (Blok et al. 2011; Cooper and Spronk 2001; van Bommel, Janssen, and Spronk 2012), several questions emerge about the role of these materials in the current condition of the paintings. The type and extent of the cracking, for example, varies across the paintings:

1. **Composition V** (1914) has very few cracks limited mostly to a few passages and are mostly drying cracks and stretcher-bars cracks.
2. **Composition with Color Planes 5** (1917) exhibits much more cracking, particularly drying cracks in the areas of artist overpaint.
3. **Composition C** (1920) exhibits drying cracks in all the blues and gray-blues, and slight tenting in the yellow greens.

As the number of paintings examined increases, the role of the paint composition on condition will be clarified. Additional future work will include continued historical research to determine brands of paints Mondrian used. XRF analysis and RTI should be completed for the rest of the collection. Sampling the works for cross sections is required to fully establish the stratigraphy and identify the pigments, fillers and medium. The current XRF mapping and analysis will be crucial to guide this sampling.

As the examination and analysis of the MoMA’s collection of Mondrian paintings proceeds, the authors will continue to disseminate results. Ultimately, the authors hope that a database or file share can be set up to compile treatment reports, images, and materials analysis results that would provide MoMA as well as other institutions and art historians with a more comprehensive understanding of Piet Mondrian’s methods and materials.

### 4. APPENDIX

XRF maps were collected using a Bruker M6 Jetstream MA-XRF mapping instrument (Alfeld et al. 2013). This instrument was operated at 40 kV and 0.5 mA; step size of 500–500 μm, dwell time of 90 ms/step and a beam size estimated to be 350 μm in diameter were used. All the data were collected and visualized with the Bruker M6 Jetstream software package.

In situ XRF spot analysis was performed with a Bruker Tracer III-SDD (silicon drift detector) handheld XRF instrument with an Rh excitation source and SDD. A helium purge was used to improve the sensitivity to low-Z elements. The instrument was operated at 40 kV and 1 μA and spectra were acquired for 120 s (approximately 5 mm diameter spot size). XRF spectra were acquired on 50–100 spots for each painting for a representative assessment of the artist palette. RTI was completed using a Canon Mark 3 and a flash pack. Images were then processed using Adobe Photoshop and the RTI (Cultural Heritage Imaging) images were obtained using the RTI Builder. Radiography was performed with a Lorad LPX 200 system with 14 × 17-in. film. The film was then developed, scanned, and stitched together using Adobe Photoshop. Infrared examination was done with an InfraMetrics INFR-CAM and 12× lens.

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### NOTE

1. **Inscriptions.** *Front:* Signed in lower left corner in black: MONDRiAN, 1914. *Back:* In the upper left quadrant, diagonally from bottom to top, in thin black paint with a medium flat brush: P. MONDRiAN., underlined with a black line; just beneath that and to the
left center is a canvas stamp of Blanchet, 38 rue Bonaparte, Paris, oriented vertically. To the upper right there may have been something that is now illegible with surrounding tidelines. The area has been struck through with a finer flat brush with horizontal strokes in blue paint that has become greenish due to the wax treatment (rubbed or wiped away); on the right side through the center, diagonally in black paint with a medium flat brush: titer [crossed out with a blue line discolored green]; beneath that in black paint, again with a medium flat brush: TABLEAU N:2 [crossed out with a blue line discolored green]; on the upper bar of the original stretcher [now lost, but indicated in MoMA archival records] in blue oil: COMPOSITION – N.V. and: HAUT; written in pencil on the original stretcher: Monsieur Mondrian.

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THIS ARTICLE HAS NOT UNDERGONE A FORMAL PROCESS OF PEER REVIEW.
Refining Style: Technical Investigation of an Early Work by Georges Pierre Seurat in the Maurice Wertheim Collection

ABSTRACT

Georges Seurat devoted himself to the current color and aesthetic theories of his time. Early on, he began applying these theories to canvas, fine-tuning both his technique and selection of materials. This study investigates an early work by Seurat, Vase of Flowers, ca. 1878–ca. 1879, in the Harvard Art Museum's Collection. A number of recent studies have characterized Seurat's later style, technique, and material choices. There is, however, a dearth of material about his earliest works. The goal of this study is to gain a better understanding of Seurat's early technique and style, especially when compared to his later works.

1. INTRODUCTION

Georges-Pierre Seurat is best known for his systematic and controlled artworks, associated largely with pointillism. He developed his techniques and divisionist style of painting over a little more than half a decade, devoting himself to the current color and aesthetic theories of his time. Vase of Flowers, painted ca. 1878–1879, is an early work within Seurat's oeuvre and shows the groundwork of his technical development as an artist (fig. 1). The goal of this project was to gain a better understanding of Seurat's early technique and style and how Vase of Flowers is characteristic of this period in his artistic development, especially when comparing this painting to his later works.

There is little to no information published regarding the materials and methods of Seurat's earliest period. However, a number of Seurat's paintings—both sketches and finished works from his independent and later period—were recently studied and analyzed by other institutions, including The Art Institute of Chicago and the National Gallery of Art, London. These studies provide a wealth of information that characterizes Seurat's later style, technique, and material choices, providing comparative material for the study of Vase of Flowers.

The opportunity to study this painting by Seurat provides valuable new data for an important part of Harvard Art Museums' collection. Historical research into Seurat's life and career as an artist will help guide the technical investigation of Seurat's techniques and materials. Analysis of the pigments and...
layering structure of Vase of Flowers will deepen the understanding and appreciation of the painting and shed light on his early development as an artist.

2. GEORGES PIERRE SEURAT

2.1 ARTISTIC DEVELOPMENT

On December 2, 1859, Seurat was born in Paris into a bourgeois family and fortunate that his family supported his artistic inclination, allowing him to pursue art early in life. At the age of 16, in 1875, Seurat was enrolled at the École Municipale de Dessin et de Sculpture in Paris. Taught by Justin Lequien, he acquired the drawing skills needed to enter the prestigious École des Beaux-Arts by drawing from plaster casts and copying lithographs (Homer 1964, 13). In 1878, Seurat was admitted to the École des Beaux-Arts in Paris and taught by the conservative academic painter Henri Lehman, a pupil of neo-classicist Jean-Auguste-Dominique Ingres. In Lehman’s atelier, Seurat followed the conventional academic practices, studying works by early Italian and 17th-century French artists in the Louvre, making studies of these works and drawing from the École’s collection of plaster casts, paintings, and sculptures.

Through Seurat’s own diary and letters, there is evidence enough to recognize it was early in his academic career, while still enrolled in the École des Beaux-Arts, that he became unsatisfied with the academic approach to art. Although Seurat enrolled in Lehman’s class in March 1878, he left shortly thereafter and rented a studio in the rue de l’Arbalete in the fifth arrondissement of Paris, which he shared with another former student of the École, Aman-Jean. At this time, Seurat began to work on his own, producing small-scale paintings and drawings. In an account from Aman-Jean’s memoirs regarding this period and choice to leave the École, he wrote “When we left the École des Beaux-Arts, we took a studio, whose rent we shared as to work together and to try to find what stuff we were made of; to add, to complete, and to erase partly what was inane and so incomplete in the Gaminaire des art taught at the École” (Herbert et al. 1991). In November 1879, Seurat joined the army for one year of compulsory service, after which he returned to drawing and painting, rejoining Aman-Jean in their studio.

Only five known paintings by Seurat date to or near his earliest academic years, 1876–1879, all of which seem to fall into the category of painted sketch, rather than a finished work. Two of these five paintings, Angelica at the Rock (After Ingres) [1878, oil on canvas, 32½ × 26½ in (83 × 66.3 cm.), Norton Simon Museum of Art, California] and Head of a Young Girl [ca. 1877–1879, oil on canvas, 12 × 9½ in. (30.48 cm × 25.08 cm), Dumbarton Oaks Research Library and Collection, Washington D.C.], were executed using traditional technique, starting with a graphite sketch on a cream ground, followed by layered paint. The former, is a painted copy Seurat made of Ingres’ Roger Freeing Angelica, while it hung in the Louvre.

There is very little information regarding two of the other early paintings, La Baigneuse au Rideau [1879, oil on board, 12½ × 8½ in. (31 × 21.5 cm), location unknown] and Jupiter et Thétis [1881, oil on board, 18½ × 14½ in. (46 × 38 cm), location unknown], including their current locations. Their classical subjects are those of the Beaux-Art tradition but even in old reproductions of the paintings, it is clear that the brushwork is more broken and less blended than would be expected from a student in training. The fifth painting from this period, Vase of Flowers, is aesthetically closer to the two mythological paintings than Angelica at the Rock (After Ingres) and Head of a Young Girl. In terms of its date, Vase of Flowers falls near the academic years, though the palette and technique clearly move away from the academic tradition as Seurat moved away from the use of line and traditional handling and modeling of paint.

During Seurat’s independent period, his focus shifted from the academic painters he studied at the École to the impressionists, Barbizon school, and works of Eugène Delacroix. The paintings he produced from 1881–1884 were mainly natural scenes; landscapes often with peasant figures in the composition.

While working independently, Seurat refined his working process, fine-tuning both his technique and selection of materials. In 1883, Seurat submitted Bathers at Asnières [oil on canvas, 1884, 79¼ × 118½ in. (201 × 300 cm), National Gallery, London] to the jury of the Salon for public exhibition but was rejected. Although Bathers at Asnières is considered Seurat’s first major oil painting, he did not fully reach what is considered his mature style until 1886, best exemplified in A Sunday on the Island of La Grande Jatte [oil on canvas, 1884–1886, 81½ × 121¼ in. (207.5 × 308.1 cm), Art Institute of Chicago, Illinois], which he completed in May 1886.

Throughout Seurat’s career, his style and technique were constantly evolving. He continually sought new ways to improve his technique and implement what he described as an “optical formula.” This evolution of his style is best exemplified when comparing the technique used in Vase of Flowers to paintings made only slightly later in time, such as Bathers at Asnières and A Sunday on the Island of La Grande Jatte, and then these to his even later works such as Young Woman Powdering Herself [oil on canvas, 1890, 37½ × 31¼ in. (95.5 × 79.5 cm), Courtauld Institute of Art, London]. When comparing the technical aspects of these paintings, one can see how Seurat’s divisionist technique became even more polished and tightened over time with the application of individual small strokes of paint that result in subtly and thoughtfully constructed harmonies and contrasts of color (Kirby et al. 2003).
2.2 AESTHETIC AND SCIENTIFIC INFLUENCES

In 1890, Seurat wrote a letter to the art critic Félix Fénéon, to set the record straight that, he, Seurat, not Paul Signac, established the technique of optical painting. To prove his point, Seurat gave a precise account of the early theoretical readings and artistic interests that he pursued in search for an "optical formula." (Herbert et al. 1991). Seurat pursued a way to apply valid laws of art, aesthetics and color theory to his own technique, literally applying these theories to canvas. To appreciate why Seurat used a specific color in a particular way, it is crucial to understand those whose work affects the creation of "Vase of Flowers." These specific scientific and artistic influences include Eugène Delacroix, Charles Blanc, Michel-Eugène Chevreul, and David Sutter.

One of Seurat's earliest and major artistic influences was Eugène Delacroix. Throughout 1881, Seurat saw at least nine of Delacroix's paintings and wrote detailed accounts of each in his diary. These accounts focused on Delacroix's use and placement of colors throughout a composition, as well as describing technical aspects such as the color of the ground, underpainting, and brush handling. In one particular account of a painting, he wrote vividly about the "delicacy of the orange-grey and blue-grey ground" (Broude 1978, 13). Another point Seurat fixes on in his descriptions of Delacroix's work is the harmony and the relation that certain colors create when placed near one another.

Seurat's diary entries describe what he was most interested in at the time and remained interested in throughout this career, "the use of complementary hues to create coloristic harmony and more particularly, the way in which complementary colors can be used as agents of modeling, to modify and enliven neutral tones of grey" (Broude 1978, 2).

Alongside his musings on the harmony of Delacroix's red and greens, Seurat became increasingly interested in the scientific and theoretical writings on color theory of his time. Seurat's first acquaintance with color theory was before admission to the École, when he read Charles Blanc's Grammar of Painting and Engraving (1867). Blanc wrote extensively on art theory, Chevreul's book Principles of Harmony and Contrast of Colors (1855), and created objective laws of art based on the artworks of those he believed to be "model artists." Blanc extolled two contemporary artists of the day, praising Delacroix's use of color and Ingres' expression of form.

Blanc also believed chiaroscuro and color were equally important and that a progressive artistic training should move from line, via chiaroscuro, to color. This may explain why there are so many drawings by Seurat during his earliest period and so few paintings. Another influencing factor of Blanc's writings on Seurat, are his established rules for the formation of light and dark tones, in which he states "a painting should never have two bright or two dark masses of the same intensity. Half-tones should occupy about half of the surface; the other half should be parcelled out into equal areas of light and dark" (Zimmermann et al. 1989, 202).

Furthermore, in Blanc's Grammar of Painting and Engraving, he describes that the way in which two colors are juxtaposed affects how those colors are perceived; when two complementary colors are placed alongside one another, the boundary that separates them produces the most striking optical mixture (Blanc and Doggett 1874, 162–164). Furthermore, if the colors are placed in narrow stripes the "individuality" of both the color and the form becomes indistinct and will result in an "optical mixture" with the colors appearing grayish and colorless (Herbert et al. 2004, 610–612). Most successful, is if the boundary is broken by small indentations that confound the eye, producing a perfect colorless tint.

Blanc is not only a fundamental influence of Seurat's early development as an artist but he introduced Seurat to Chevreul's laws of simultaneous contrast of color and tone, a key element to Seurat's paintings. The basis of Chevreul's theories deal with human perception and how the eye and brain work together to interpret a color. The theory of simultaneous contrast of color states that when two complementary colors are placed side by side, they will display maximum contrast. Furthermore, when complementary colors are adjacent to one another they will clarify one another and appear more vibrant than in actuality or if viewed alone. While if two non-complementary colors are juxtaposed, their color will appear muddied. An example demonstrated by Chevreul in his work includes a red circle that is surrounded by a green halo; the former appears brighter, it's luminance increased. Similarly, in the theory of simultaneous contrast of tone, when two tones of a color are placed side by side, the lighter tone will be lowered and the darkest tone will be heightened.

Lastly of note are the influential theories of aesthetician David Sutter, many of which deal with the aesthetic of line, composition, and the analysis of antique sculpture. It is, however, his theories regarding color and chiaroscuro that are most relevant to Seurat's art. In an article written by Sutter that appeared in the journal L'Art in 1880, Sutter described "irradiation" as an effect that helps to increase definition of form; it is a luminous phenomenon that creates separation between two forms, producing high relief (Herbert et al. 2004, 46). In this way, color is used to create a chiaroscuro-effect in painting. Seurat uses "irradiation" extensively throughout Bathers at Asnières. Examples of it can be seen in the boundary created by the deep blue water edged by pale flesh or the white highlights surrounding the figures. It not only helps to separate the figures from the background but gives them relief.
Blanc, Chevreul, Delacroix, and Sutter’s theories on color and harmony are of the utmost importance to Seurat and deeply penetrated his technical approach to painting throughout his career, though especially those early independent years when his technique was both methodical and experimental.

3. VASE OF FLOWERS

_Vase of Flowers_ is a stepping stone within Seurat’s artistic career, a means of developing and advancing his painting technique. It is a rare example of Seurat’s pre-pointillist work, and it is his only known painted still life. Closer examination of the quality of certain paint strokes, the way in which colors are juxtaposed and forms shaped by brush strokes, show Seurat developing his technique, thinking about an “optical formula” and how to use it in conjunction with his tools and materials to best represent a subject. Furthermore, there is a certain amount of freedom and experimentation in _Vase of Flowers_; colors, highlights, and compositional elements are reworked showing uncertainty.

_Vase of Flowers_ came into the Harvard Art Museum’s collection in 1974, with no information regarding its treatment history. It is oil (est) paint on canvas that has a tight and even plain weave. The painting is 18 1/4 × 15 3/16 in. (46.3 × 38.5 cm), measured height by width. The ground is off-white in color and most likely artist applied, though using a proprietary pigment mixture. There is a fair amount of textured brushworking throughout the composition and some areas of impasto along the left, top and right edges. The painting is covered in thick yellowed varnish, none of which is believed to be original. In 1887, Seurat begins a letter to Octavas Maus “It is appropriate that I tell you of my horror of varnish…” going on to say, “VETO. I am against any varnishing of my canvases, either free or for a fee” (Herbert et al. 1991, 405). Currently, the painting is in good condition, though lined and no longer on its original stretcher.

3.1 TECHNICAL INVESTIGATION OF THE PAINTED STRUCTURE

The painted structure of _Vase of Flowers_ is complex and shows just how much forethought and planning Seurat invested in a painting. Examination of the painted surface with the stereo-microscope and analysis of cross-sections with polarized light microscopy helped to better understand the complexity of the painted structure.

3.1.1 Ground

Cross-sections taken from _Vase of Flowers_ all have a thick ground, composed of one to three layers. It is likely Seurat bought a proprietary pigment mixture containing lead white, barium sulfate and a small amount of yellow ocher from which he made his ground. As noted by Leslie Carlyle, lead white was often adulterated with materials such as starch, chalk, powdered talc, gypsum, various “chalky earths,” and barium sulfate (2001, 513–515). These different materials were frequently added to reduce the cost of production of lead white or even to help prevent the darkening of lead white by polluted air (hydrogen sulphide). In addition, barium sulfate was often listed as a substantial ingredient in various whites; for example, Venetian white could consist of 50% barium sulfate or Dutch white, which could have 75% barium sulfate (Carlyle 2001, 513–515). Furthermore, in the 19th-century, light-colored grounds, either white or cream colored were preferred. For this reason, yellow ocher would often be used to tone the ground to an appropriate color.

In general, Seurat tended to use light-colored or white grounds. In some cases, he used commercially primed canvases and then applied his own ground on top.

On some of Seurat’s later finished paintings, dating from 1883 to 1890, commercially applied grounds were identified, which it seems, he tended to favor (Kirby et al. 2003, 5 [Table 1] and 17–19). In the few cases in which the ground was completely artist-applied, the layer(s) were composed of chalk, lead white or a combination of the two. Furthermore, silica was identified in a few of these ground layers.

3.1.2 The Paint Layering System and Technical Application Methods

Unlike Seurat’s academic or finished paintings, no underdrawing was found with IR, nor were reserves used on _Vase of Flowers_. In general, throughout his artistic career, Seurat left reserves for principal elements of a composition on finished works and even on some sketches, though his use of preparatory drawings, painted sketches, and reserves was not consistent. In _Bathers at Asnières_ for example, a preliminary drawing in charcoal or conté was found, and he left reserves for main elements. On _A Sunday on the Island of La Grande Jatte_, Seurat used a grid system drawn in black conté that helped delineate the composition. In his late technique, Seurat would sometimes use cobalt blue for a preparatory sketch or to outline a design area.

In the painted structure of _Vase of Flowers_, one of the lower, visible layers is a light tan layer. It is visible throughout the composition, especially in the table. Although it is the lowest visible layer, it was not necessarily painted directly on top of the ground. Next, a green layer was painted that extends into the background and under the bouquet (fig. 2). The background was then painted on top of the green layer, used to define the shape of the leaves and bouquet (fig. 3). In figure 3, it is clear that the pink strokes of the background are on top of the green paint layers. In figure 4, the yellow arrows indicate the different layers: layered on top of the green layers (1) is the bouquet (2), then on top of the background (3), is the deep blue halo (4).
Cross sections also helped to better understand the layering structure of the painting. In cross section 2, Figure 5, taken from the impasto on the right edge of the painting, the bottom half of the section is composed of many thin green layers that make up the green leaves, while the upper half of the cross section, the blue and red layers, compose the background.

This complexity of layering is not unique to *Vase of Flowers*; other works, such as *Bathers at Asnières* show similar paint structures. Rather than complex paint mixtures, Seurat superimposed many thin transparent or semi-transparent paint layers. In addition, cross-sections show that many of the layers were applied wet-in-wet, such as the yellow-green layers that compose the green leaves in cross section 2. There is, however, a distinct boundary in the same cross section between the green layers and blue/red layers, indicating Seurat allowed enough time to pass for the green paint layers to dry and a skin to form before applying the violet shades of the background.

One of the distinguishing characteristics of Seurat’s layering system in *Vase of Flowers* is the strong prominent brushwork throughout most of the composition. Visually, this is most obvious in the center of the painting (fig. 6). This brushwork
has no correlation to the painted objects within the composition and from cross sections, it is clear this layer is not a ground layer. As seen in cross section 2, Figure 5, this brushworking is found in between other paint layers: The small patches of white paint between the greenish and red layers are that prominent brushwork.

This brushworking was used as part of Seurat’s technique of sanding or abrading away the top paint layers when the paint was dry or stiff enough to create distinct edges. Full examination of the painted surface under magnification helped to prove that this feature was not due to overcleaning; rather, Seurat used a strategic and complex layering system on top of the brushwork, to intentionally reveal layers below. Figure 7 helps to illustrate the strategic abrasion of layers and the layering system used by Seurat over the prominent brushwork. After Seurat applied the first round of blue and green glazes, he sanded the surface to reveal the paint layers below and specific colors side by side. In Figure 7, the white brushwork was exposed (indicated by the red arrows), leaving green/blue glazes to the left and right of the peak (indicated by the green arrows), which are then surrounded by the tan paint layer (indicated by the orange arrows). After this process, he further reworked the area by painting more blue and green glazes on top of some of the exposed areas. This is most easily seen in the top left corner of Figure 7 (indicated by the cyan arrows).
The flattened top of the peak indicates the deliberate exposure of the area, revealing the blues and greens layers. Lastly, from SEM–EDS analysis performed on cross sections, the composition of the paint mixture used for the brushworking is similar to the composition of the ground layer, containing both lead white and barium sulfate.

From examination of other early works, there is evidence that Seurat used this technique on other paintings. For example, on *The Forest at Pontaubert* [oil on canvas, 1881, 31 1/8 × 24 5/8 in. (79.1 × 62.5cm), The Metropolitan Museum of Art, New York], near the bottom left corner and middle of the painting, it appears that lower yellow paint layers were revealed after scraping away layers of green.

### 3.1.3 Compositional Changes, Re-Working and Other Interesting Features

Examination of the x-ray radiograph helped to identify a number of interesting features, including compositional changes and evidence of reworking of the composition (fig. 9). Compositional changes include the shape of the table on the bottom left and adjustment of highlights on the vase and table, which were made larger in the final composition. Areas of re-working include the left side of the bouquet, identifiable in the x-ray radiograph by the denser build up of paint.

There are a number of clumps of impasto along the left, top, and right edges of the painting, which are visible in both normal light as well as in the x-ray radiograph. In the latter they appear white, indicating they are composed of a dense material. Even though these areas do not contribute to the composition, moating clearly suggests they were present when the painting was lined. The paint on top of them is seamless with the background, and there is no evidence that they were painted at a different time. The strongest argument for their presence is that as Seurat was applying the ground layer, he wiped excess paint from his brush on the edge of the painting leaving this buildup. This suggests that *Vase of Flowers* may have been a study, never intended to be a finished work of art.

Lastly, in the x-ray radiograph, creases along the edges of the painting that follow the edges of the impasto are visible. Like the impasto, this feature doesn’t correlate to anything on the face of the painting. Although examination of the
edges of the canvas is limited due to paper tape that covers them, it is possible that the creases indicate the original fold of the tacking margin. It is likely that when the painting was lined, the tacking margins were flattened and the composition enlarged.

3.2 MOCK-UPS

To better understand the unusual and prominent diagonally crisscrossed texture found throughout the painting and definitively prove that a similar surface could be achieved through technical means and not by overcleaning, mock-ups were made using canvas board and oil paint (fig. 10).

The canvas board used for the mock-ups came prestretched and primed with an acrylic gesso. Ultimately, titanium white paint was used to create the prominent brushwork, though tests were also made using lead white paint. The lead white paint tended to settle out rather than hold any strong peaks, which are key to the overall effect Seurat created. Despite that titanium white is not consistent with Seurat’s palette, it was used to help achieve the best results. Various contrasting colors such as cadmium yellow, cobalt blue, and brown earth were chosen for layering on top of the titanium white.

The prominent underlying brushwork was easy to create with a good stiff bristle brush, though the overall effect of the abraded paint was more difficult. Contrary to what was originally expected, it was by sanding the paint layers after they were completely dry, using a circular motion, rather than by scraping them while wet or semi-dry, that a surface similar to Seurat’s was achieved (fig. 11).

Tests were made daily as the prominent brushwork dried, by scraping the surface with a palette knife, razor or other sharp implement. This only resulted in smushing the peaks of the brushwork over the surface or lifting the skin that formed as it dried. Furthermore, the paint surface of the brushwork had to be dry enough and have formed a thick enough skin before any colored layers could be applied. If the colored layers were applied too soon, they would disrupt and blend into the brushwork below. The only method that preserved the peaks of the brushwork and colored paint layers was by sanding the layers once completely dry. Even at this stage, when a palette knife or razor was used, it tended to abrade the whole surface and pull at it unevenly. The quality of Seurat’s paint surface appears fine and intentional, while the effects achieved on the mock-ups using a palette knife or razor were clumsy and resulted in an ungainly surface.

During attempts to recreate the quality of Seurat’s paint surface, the direction that the surface on the mock-ups was sanded made a difference in the overall effect of the revealed paint. Neither by solely sanding the surface against or in the direction of the prominent brushwork resulted in a surface similar to Seurat’s; however, the effect was achieved by sanding the surface in a slightly circular or curved stroke and lifting the sandpaper after each stroke (rather than sanding the surface back and forth repeatedly).
3.3 MATERIALS IDENTIFICATION: PALETTE

3.3.1 Seurat’s Mature Palette

By 1886, when Seurat finished *A Sunday on the Island of La Grande Jatte* and was working in his mature style, he developed and was dedicated to a limited palette. He used only pure spectral tube colors, laid out according to their order on the color wheel. Only adjacent colors on the palette could be mixed, never a color that was further away, this would muddy the color. Relative to Seurat’s mature technique, in which his paint mixtures within a layer tend to be very simple, typically containing only one or two pigments, the paint layers in *Vase of Flowers* are much more complex, containing more pigments mixed within each layer. In Seurat’s layering technique, he layered simple paint mixtures or glazes to create a specific color or effect, rather than adjusting a color by adding more pigments.

Analysis of paint samples from Seurat’s oeuvre by Kirby et al., indicate that he tended to use high quality materials, those that were not cheapened by the addition of extenders, cheap materials or fugitive pigments (2003, 19–27).

Seurat’s palette was found in his studio after his death but it has never been analyzed. However, from numerous technical studies his specific pigment choices are known. In general, he only used two red, greens, blue, yellows, which were placed in the first row on the palette. These pigments are placed on the palette from the top left corner to the top right corner: chrome yellow, emerald green, viridian, cobalt blue, French ultramarine; a mixed purple (ultramarine and red lake), madder lake, a mixed red (red lake and vermillion), vermillion, a mixed orange (vermillion and chrome yellow), and cadmium yellow. Below these pigments is a second row, a series of tones, the same spectral colors mixed with lead white, and last, below this is a third row that consists of daubs of pure lead white for mixing.

In a second version of the letter Seurat wrote to Félix Fénéon in 1890, he stated that he gave up the use of earth pigments, including yellow ocher, red ocher, sienna-type earth pigments, and black pigments in 1882–1884 (Rewald 1962, 82; Kirby et al. 2003, 19–27). This statement was not entirely true; though Seurat abandoned the use of earth and black pigments in his mature palette, yellow ochre has been identified in a few of his later works.

3.3.2 Pigment identification of *Vase of Flowers*

Pigment identification on cross sections was mainly carried out through SEM–EDS and XRF analysis. Cross sections were taken either from areas of active paint flaking or cracked paint. Throughout this section, please refer to cross section 2, Figure 4, in bright field illumination and Figure 12, cross section 2 in UV-induced fluorescence.

Through mainly SEM–EDS analysis, a chrome-based green was identified, though no emerald green or other green pigments were found. Rather than the chrome or cadmium yellow pigments Seurat favored in his mature style, the only yellow pigment present in the cross sections taken are thin rectangular particles of Indian yellow. The particles characteristically fluoresce like Indian yellow, and in SEM–EDS analysis, magnesium was identified. The principle constituents of Indian yellow are calcium and magnesium salts of euxanthic acid, the active principle of mango leaves (Feller et al., 1986, 17–21). While the identification of Indian yellow in cross sections was unexpected, it is not entirely unlikely. The pigment was still available to artists throughout the 19th century; it wasn’t until 1908 that the Indian government prohibited the pigment’s manufacture on inhuman grounds (Feller et al., 1986, 17–21). Furthermore, according to Merimee, in 1830, French supplies of Indian yellow were obtained through the English (de Graaff et al. 1991, 76–85; Kirby et al. 2003, 34). Although this pigment was not generally used by impressionist artists, it was identified in paintings by German 19th-century artists (Kühn 1975, 111). Lastly, pigments of yellow organic dyestuff on a lead white substrate were identified in a number of paintings by Seurat in a survey conducted by the National Gallery, London (Kirby et al.}

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Figure 12. Cross section 2 under ultraviolet induced fluorescence
The yellow dyestuff first appears on *Bathers at Asnières*, though it was used only sporadically afterwards.

As in the actual palette, two blue pigments were identified, both cobalt blue and ultramarine. The cobalt blue is identifiable by its larger particle size, though it seems it was used more sparingly than ultramarine blue, which composes the bulk of the upper blue layers in cross section 2.

Three different red pigments were identified in cross sections: vermillion and two different types of red lake, which is consistent with Seurat’s mature palette. SEM–EDS identified particles of vermillion throughout the cross sections, which are also identifiable by their orange-red color in normal light and lack of fluorescence under UV radiation. The two different red lakes were identified by their difference in fluorescence under UV radiation; some particles fluoresced a bright salmon-pink color whereas others had no fluorescence. The former’s colored fluorescence is indicative of the plant-based red lake, madder, while the latter is most likely an insect-based lake, known for its lack of fluorescence. The insect-based lake composes the red glazes in the upper portion of cross section 2 and is also found mixed with ultramarine throughout, to make a purplish color. This is typical of Seurat throughout his oeuvre; he preferentially mixed a red lake with ultramarine blue rather than vermillion to produce violet tones.

Previous studies have suggested that certain color combinations often found in Seurat’s cross sections may have been supplied by a colorman (Kirby et al. 2003, 21–22.). This may include the ultramarine blue and red lake mixture, as well as a green mixture identified in other paintings that included viridian with a touch of chrome yellow and lead white. The later was not found in *Vase of Flowers*. Instead, viridian or another chrome-based green was mixed with Indian yellow.

Although Seurat is known to have used both carbon and bone black during the first half of his career, only a few particles of carbon black were identified in the cross sections taken. Similarly, SEM–EDS only identified areas of higher iron content, not individual particles, which indicates the use of some earth pigments but not a great deal. With XRF analysis, a large peak for iron was identified in the small red-brown stroke of paint in the bottom left corner of the vase. This may be a mixture of a red earth with a small amount of vermillion.

4. APPLYING THEORIES TO VASE OF FLOWERS

Understanding the point at which Seurat was in his artistic career when he painted *Vase of Flowers*, the aesthetic and scientific influences he pursued at the time, as well as the technical quality of the painting itself helps to appreciate Seurat’s application of scientific theory. In Seurat’s diary, he took notes, and copied quotes and diagrams from the writings of those that influenced him. One such passage that interested Seurat is from a section of Chevreul’s book that focused on creating harmony of color by following the laws of simultaneous contrast of color and tone:

To place color on a canvas is not just to colour with this colour that part of the canvas to which the pigment has been applied; it is also to colour the surrounding space with the complement color…to place white next to a colour is to heighten its tone, it is tantamount to removing from the color the white light that diminishes its intensity…to place a dark colour next to a different, lighter colour is to heighten the tone of the first and to dampen that of the second, independently of the change that result from the mixture of the complementsaries (Zimmermann and Seurat 1991, 44).

For *Vase of Flowers*, Seurat must have been thinking about Blanc’s and Chevreul’s theories on color placement, as well as Delacroix’s pairing of opposite colors. Seurat uses staggered broken and directional paint strokes of contrasting colors in the background, juxtaposing shades of deep red and pink, alongside shades of a deep blue and a lighter blue (refer to fig. 2). As Blanc described, Seurat places complementary colors alongside one another to produce the most striking optical mixture or maximum contrast as Chevreul stated in his laws of simultaneous contrast of color and tone.

Delacroix also used divided color; choosing to never apply a color evenly, he broke color into separate tints and never blended them on the canvas. This can be seen not only throughout the background of *Vase of Flowers* but also in the bouquet of flowers, in the different tints of reds (refer to fig. 4: the background of the backing). Following both Chevreul’s theories on simultaneous contrast of tone and Delacroix’s technique, Seurat juxtaposes tones of a color side by side to create a harmonious balance of color, as well as an effect more exciting to the eye than that of a single unified color (Homer 1964, 29–36). This technique of adjusting tones of a single color can also be found in the background, in which Seurat creates tonal contrast and a type of chiaroscuro effect with paint. Furthermore, also following in the vein of Delacroix’s work, Seurat places quick strokes of pale blues and yellows within the bouquet. This effect Seurat creates is the same he focuses on so accurately describing in his diary about paintings by Delacroix.

Also inspired by Blanc’s recommendation of “gradation” and the arrangement of dark and light, Seurat uses shorter crisscrossing brushstrokes of partially mixed paint, as seen in Figure 4. This type of brushstroke is common in Seurat’s early work, though as his style progresses; it is a technique reserved mainly for painted studies.
In *Vase of Flowers*, Seurat explored what Sutter called “irradiation” in several passages of the painting. Irradiation, the luminous phenomenon that creates separation between two forms, producing high relief, was created by the deep blue halo that contrasts with the red flowers and background. This halo extends to surround the vase and table as well, further defining the forms that compose the still life and creating spatial depth within the composition (refer to fig. 1). The lighter highlights that Seurat placed on the edges of the vase and tablecloth intensifies the luminous quality of the blue halo (refer to fig. 1). Furthermore, this effect is commonplace throughout Seurat's oeuvre and late works such *Young Woman Powdering Herself*.

In using the scraping technique, Seurat also applies Chevreul’s and Blanc’s theory to canvas, just on a very small scale. He creates optical mixtures of contrasting tone as seen in Figure 7, or optical mixtures of contrasting color with the pinks and pale blues as seen in Figure 13.

As Seurat develops his technique, many of the elements seen in *Vase of Flowers* remain; the execution of them just becomes more refined. This difference can be seen for example in the way Seurat achieves the effect of irradiation in *Vase of Flowers* versus *Young Woman Powdering Herself*. In the former, the dark blue halo is painted in larger brushstrokes that abruptly and boldly contrast with the colors of the background. On the other hand, in *Young Woman Powdering Herself*, the brushstrokes are much smaller and finer, applied in the form of tiny dots. Furthermore, the dots are optically blended with the background in such a way that renders the colors softer and more gently graduated.

5. CONCLUSIONS

Seurat was a meticulous artist. He used materials and methods of paint application as a means of integrating theoretical concepts into his paintings. In his early use of such techniques as divided or crisscrossing brushwork and the scraping away of paint, we observe the development of pointillism and Seurat’s creation of an aesthetic. In *Vase of Flowers*, Seurat applied thin dashes of color of varying length next to one another without blending or mixing on canvas, which developed into a smaller and tighter paint application of small dots or strokes of divided color later in his career.

At this early point in Seurat’s career, as he searched for the means to best create his “optical formula,” his techniques of paint application were somewhat experimental. His early research led him to prefer particular pigments for their optical effect and his pigment choices for *Vase of Flowers* indicates that the use of pure spectral colors became ingrained from the beginning of his career. Seurat seemed to be experimenting with a number of different techniques in *Vase of Flowers*, though there was reason and theory behind every choice. *Vase of Flowers* can be viewed as a stepping-stone in Seurat’s career, as he worked toward Pointillism.

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Figure 13. Photomicrograph at 25× of decoration on the vase from *Vase of Flowers*, highlighting the optical mixtures of contrasting color with the pinks and pale blues.
NOTES


2. In the letter Seurat wrote to Félix Fénéon dated June 20, 1890, he uses the words “optical formula.” Georges Seurat, Letter to Félix Fénéon June 20, 1890, in the collection of César de Hauke. Herbert et al. 1991. Appendix E.3.

3. See Notes and References section of Kirby et al. 2003, 34; Note 44: The pigment analyzed in the study is described as an “intense bright yellow, with no tendency toward green or orange.”

4. While this effect doesn’t seem as strong compared to Seurat’s other works, it is important to note that the discolored varnish on Vase of Flowers greatly mitigates Seurat’s desired effect.

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ADDITIONAL SOURCES CONSULTED


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The Reconsideration of a Reattribution: *Pierre-Edouard Baranowski* by Amedeo Modigliani

**ABSTRACT**

The attribution of the portrait of *Pierre-Edouard Baranowski* by Amedeo Modigliani in the Fine Arts Museums of San Francisco has been questioned during its history in the collection and was ultimately deemed a forgery in the 1990s. A new technical study took place in 2011–2012. It was found through the examination and comparison with works by the artist in other collections that many of the idiosyncrasies of the painting that were initially taken as signs that it is not authentic are the very reasons for a favorable attribution. In the course of the study, the enormous influence that bias can play in the approach toward research was recognized.

The *Portrait of Pierre-Edouard Baranowski* was painted by Amedeo Modigliani in 1918 (fig. 1). For much of its history, it was in the collection of Robert and Lisa Sainsbury in England, who purchased it for each other as a wedding gift in 1937. They sold the painting in 1999 through Sotheby’s for just over 7.1 million dollars (Sotheby’s 1998). More recently it was up for sale at Christie’s in November 2013 with an estimate of 25–35 million dollars (Christie’s 2013). Throughout this article, this work will be referred to as the ex-Sainsbury painting.

M. Baranowski was a fellow painter and Polish émigré who lived in Modigliani’s neighborhood of Montparnasse. He exhibited regularly in Paris in the 1920s, but it is his appearance as documented by Modigliani for which he is remembered. This portrait is a perfect example of all the characteristics associated with portraits by this artist such as elegant lines, stylized form, and vacant blue eyes.

The painting was first owned by Modigliani’s dealer and friend Leopold Zborowski, and it has a very clear provenance before being purchased by the Sainsbury’s (Christie’s 2013). It has a long exhibition history, beginning in 1925 at the Galerie Bing in Paris, and even longer number of listings in the literature on the artist (Christie’s 2013).

Another version of the portrait of *Pierre-Edouard Baranowski* (fig. 2) belongs to the Fine Arts Museums of San Francisco. The painting entered the collection in 1981 as a gift of Marian Walter Sinton, who had in turn purchased it from the Thannhauser Gallery in New York in 1953. Nothing was
known of its earlier provenance when it entered the Museums’ collection. Although two paintings of Baranowski are listed in the earliest catalogue raisonné, which dates from 1929 and was updated in 1956, they are both listed as on canvas, and the San Francisco work is painted on hardboard (Pfannstiel 1929; Pfannstiel 1956). Only the ex-Sainsbury painting appears in subsequent catalogues raisonnés.

Soon after its acquisition, there is a clear indication in the curatorial file that there was some question about the attribution among the Museums’ curatorial staff. With suspicions raised, further opinions from experts were sought. In 1989, the New York dealer Klaus Perls responded to a curatorial query “[N]o, I am quite certain in my mind that Modigliani did NOT paint this” (Perls 1989). The same year the Swiss dealer Ernst Beyler wrote that is was “very doubtful” that the San Francisco painting was by the artist. He felt that it is too sentimental and “there are also some details which show a hesitating hand [and there is] one ear which is wrongly placed” (Beyler1989). Five other scholars and dealers are mentioned in the files as stating that the painting did not appear to be right.

The fact that the portrait did not appear in the catalogue raisonné produced by Ambrogio Ceroni in 1958 and updated in 1970 was also problematic because it is the one catalog that is generally agreed to not be corrupted by forgeries (Ceroni 1958; Ceroni and Piccioni 1970). The major auction houses will not accept a painting attributed to Modigliani unless it is in Ceroni or it has an absolutely impeccable provenance. The provenance research with the Fine Arts Museums’ portrait hit a dead end at the time with no information that could be found predating the Thannhauser Gallery.

The painting was X-rayed in 1987 (fig. 3). A letter in the curatorial file noted that there appeared to be two large eyes and a mouth underlying the portrait but that it was difficult to determine anything else (Moffet, n.d.). An underlying

Figure 2. Amedeo Modigliani, Pierre-Edouard Baranowski, ca. 1917, oil on hardboard, 24 3/8 X 18 in. (62 X 45.5 cm), The Fine Arts Museums of San Francisco

Figure 3. Amedeo Modigliani, Pierre-Edouard Baranowski, The Fine Arts Museums of San Francisco; x-ray radiograph taken in 2011 with the cradle filled with Elvacite 2046
The Reconsideration of a Reattribution: Pierre Edouard Baranowski by Amedeo Modigliani

Small mouth. Interestingly, both gold-colored metallic foil and gold-colored paint were found in several areas of the first painting. The portrait is painted directly on top of this earlier work with no interlayer ground or imprimatura. It appears that the contours of the face and clothing were first delineated with brushstrokes of blue-gray paint directly over the earlier painting (fig. 5). The modeling of the face was built up with stiff paint applied in brushmark dabs and dragged strokes in a variety of tones and colors. The background was painted more broadly but also makes use of the stiff paint consistency. The artist left a gap in between the different regions such as the face and background. Areas of the fiberboard support are visible through the medium-rich black of the sitter’s jacket (fig. 6). Fingerprints pressed in the paint in handling by the artist are visible around the sides and top edge as well as on the forehead (fig. 7).

The paint has had a tendency to flake from the earlier paint layers, and there is an extremely early campaign of liberally

Figure 4. Amedeo Modigliani, Pierre-Edouard Baranowski, The Fine Arts Museums of San Francisco. Reflectance transformation image
applied cool-toned pink that covers small paint losses (fig. 8). This pink dramatically alters the coloration of the face; however, no interlayer varnish or grime layer could be detected in cross-section, and at this point the possibility that this paint was applied by the artist cannot be ruled out.

Modigliani died in January of 1920, and it was quickly established with handheld XRF that there did not appear to be any red flags like cadmium red or titanium white in the painting (Eastaugh et al 2004). The hardboard support was a brief concern because it looked like Masonite, which was not invented until 1924; however, a quick query on the Paintings Specialty Group distlist provided helpful information that pressed wood pulp fiberboard indeed would have been available at least from the late 19th century (Urry to Effmann Clifford 2011; Favero to Effmann Clifford 2011). It also
The Reconsideration of a Reattribution: Pierre Edouard Baranowski by Amedeo Modigliani

by Amedeo Modigliani exhibition at the Musée d’art Moderne in Paris (Delbourgo and Faillant-Dumas 1981). A technical study of what turned out to be a forged Modigliani was published in the article in the conservation journal of the Reina Sofia in 2007 (García Hernández 2007).

What became very clear from speaking with conservators who have paintings by Modigliani in their collections as well as from studying the various catalogues is that, although the artist is associated with having a signature style, there is far more variation in his paint handling that has often been acknowledged. The heavier buildup of paint and dabbed brushwork in the Fine Arts Museums’ painting that is so different from the thin fluidity of the ex-Sainsbury work is not in itself a valid reason for discounting our portrait. In fact, the rough and thick paint application of the San Francisco painting can reasonably be explained by the technical need to cover the raised impasto and dark tonality of the underlying work.

The initial definition as well as later reinforcement of the figure with long slender brushmarks is actually very characteristic of Modigliani’s technique. Most frequently for the artist, this was done in black or a dark-colored paint; however, because parts of the underlying painting in San Francisco are dark in tone, it makes sense that the artist would choose a gray-blue paint. Likewise, the gap between the compositional elements is also characteristic of Modigliani’s technique. This gap often is visible in the X-radiograph appearing as clearly defined contours around the figurative elements. This is the case in the Fine Arts Museums’ painting. Although it may have less in common in paint application with the Sainsbury painting, it does have striking similarities with other works such as Portrait of a Woman in the Art Institute of Chicago and Tototé de la gaité in a private collection.

The condition has also impacted the reading of the painting. The lamination with heat and pressure of the hardboard to a second board subtly but significantly altered the surface texture of the paint giving it a flatter appearance. It seems likely that this factor as well as the tendencies of the paint to flake, multiple retouching campaigns, and a thick discolored varnish, led to the earlier suspicions that the surface may have been intentionally distressed.

As the study of the Fine Arts Museums’ painting progressed, the technical findings appeared to actually support the conclusion that the painting is by Modigliani. It could not be thought of as a copy because the sitter’s head is in a more frontal position. The paint handling, although different from Modigliani’s more thinly painted works on canvas, does have parallels with other works. It was felt by the author that a forged Modigliani would look more like someone’s idea of what a Modigliani should look like rather than a complexly

became apparent that there were numerous errors in the media listed in Ceroni and the other catalogues raisonnés. Although in 1994, the curatorial report noted that the use of hardboard was not common for Modigliani, it was actually more prevalent in his work than was previously known.

As had been mentioned in the previous conservation report, the underlying painting appears to have similarities with Modigliani’s sculptures, drawings, and paintings of highly stylized figures and heads from roughly 1910 to 1914. Influenced by African art, Cambodian sculpture, Greek caryatids, as well as Constantin Brancusi, Modigliani was focused far more on sculpture than on two-dimensional works in these early years of his career (fig. 9). Some of these lesser-known works related to his sculptures are on a hardboard support.3

There is surprisingly little published on Modigliani’s technique and much of scholarship focusing on attribution is dependent largely on connoisseurship. The largest technical study comparing multiple works was made in 1981 in conjunction with an

Figure 9. Amedeo Modigliani, Head of a Woman, 1910/1911, limestone, 25 7/16 × 7 15/16 × 9 3/4 in. (65.2 × 19 × 24.8 cm), The National Gallery of Art, Washington D.C.
layered and idiosyncratic painting like the Fine Arts Museums’ work. It also seemed unlikely that a forger would use a hardboard of the type used by the artist with an underlying painting that appears to be related to his earlier but less known works. In addition, a forger intent on making a painting that could pass for a Modigliani also likely would be aware that fingerprints left behind could be used in comparisons with those found on other works by the artist.  

In the fall of 2012, the painting was sent to Marc Restellini at the Wildenstein Institute in Paris and he declared the painting to be “c’est magnifique” and that it would be included in his catalogue raisonné (Restellini 2012).

Since then, the provenance has been traced back almost to the artist. The Fine Arts Museums’ Modigliani was published in 1934 in a catalogue for the auction of Baron Adolf Kohner, a Hungarian businessman and collector (Pogány 1934). He purchased the painting from the Galerie Zak in Paris in 1930. A letter of authentication from the gallery notes that it had been purchased from a Mme. Jeane Renouard, who knew the artist (Zak 1934). This may be Jeanne Renouardt who was an actress and owned at least one other painting by Modigliani.

It is easy to look back at the confident statements of experts and curators that discounted the Fine Arts Museums’ painting and be critical of the reasoning that went into such assertions. However, it is only with the bias of hindsight that the authenticity of the San Francisco painting seems so clear. As I was reviewing the history of the demotion and reattribution of this painting, I began to think about the different places where bias seemed to creep into the story. I began to look into this topic and found that bias has been a rich field of research by social and cognitive psychologists since the early 1970s, although it has very seldom been applied to the visual arts. This is a huge field of study, and it is only possible to address a few aspects of it in this article.

Increasingly researchers in psychology have recognized that the mind can be described as running two separate systems of thought—one that is quick, reactive, and intuitive and the other that is slower, reflective, and conscious (Kahneman 2011). These dual processes have been given a number of different names by various people, but here I will call them the intuitive system and the reasoning one. The intuitive system is the one at work when we sense anger in a voice, have the answer pop up when you hear $2 + 2 = ?$, or read two lines in Figure 10 as being of different length. The reasoning system is the one that searches your memory to identify the artist in Figure 11 and count the number of people in the background, or recheck the length of these lines and see that they are the same size (fig. 10). Both systems are essential to how people function but it has been found through experiments that some of the mental short cuts people make in the first system can lead to predictable errors or biases in the second system, and that sometimes people lack the skill or training to reason effectively.

The mental short cuts, also known as heuristics, serve to help us make quick decisions based on things we know and have experienced without having to research and analyze each new situation. However, this intuitive system can discard or suppress information that is ambiguous or inconsistent without us even realizing it. We have the propensity to form judgments based on the information immediately available to us and our mind may be predisposed to jump to conclusions using that information without questioning whether it is accurate, incomplete, or irrelevant. Our drive to resolve ambiguities and return to a state of cognitive ease is strong.

I’ve been sorting out at which points bias came into play in the story of our Modigliani, where that bias stemmed from, and what errors in reasoning resulted. The first introduction to a painting is of course as a visual experience. One is likely to
have an immediate reaction of liking or disliking an artwork, and we also often start comparing the work to others. If you think back to the beginning of this article, your mind was probably already at work deciding if you liked one painting better than the other and how they were alike and different. You also likely felt your mind recalling other paintings by the artist to start judging the status of the San Francisco painting. You didn’t have enough information to make any kind of judgment and yet likely your mind was already trying to make one. Your initial opinion would also have been affected if the title of this article referred to the painting as “Attributed to Amedeo Modigliani” rather than as solidly by the artist.

Modigliani has a reputation as one of the most forged artists of the 20th century. I believe that it is safe to hypothesize that this factor played a key role in the analysis. It has been acknowledged for some time that the issue of forgeries of his work has been a huge impediment to the scholarly study of his oeuvre. For instance, Ambrogio Ceroni’s catalogue raisonné that was mentioned earlier only contains works that he saw in person omitting almost all the paintings that were in America at the time when he was writing. However, the fear of forgeries has made auction houses and dealers extraordinarily cautious, declining to touch any work not included.

Forgeries of Modigliani also were made very public by the well-known fakes made by Elnyr de Hory from the late 1940s through the 1960s. His story was recounted in the book Fake! published in 1969, and a movie about the scandal was made by Orson Welles in 1974 (Irving 1969). Klaus Perls, the expert consulted about our painting, was actually both de Hory’s first dupe in America when he purchased a forged Picasso gouache in 1947 and also one of the key people involved in unmasking de Hory as the forger of numerous works in Alger Meadow’s collection twenty years later. I feel comfortable speculating that these prior experiences primed Perls for being cautious as well as skeptical in the face of paintings that didn’t look comfortably like the artist’s archetypal works. Another interesting aspect of the expert opinion that must be kept in mind is that there is much lower risk to an expert’s reputation in saying that something isn’t authentic and later being proved wrong than saying it is authentic and being proved wrong.

The direct on-site comparison of the San Francisco and ex-Sainsbury paintings ended up being overweighted in the final analysis. In this case, it appears that the psychological phenomenon of attribute substitution may have been at work. The larger question of if the painting is genuine was replaced by the easier question to answer: “Does it look like the other painting?” With minds primed by expert opinions and an interest in drawing a conclusion from the immediately available data, confirmation bias was also likely at play. Only the information that supported the conclusion that the painting was a forgery was used in the final analysis and relevant information that did not fit was discarded, such as the underlying painting and the fingerprints.

As I began to compose the talk that became this article, I wrote: “From the beginning of my interaction with the painting, I was hyper-aware of my own biases.” I wanted to double-check this memory and I was stunned when I reviewed my earliest e-mails to other conservators as I began this investigation. In one I wrote: “Everyone who has looked at it agrees that it is crudely rendered.” (personal communication; Effmann Clifford to Duvernois 2011). And to my horror, wrote to another: “I am revisiting our Modigliani that is not a Modigliani—it has long been discounted but I’m putting together the technical info to put the nail in the coffin.” (personal communication; Effmann Clifford to Urry 2011). Clearly, I was writing my lecture under hindsight bias—not aware of how biased I actually was when I started. I was primed by the earlier study that had declared it to be a forgery and unbeknownst to me, my drive going into the investigation was to confirm these preconceptions. I also think that my initial negative reaction to the painting was formed by my intuitive response to it, because it simply isn’t my favorite painting.

The overconfidence effect is a bias category of its own and a common thread throughout the story. The same phenomenon that led Klaus Perls to state that he was quite certain that Modigliani did not paint our painting, also led a former curator to state that he personally had little doubt that it was a forgery, and also compelled me to write that I was investigating our Modigliani that is not a Modigliani. In each case, only information that supported this conclusion was brought into consideration. As objective as we, as conservators, try to be in our assessment of works of art, so much of visual examination and interpretation is subjective and our biases are very much a part of everything we do and see. I know for myself now to slow down and pay extra attention to my conclusions if I find myself saying or writing that “I have no doubt” or “I feel quite sure.”

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NOTES

1. Although the production of titanium white began on a commercial scale in Norway in 1916, its use the following year by Modigliani would be unlikely. Cadmium red (cadmium sulfoselenide) was first introduced in 1910, but it was not until 1919 that it became widely available.

2. Portrait of a Woman in the collection of the Art Institute of Chicago is on a board that that appears to be similar to the support of the Fine Arts Museums’ painting.

3. The majority of these works, such as The Red Bust painted 1913, are in private collections.

4. Fingerprints have been used for criminal identification since the late 19th century. See: http://www.usmarshals.gov/usmsforkids/fingerprint_history.htm

5. Daniel Kahneman and Amos Tversky are the fathers of bias research. In the early 1970s, they published a series of seminal papers that established the field of study. Kahneman’s book is an excellent introduction to the field.

6. The painting is: Jacopo Tintoretto, The Worship of the Golden Calf, ca. 1560, oil on canvas, 62½ × 107 in. (159.1 × 271.8 cm), The National Gallery of Art, Washington D.C.

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STUDIO TIP: Vertical Support for Strip-Lining

The tacking edge support is just a piece of heritage board or foam-core scored, folded, and taped into a triangle shape and covered with silicon release paper. It enables you to apply adequate pressure to the tacking margin during BEVA film strip-lining without flattening the tacking edge.

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Figure 1. Folded cardboard tacking edge support covered with silicon paper

Figure 2. Using support to attach BEVA film and polyester strip-lining to the tacking margin of a painting
STUDIO TIP: Filling Ground Cracks Quickly

A quick method for filling ground or other fine cracks is to take a chunk of nearly dried out Modostuc and rub along the cracks. The Modostuc that clings to your finger or thumb is enough to fill hairline cracks. Brush or wipe off excess with a dry cleaning sponge or your finger. (Do not use this where burnishing of the paint film could be a problem.) On pale-colored paint films or grounds, retouching may not even be necessary.

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The painting had multiple layers of varnish on the surface. Testing indicated that the uppermost varnish was thick and difficult to penetrate safely without invading all the varnish layers and sensitive underlying paint. (This was confirmed by sample analysis of the paint and varnishes.)

However, because the upper varnish was extremely brittle and a soot/grime layer separated it from the underlying varnishes, it could be removed mechanically using pressure-sensitive tape. Several types of tape were tested, and the best was Scotch brand clear strapping tape. The tape was cut into small approximately 0.5 × 2 in. strips, placed on top of the varnished surface, rubbed to adhere it, and then gently pulled away with the varnish adhered to the tape. Most of the varnish released using this method; although, residual varnish residues were removed with a second application in localized areas or removed with a small scalpel. Once the varnish was removed, the remaining discolored varnish films could be removed with solvent mixtures and more traditional means.

The painting had been lined because of large planar distortions, so, when the tape was removed, the canvas did not flex and cause further damage to the paint and ground structure.

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Figure 1. Detail of tests along right edge
Figure 2. During uppermost varnish removal showing varnish removed on pressure-sensitive tape

Figure 3. After varnish removal showing powdery residues of resin varnish
STUDIO TIP: Cutting Polyester Batting for Stretcher Inserts

The author has always found it difficult to get a nice straight cut when working with polyester batting for stretcher inserts. This tip addresses that difficulty.

A laser level can be used to mark the cut line across the polyester batting without having to compress or distort the fluffy batting. The laser line is traced with a Sharpie marker and then the batting is cut along the line. Simple and straight (forward).

The scraps of polyester batting make excellent nonabrasive cleaning sponges. (An appropriate note as the topic of this year’s meeting (2014) was sustainability.)

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STUDIO TIP: An Affordable Microscope with Increased Working Distance

The author ordered a trinocular inspection microscope from Amscope, and rather than buying a packaged set, assembled a microscope from components more suited to our needs as painting conservators. The working distance of this microscope is 8 in. It is generally used for circuit board work. The magnification is 3x–90x. The cost of the entire package was less than $1000. The author was very happy with the optics and especially the ability to hold tools and work under magnification.

The author chose the articulated arm that attaches to the table surface, and the directional LED illumination, which is great for achieving raking light conditions as well as direct light, due to its independent 4-zone LED controller. Various DSLR camera adapters can be purchased to fit the trinocular port.

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Figure 1. Amscope trinocular microscope 3x–90x (inspection microscope) with 144 LED 4-zone directional ring light with articulated arm stand

Figure 2. LED light ring and controller
The Information on the Reverse of Paintings (IROP) database is a resource devoted to the documentation, compilation, and organization of stamps/stencils, inscriptions, labels, and wax seals commonly found on the reverse of paintings. This type of information can be very important for conservators and scholars in establishing dates, provenance, and even attribution; however, it is usually only stored in object files and not easily accessible to researchers. This database makes this material available, in searchable form, information and images submitted by contributors in the curatorial and conservation professions around the world. It will be an invaluable research tool and will encourage international collaboration between conservators, curators, and art historians in the study of paintings.

The database will be hosted on the website of the Fine Arts Museums of San Francisco. Contributors need to register to upload information, and users are expected to also be contributors. In the interest of security and permissions, a login will be required. Privacy settings will be adjustable to make the information available to the public or limit it to the user group. Images up to 30MB of the front, reverse, and individual marks will be able to be attached to each entry. Transcriptions of marks and key terms will enable the searching of unknown marks and seals. During the PSG Tips Session, it was announced that the database should enter beta testing by a small group of volunteers during the summer of 2014. For additional information please contact the author.

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1. IMAT AT A GLANCE

The creation of new, improved conservation materials and sophisticated instrumentation is of fundamental importance to the advancement of best practices in the field of art conservation. Yet, the tools currently available to conservators for heat transfer, an essential element for success in most structural treatments of paintings, works on paper, textiles and other cultural heritage assets, has remained relatively unchanged in recent decades.

The Intelligent Mobile Multipurpose Accurate Thermo-Electrical Device (IMAT) Research Project (2011–2014) responds to this need, filling a critical gap in the conservator’s toolbox for an instrument that provides accuracy, selectivity, and portability when the application of heat is required.

The IMAT Project has advanced cutting-edge technology of carbon nanotubes while designing a series of innovative, state-of-the-art precision instruments for mild heating, designed specifically for art conservation, in the form of ultra-thin profile, lightweight, flexible, transparent, and breathable mats. The heat source in the laminated mats is a conductive carbon nanotube film, custom-designed to perform within the conservation field’s operational parameters by nanotechnologists in the project consortium. The mats are driven by a programmable mobile touch screen console, also custom designed by the project, that gives the operator unprecedented control over the temperature and heating cycle, and allows the conservator to achieve a more nuanced and customized heating treatment that corresponds better to the current demands of our field. Although the IMAT is designed to provide uniquely uniform and steady heat up to the temperatures customarily required to activate thermoplastic conservation materials, of particular interest is the unsurpassed accuracy of the device at low temperature ranges (75°–125°F/24°–52°C), opening new possibilities in treatment methodology. Breathable mats have been designed to permit the migration of vapors and airflow so often used in combination with mild heating in conservation treatments.

The IMAT’s portability and low energy consumption make it an ideal multi-use instrument for work in the field and in the laboratory, indispensable for in situ treatment, for emergency response conditions, for treatment of large-scale works, and for work in locations with limited power supply or in areas of limited access. The EU funding of the research project has allowed the design to be manufactured at the lowest cost possible, fulfilling another important goal of the project to provide a high-performance tool that is also cost accessible.

The core of the project’s consortium is formed by art conservators, who have been involved during the design, development, and field-testing phases so as to gain the best insight into design improvements, to optimize the range of potential applications of the IMAT, and to formulate new conservation methodology associated with the new technology.

2. THE FIRST APPLICATION OF CARBON NANOTUBES IN CONSERVATION OF CULTURAL HERITAGE ASSETS

Ever since their discovery in 1991 carbon nanotubes (CNTs) have inspired scientists and developers of future technologies. This is due to the unique material properties of the one-atom-thin tubes composed of pure carbon. As widely recognized, single-wall nanotubes (SWCNT) consist of single seamless rolls of graphene, while multi-wall nanotubes (MWCNT) consist of two or more rolls. CNTs are the strongest and stiffest material known to man and perhaps the only material that may be someday eligible to design a futuristic space elevator that would not break by its own weight. On the basis of new industrial processes, cost-efficient mass
production has become viable and CNTs has triggered lively interest for application in cutting edge electronics, optics, and material engineering—50 000 times thinner than a human hair, with an E-modulus 10 times greater than steel, nanotubes are lightweight, flexible, and highly conductive. Perhaps one of the greatest technological potentials of CNTs at the present time lies in their highly efficient electrical properties to generate heat when electrical current is applied. For traditional materials, the change in temperature is usually slow and delayed due to their large thermal mass. In contrast, the thermal response of CNTs can be very fast even up to the incandescent state. To use these outstanding properties in art conservation, the IMAT research project was launched in 2011.

3. THE IMAT PROJECT UNDER THE EU'S SEVENTH FRAMEWORK PROGRAM FOR RESEARCH (FP7)

The IMAT project aims to resolve at its core the pressing need for mobile accurate heat transfer technology by inventing a long awaited mobile device, composed of flexible mild heating mats and precision controls that will bring the latest advances in carbon nanotube research to the service of art conservation. The IMAT Project (2011–2014), selected by the European Commission under the EU's Seventh Framework Program for Research (FP7) in the context of the EC-FP7 Environment Theme (ENV-NMP.2011.2.2-5), has advanced technology of carbon nanotubes while designing a series of flexible mats, designed specifically for heat accurate transfer, indispensable in various conservation treatments.

The IMAT research project is composed of a consortium of researchers from the fields of thermoelectrical engineering, nanomaterial science, and industrial design to join the conservators who conceived the IMAT project (and who will become the end users), conservation product retailers, and specialty publishers to form an interdisciplinary consortium. Università degli Studi di Firenze (UNIFI, Italy) is the coordinator of the project, which is led by paintings conservators Tomas Markevicius and Nina Olsson. UNIFI has developed the console and temperature controls for the new device. Future Carbon GMBH (Germany) is responsible for the development of the innovative nano-coatings, which is carried out in close collaboration with Sefar AG (Switzerland) and the UNIFI. Stichting Restauratie Atelier Limburg-SRAL (the Netherlands), Laura Amorosi (Italy), Lorenzo Conti (Italy), Lietuvos Dailės Muziejus (Lithuania) and Istituto per l’Arte e il Restauro Palazzo Spinelli (Italy) are responsible for the field testing of the IMAT technology. Nardini Press S.r.l. (Italy) will contribute in the dissemination and C.T.S. S.r.l. (Italy) in marketing to make the finished device available for conservators.

4. THE IMAT DESIGN

The IMAT is an entirely new heat-transfer device, unmatched by any other available heating tool in use in the field of conservation.

IMAT is

1. Portable, mobile, versatile, and selective (gives the possibility to apply heat selectively in the desired area)
2. Fast thermal response and highly accurate temperature control
3. Ultra-stable temperature and uniform heat distribution
4. Transparent or translucent
5. Permeable to gases: airflow, water vapors
6. Flexible with soft nontack surface, resistant to chemicals used in conservation and to physical stress factors related to frequent use
7. Low power needs, safe low voltage at 36V and 96V
8. Economically accessible

The IMAT device is composed of inter-exchangeable conductive flexible mats (heaters), made with CNTs or other nanomaterials, and an associated control unit (console) that also serves as a power outlet for the heater. The console includes an electrical “power box” that drives the heater, a digital touch screen console to control the heating process, and a wireless thermocouple (TC) that is connected to the console via a Bluetooth connection. The IMAT operates with a universal 110–230V input and has two separate power boxes that offer lower and safer voltage with galvanic insulation 36 V (for smaller heaters) and 96 V (for larger heaters). The controls will allow the target temperature to be set with an accuracy of 0.5°C, which is sufficient for most thermal treatments and will also allow the desired heating and cooling time to be programmed. The operating temperature was calculated up to 85°C, which exceeds the conservation treatment needs by 25%.

The following types of the IMAT heater are under development:

1. IMAT-S, or STANDARD, is an opaque and nonbreathable low-voltage heater with a soft and nontack silicone surface. The IMAT-S is intended for thermal treatments where visibility and breathability are not required.
2. IMAT-B, or BREATHABLE, is an open-mesh low-voltage heater with nontack silicone surface that allows airflow and water vapors to migrate during low temperature heat treatments.
3. IMAT-T, or TRANSPARENT, is a transparent low-voltage heater that allows for precision placement and monitoring of the paint surface during treatment.
The IMAT heater (mat) is flexible multilayered laminate composed of a substrate, covered first with a conductive nanomaterial coating, and then finished with an exterior protective coating, which also provides the nontack surface and electrical insulation. Each IMAT heater has integrated parallel electrodes and when voltage is applied, the current is uniformly distributed over the conductive layer of the nanomaterials and heat is instantly generated evenly over the entire surface. The IMAT heater has a soft, nontack, and smooth surface. In the research for the standard and breathable IMAT heaters, highly conductive multiwalled carbon nanotubes (MWCNT) are used. For the transparent heater, the research will focus on the use of single wall carbon nanotubes (SWCNT) and recently on silver nanowires (AgNW).

At the current stage of progress, a series of IMAT prototypes have been prepared and are being field tested in conservation studios in Italy, the Netherlands, Lithuania, and the United States.

5. CASE STUDY: TREATMENT OF LORENZO TIEPOLO, MARIA LUISA INFANTE DI SPAGNA, XVIII CENTURY, OIL ON CANVAS, 70 X 60 CM., GALLERIA PALATINA, PALAZZO PITTI NO. 706.

In Florence, Italy, consortium conservator Lorenzo Conti, in collaboration with Muriel Vervat, has employed the IMAT to reduce cupping on an unlined 18th-century painting on canvas, with slow humidification via a breathable membrane and subsequent application of low temperature over an extended period. The treatment is emblematic of the selective and targeted methodology that will be supported by the uniform, steady, and accurate heat transfer at low temperatures of the IMAT.

6. CONCLUSIONS

Today, the application of CNTs in the field of heat transfer remains a challenging task for CNT researchers globally. IMAT is the first application of carbon nanotubes in art conservation, but the results obtained could be applied in many other fields as well. As an end goal, the IMAT project will make the new technology based on carbon nanotubes and other nanomaterials available to conservators and scholars in multiple formats: through the presentation of research at conferences, open source publications, as well as through a dedicated website (www.imatproject.eu), workshops and symposia. The expected results of the IMAT project—offering to conservators an essential, sophisticated, yet simple-to-use technology and tool for their everyday needs, with its ambitious multifaceted aspects of joint effort in interdisciplinary exchange, diffusion of knowledge, and goal of improving the best practices of conservation of cultural heritage assets epitomize many broad goals addressed by conservators and conservation scientists today, and emphasizes, in particular, the need to continuously address and reevaluate the objectives and demands of the field, to integrate contemporary science with conservation practice and to affirm cultural heritage conservation and conservation research as a professional pursuit, fundamental for its role to society.

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