The AIC Painting Specialty Group

POSTPRINTS

VOLUME TWENTY-THREE 2010

The American Institute for Conservation of Historic and Artistic Works

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VOLUME TWENTY-THREE 2010

Papers Presented at the 38th Annual Meeting of the
American Institute for Conservation and Historic Works
Milwaukee, Wisconsin, May 11 – 14, 2010

Compiled by Barbara Buckley
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Cover photograph: Charles Prendergast, American, 1863–1948
Angels [detail], c. 1917, Tempera, graphite, silver and gold leaf on panel;
25 1/2 x 33 1/2 in. (64.8 x 85.1 cm), The Barnes Foundation, BF520
Photograph by Anya Shutov

AIC PAINTINGS SPECIALTY GROUP

POSTPRINTS
VOLUME 23 2010 ANNUAL MEETING

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PAINTINGS SPECIALTY GROUP

ERICA ESH JAMES

Anselm Kiefer's *Let a Thousand Flowers Bloom:* A Preventive Conservation Collaboration

ABSTRACT

The paper examines two topics. The first is Anselm Kiefer, whose work the author researched at the Museum of Fine Arts, Houston (MFAH). The second discusses how the Kiefer conservation project is reflective of greater collaboration within the field of painting conservation in general. The author ventures that the treatment of the Kiefer is indicative of a new mindset in the field of art conservation in general and if that mindset puts as much emphasis on treatment and continuing to advance the bench skills that set conservators apart, these skills will translate into the next generation with ease.

Let a Thousand Flowers Bloom, created in 2000 by Anselm Kiefer, is a painting whose multi-media composition defies standard preconceptions of how a painting ages. The presentation surface is composed of ten large chromagenic photographic panels attached to a primary support canvas with a lead-based (est.) ground. The portrait of Mao is a silver gelatin photograph stapled to the underlying layers. The imagery is conveyed through the photography, taken by Kiefer himself in China (1993), and highlighted by the addition of oil paint and shellac to the photographic surfaces that not only amplify the photographic image but also add to the image by altering the perspective.

In order to better understand *Let a Thousand Flowers Bloom*, however, it is helpful to look at other paintings by Kiefer in the MFAH permanent collection. *The Sorrow of the Nibelungen* (1973) is relatively straight-forward and composed of oil and charcoal on burlap. Most notable is the heavy-weight of the canvas whose color and weave form the basis of the room depiction. The use of burlap on such a monumental scale contributes significantly to the depth of field and the recreation of wood paneling. Its darkening over time enhances its own texture and volume on a smaller scale and this, in turn, works toward the evolution of the whole image.

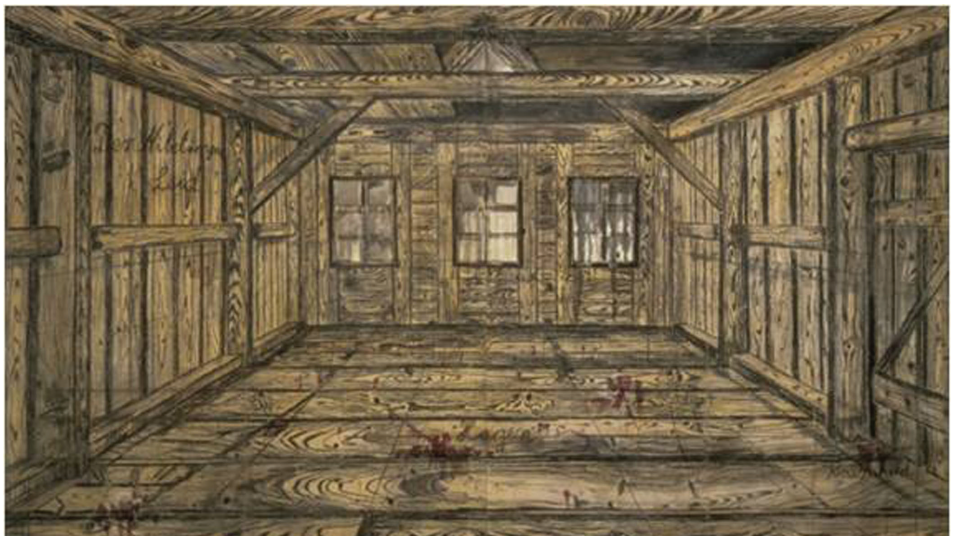

Figure 1. Anselm Kiefer, *The Sorrow of Nibelungen*, 1973. Oil and charcoal on burlap 118 ¼ x 173 1/4 inches (300.3 x 440cm)

St. John's Night (1981) is the beginning of a more complicated material approach, composed of gesso and straw on a photograph. Further examination reveals that in some areas the image is enhanced by the

artist creating an atmosphere that is part fiction and part non-fiction. Some stars were captured in the photographic image; some were created by texture and paint. Scratches and wrinkling in the substrate contribute to the image, also enhancing the starry night.

It was in studying *St. John's Night* that Kiefer's intent was further questioned. Was the picture something that had been lying around the atelier, subjected to the environment or had it been created specifically for the final art object? The answer from Mr. Kiefer was that the photograph was processed and then the straw and paint added shortly thereafter. The wrinkling, dust, and accretions were not due to time but to the artist's hand. [1] Something new, made to look old, used as a substrate for the straw and paint, and then whose aging took on a whole new meaning outside of the materials used.

Heavenly Jerusalem (1987/88 and 1997) is composed of oil and shellac with lead, metal leaf, and corrosion products on canvas. It is a maturing shift for Kiefer, combining the monumental with assemblage for a visual evolution reminiscent of alchemy. In many areas the copper leaf retains its yellow metallic coloration but overall, green and white corrosion products have invaded the paint surface and contribute to and create much of the image that is on the presentation surface. Mr. Kiefer confirmed the painting's creation with evolution and planned obsolescence in mind.[2] The corrosion products from the lead and metal leaf were part of the intended evolution of the picture.

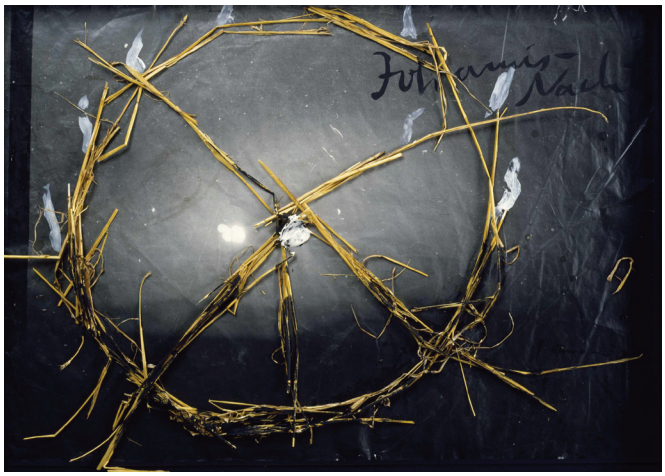

Figure 2. Anselm Kiefer, *St. John's Night*, 1981
Mixed media (including gesso and straw) on photograph
25 7/8 x 35 5/16 inches (65.7 x 89.7cm)

From the 1970s with the *Sorrow of Nibelungen* to the 1980s early assemblage of *St. John's Night* followed by *Heavenly Jerusalem*, all three creations contribute to a better understanding of Kiefer's creative methodology in *Let a Thousand Flowers Bloom* (2000).

Figure 3. Anselm Kiefer, *Heavenly Jerusalem*, 1987-88; 1997
Emulsion and shellac with lead, salt, and metal leaf on canvas
87 x 128 3/8 inches (221 x 326.1cm)

There are various anomalies in the paint and photography layers, including staples attaching the portrait of Mao, which puncture through to the back side of the canvas, pulling the layers together, as well as originally delaminated areas of the chromagenic paper support, again part of Kiefer's aesthetic, that create atmospheric perspective in the presentation. What is especially notable about *Let a Thousand Flowers Bloom* (2000), however, is that pictures taken at the time of its creation identify no significant changes from its current state.

Wynne Phelan, Conservation Director at the MFAH, states that, in fact, the painting is not unstable. [3] It is stable but mutable, evolving. And further, she states, this mutability gives us the illusion of deterioration; the same creative/destructive forces communicated in the Cultural Revolution theme. And, considering the density of *Heavenly Jerusalem*, it is amazing that Kiefer has managed to compress almost as

many layers, if not just as many, onto this canvas; maximizing the ability of the chromagenic photographs to create depth. Changing our perception of depth.

The question becomes when to intervene or whether to intervene at all. Any slow degradation is part of the work, part of the evolution of a painting, or painted photograph on canvas rather, that includes deterioration, discoloration, decline – a metamorphosis of materials. Are these condition issues or, even more elusive, creation issues?

Creation issues go beyond the intentional use of a material for its aesthetic attributes, which may or may not result in accelerated deterioration, into the realm of choice which dictates that materials are chosen for not only how they look now, but how they will look as they age, and how a multiplicity of materials can age together to form a resultant image, 10, 15 or 50 years in the future.

This type of complexity, where the artist's intent runs cross-current to the conservator's plan for long-term preservation is not new to art, especially art of the 20th century. Unlike a painting that ages rapidly over time and then becomes vulnerable, the original shredding in the paper support indicates that the picture was conceived initially, in part, as an ephemeral object similar to the ephemeral nature of the subject matter itself.

Certainly, these questions that chip away at a conservator—issues of intent—are constantly part of the collective conversation in the conservation community. Mr. Kiefer confirmed to the author that his material choices, his intent, his engagement with the viewer – are all well-crafted and expected, of course.[4] Anselm Kiefer does not leave much to chance. In other versions of *Let a Thousand Flowers Bloom*, Mr. Kiefer did add material, such as rose petals, that he knew would age, break away, etc. and contribute to the final presentation of the picture. Also, the shellac, readily visible on the MFAH version, initially appears as rust – one thinks one is looking at metal. In a sense, one is, only this time it is lead in the form of lead oxide paint as opposed to the large planks or blocks of lead that are often included in Kiefer's oeuvre and seen in Heavenly Jerusalem. The "rusted" appearance or appearance of patination is simply the yellowed aging of the resin which Mr. Kiefer confirmed he applied with the intention that it would discolor, "to whatever end may be."[5]

This is one of the most important parts of Kiefer's creative process. It is not a secret that everything is planned, even the evolution of the work, but at a point Mr. Kiefer lets go and appears to let go completely – he lets the material take over. And the presentation surface is still readable – it still communicates; it evolves in Mr. Kiefer's hands and out of his hands and, in short, the image still works. And therein lies Kiefer's ingenuity, the ability to infuse a painting with meaning via the materials he uses.

Understanding the ideas that Kiefer puts forward with different materials meant, inherently, that many eyes were going to examine this painting. And, like the variation of materials that compose the object, there were a wide convergence of conservation disciplines that came together. During initial documentation, analysis performed by the MFAH Photography/Paper Conservation Lab clarified what materials were used. Fragments showed a heavy encrusted layer of painting attached to chromogenic photographs.

XRF analysis of the silver gelatin photograph of Mao was conducted on the design/paper substrate of the fragment and then of the substrate and design layer.

Figure 4. Anselm Kiefer, *Let a Thousand Flowers Bloom*, 2000. Oil, shellac and emulsion on paper, mounted to canvas 110 ½ x 197 inches (280.7 x 500.4cm)

Although original, some shredding in the chromagenic substrate required stabilization by the Photography/Paper lab using a wheat starch paste adhesive so that the original contour of the shredded paper was strengthened and preserved and, although inevitable, the aging process could be slowed. It should be noted that some of the stabilization was completed in public view answering questions from the public as necessary.

After analysis and stabilization of the original tearing, the painting conservation team took over applying polyester batting material attached to the underside of the strainer bars.

On top of the batting material, ethafoam and foam-core inserts were attached and held in position by rigid aluminum laminate backing boards. When the final treatment was completed, it was remarkable how many minds had contributed to the conservation of this work of art. Photography and paper conservators, painting conservators, even conservation science, all brought together to discuss how to properly care for parts of an entire artwork. In the end, the final conservation treatment was more palliative than invasive and that aligned with the artist's intent.

In consideration of the field of art conservation in general, it should be noted how many hands were involved in the assessment of the Kiefer painting and how the end treatment was relatively non-invasive. The Kiefer project proved no small amount of inspiration for the next section of the paper. For quite some time, the author has been interested in how the conservation field changes, maintains and evolves as a profession.

Interaction *about* paintings has, to some degree, superseded interaction *with* paintings.

How best to describe the practical changes which have affected conservation philosophies and treatment methodologies? They can best be summarized in the tools used for documentation of the work conservators do. First, there is the written word. It seems that now, as opposed to the past, there is no phase of documentation that is not touched in some way by a computer. Conservators not only write reports but are able to ask questions to multiple conservators at once via the PSG distribution list. No more life in a vacuum.

The second, but certainly not secondary, practical change is that of digital photographic documentation. When it comes to imaging the changes are spectacular. Now, with the state of digital photographic documentation, details can be extrapolated from images on the computer and although not a substitute, it is remarkable how much information that is not visible to the naked eye can be gleaned from a top notch digital image. Of course, this is the entire reason for multi-spectral photography, to see beyond what eyes can. And after the image is taken, there is work that remains. The digital image is shot and taken from .raw to .jpeg, color balanced, profiled and finally named, using a naming standard, not to mention the management of any associated metadata.

Finally, instrumental analysis. The Kiefer was analyzed using a portable XRF device. In addition to the basic photographic documentation, multi-spectral photography and even digital x-radiography there is, in addition, the new-found ability to glean information from instrumental analysis. The conservator is now better able to perform some areas of instrumental analysis on his or her own.

The world is opening up, and it is limited, all at the same time. It is complicated really. The dilemma is that, in the past, conservators were in charge of their own documentation but the tools were pretty limited. And even though they were accessible to others, conservators knew tricks-of-the-trade (for example – bracketing during photography). Anything conservators couldn't do was passed along to another conservation professional, a conservation scientist or an imaging specialist. Now, conservators have access to a lot more tools and information but, so do others whose specialty may or may not be conservation related. And, although out of habit conservators hold onto their tools, they don't necessarily have the time to do so - either in mastering the tool from the outset or keeping up with the technology as it changes.

Does this matter? Well, it does, because all this time spent in documentation (and tangentially in the easy discussion with other professionals on the internet) means less time is spent at the bench. As much time as is spent in virtual communication, is also spent in actual communication, communicating more easily in person as people are pulled together through the virtual world. True, it is different for the conservator in private practice but still, it cannot be denied, the focus on treatment and bench work has changed due to engagement in other useful distractions. Often it is for the good – less invasive treatments, more thoughtful preventive conservation (i.e. the Kiefer) but losing bench time is a definite loss. What is more difficult to ascertain is how these practical changes affect a philosophical outcome.

Being able to know and see more about a painting in non-invasive ways is great. But sometimes, it holds conservators back from treatments that we would have proceeded with in the past simply because we know more – maybe too much.

Dennis Calabi, a California-based painting conservator in private practice, who spoke on this topic at the 2009 WAAC meeting stated, "Good science (technology) is obviously essential, but it seems that hand skills and intuition have been taking a back seat."[6]

Hand skills, as well as that most precious of skills gained through time and experience, intuition, are being minimized, and consequently devalued, as conservators try to and keep up with documentation, examine paintings more thoroughly, and treat paintings less by way of conservative methodologies. Which came first, the conservative methodologies that dictated that conservators treat paintings less? Or did conservators start treating paintings less because there were more means to examine them, more answers, and more uncertainty? Conservators don't always trust their intuition because in the new age, they may not have the luxury of time to develop it. Conservators can become more conservative and this can lead to "the best way, the one right way" type if thinking.

There are, however, two other practical factors that have also affected philosophies. Many painting conservators that have left their jobs in the past ten years have not had their positions refilled. This can be blamed on the economy but, the truth is, if the promotion of new exhibitions relied on several thousand more paintings being treated, these positions would be refilled.

One of the author's mentors simply said to her that she was the last graduate intern that would ever be able to treat the quantity of paintings she was able to treat in her time at her institution in 1998. There simply aren't as many treatments to do in museum settings. [7]

Now in private practice, of course, there are still paintings left to treat but there is much distress from younger painting conservators about the state of the job market. Although there are private painting conservation jobs available, the training of painting conservators doesn't appear as geared towards bench work as it used to be. This may make the private path less appealing. The author has spoken to very good young conservators who have thought of leaving the field because they couldn't get a job in a museum.

In addition, in the past couple of years there have been three conservation program closings including the Victoria and Albert/Royal College of Art Conservation Programme.

A joint statement released by the V&A/RCA stated the following: "…the V&A's priorities and needs in conservation training have changed and the RCA and V&A have therefore taken the decision to close the course." The V&A says it intends to create a work-based conservation development programme for its general staff, which will focus on developing skills "in areas where the museum needs additional assistance such as upholstery, textiles conservation and textile mounting."[8]

This is how accessible all of this technology has become. We, as conservators, are able to examine things more, treat things less, and the very special skill set that is what sets us apart – bench work – is less relevant than it used to be. Because, guess what(?), other museum staff members can undertake some of the tasks that were formally the sole responsibility of the conservator. And, in fact, they may need to because many of these activities can be elevated to a full-time job. And if conservators treat things less, why should the field be any more relevant? Why should conservators themselves be any more relevant?

The author ventures that if conservators do not continue to value our treatment skill set as much as they value all else, they will not only appear fragmented but rather unspecial. And this is the real risk for the field of art conservation. The author is hopeful, however, that this presentation will advance the discussion on these topics which are critical to our field.

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and Maite Martinez Leal, Associate Painting Conservator, all of the Museum of Fine Arts, Houston.

ENDNOTES

1. Kiefer, A. 2010. Personal communication. E-mail dated 17 March 2010 between author and artist.
2. Kiefer, A. 2010.
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5. Kiefer, A. 2010.
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7. Creager, A. 2009. Personal communication. Smithsonian American Art Museum, Smithsonian Institution, Washington, D.C.
8. http://www.theartnewspaper.com/articles/Crisis-in-conservation-programmes-as-another-UK-course-closes/18556 (accessed 1 April 2010)

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PAMELA J. BETTS

Alice Dibble and Painting Restoration in the Early Days of the Shelburne Museum

ABSTRACT

Through the late 1950s and into the 1970s, as the collection of paintings at the Shelburne Museum continued to grow, the staff increasingly relied on painting restorer Alice Dibble to prepare select paintings for exhibition. Alice and her husband Win owned a gallery in Shoreham, Vermont, almost an hour's drive from Shelburne, where they offered "picture framing, antiques, paintings restored, [and] leaf gilding." Alice helped to preserve many fine examples of American painting, today an important part of the collections at the Shelburne Museum. This paper will examine some of the paintings treated by Alice in the early days of the Shelburne Museum and how they have fared over time.

INTRODUCTION

From 1958 to 1975, Alice Burlingham Dibble (fig. 1) was the primary painting restorer for the Shelburne Museum, in Shelburne, Vermont. Before moving to Vermont, Alice lived and worked in Englewood, New Jersey where, for thirty years, she ran an art gallery with her husband Winston Dibble. Besides selling and matting and framing artwork, it is likely that the couple did art restoration there as well. The following excerpts are from a 1971 Vermont newspaper article in which Mrs. Dibble, referred to in the article as "Vermont's expert painting 'conservationist'", describes her training:

You have to learn this type of work by experience.... There are no practical courses taught in any college. I studied color chemistry and apprenticed myself to the Brooklyn Museum. It's a minimum of two years before you're even allowed to touch a painting—just day after day work. That's the only way you can learn.[1]

Figure 1. Alice Dibble (from the cover of the Annual Report for The Johnson Gallery, Middlebury College), 1977. (Middlebury College Museum of Art Archives, Middlebury, Vermont).

Another newspaper article from 1970 stated, "Alice studied the art of the conservator from the late John Bentz, restorer for the Brooklyn Museum."[2] Although no records have been found to support Bentz's connection with the Brooklyn Museum, there was an artist that specialized in miniatures named John Bentz that did restoration, notably for New York City Hall. His obituary, published in the August 3, 1950 issue of *The New York Times*, states that he also served as an official painting restorer for the National Academy of Design.

Alice and Win reportedly came up to Vermont in 1956 to retire, but they brought their business to rural Shoreham, Vermont where they opened an art gallery and restoration business in a converted barn on their property. Alice treated paintings as well as works of art on paper while Win restored

or built custom frames as necessary.[3] To better understand the circumstances and environment in which Alice worked, it is important to have an understanding of the early days of the Shelburne Museum and the formation of its collection of paintings.

ELECTRA HAVEMEYER WEBB AND THE SHELBURNE MUSEUM

The Shelburne Museum was co-founded in 1947 by Electra Havemeyer Webb and her husband James Watson Webb with the hopes of instilling those who visited with a deeper appreciation and understanding of American heritage.

Electra, born in 1888, was the youngest child of Henry Osborne and Louisine Havemeyer, collectors of old master paintings, decorative art, Asian art, and among the earliest American collectors of French Impressionist paintings. Their collection of Impressionist paintings was guided by Mary Cassatt, a close family friend. The Havemeyer residence at 1 East 66th St. in Manhattan contained luxurious surrounds and the continually growing collection of paintings to which Electra grew accustomed.[4]

Electra married James Watson Webb, the son of William Seward and Lila Vanderbilt Webb. They summered at the Webb family's estate in Shelburne, Vermont in the setting of Lake Champlain and the Adirondack mountains. Electra adapted quickly to the country lifestyle and the couple enjoyed such outdoor activities as tennis, golf, and horseback riding, and pursued hunting excursions in such locales as Alaska and the Canadian Northwest.

Early on, Electra showed interest in becoming a collector like her parents; as a little girl, Electra had collected dolls, and as a young woman started collecting a few paintings. At age twenty, on a trip to Europe with her mother and Mary Cassatt, she bought a painting by Goya (now attributed to Goya). She asked in a letter to her future husband, "How can anyone like Jewels when they can buy pictures?"[5] But, perhaps due to a newfound love of the countryside and country life, and a desire to set herself apart from her parents, Electra's tastes eventually shifted away from paintings to sculptural folk art and other forms of Americana.

When an extensive collection of horse-drawn carriages belonging to her husband's family was about to be sold, Electra and her husband proposed a solution to keep the collection. They asked family members if they would be willing to donate the carriages if they, in turn, would provide a space to house them and to display them to the public. The family members agreed, and the plans for a museum for the carriages, as well as for her own vast collections of such various objects as dolls, folk art sculpture, weathervanes, quilts, rugs, hatboxes, pewter, ceramics, and decoys began. Once the idea for a museum to showcase her lifetime of collecting gelled, she started buying up parcels of land and relocating buildings from New England and New York. Some of the structures she relocated to the grounds include a lighthouse, a covered bridge, a meetinghouse, a jail, a post office, several barns, and even a 220-foot steamboat, the *Ticonderoga*. Eventually, the museum would grow be situated on 40 acres, with over 150,000 objects exhibited in 39 buildings, 25 of which are historic, and all but one relocated to the museum grounds.

Shelburne Museum has always been known more for its sculpture and folk art than its collection of paintings. Although the museum today has a strong collection of American paintings, the formation of this part of the collection started somewhat hesitantly by its founder Electra Havemeyer Webb. Initially, paintings were at first thought of more as decorative elements in the period buildings she assembled on the grounds rather than a collection unto themselves. But at some point, she had a change of mind, and in 1957 began to actively collect American paintings more seriously, and build an art gallery devoted just to paintings. Opened in 1960, the Webb Gallery exhibited two hundred paintings. At that time, it was the only space with a controlled climate at the museum. Up to this point, and long after, many paintings were exhibited in various locations around the museum, including on the steamboat *Ticonderoga*.

CLIMATE CONCERNS

The weather in Vermont, along with the other New England states, is known to be highly changeable. In general, the weather varies greatly between seasons, and can also vary greatly daily, especially in the transitional months. Even the weather of the same season in different years can vary considerably. The saying, often attributed to Mark Twain, describes the situation well: *If you don't like the weather in New England, just wait five minutes.*

The combination of the fluctuating weather and the unclimatized spaces naturally created many problems for the growing number of diverse objects at the museum. Actively involved in caring for the collection, Electra became a member of the National Trust for Historic Preservation, and sought advice from

colleagues in other museums. Although Electra, along with the rest of the museum staff, was becoming as knowledgeable and diligent as possible about the care of the collection, climate control of such a vast amount of buildings was not yet possible.

ALICE B. DIBBLE

It's a good thing that Alice came to town! After the Dibbles arrived, Electra increasingly relied on them for the restoration of the paintings and frames in the collection. The first records of Alice working for the Shelburne Museum are from 1958—a year after Mrs. Webb decided to build the art gallery. Alice transported paintings back and forth between the museum and her studio about an hour away in her station wagon, often in wintery conditions. She would also work in the Webb Gallery, once this building was completed, when treatments could be completed on site. Whether or not the Dibbles came to Vermont for relaxation and nice scenery, they soon became very busy. Besides working for the Shelburne Museum, the Dibbles also treated many paintings and frames belonging to other clients, such as the Sheldon Museum at Middlebury College and the Fleming Museum at the University of Vermont, as well as private clients.

From the existing invoices and treatment reports at the Shelburne Museum, which are in no way believed to be complete, it is estimated that Alice worked on at least 150 paintings in the seventeen years she worked for the Shelburne Museum. She treated paintings in waves, similar to how they were brought into the collection, but also depending on the needs of the museum. As seen in the chart that indicates the number of paintings treated per year (fig. 2), the years of highest activity are 1960, when the Webb gallery opens, and between 1968 and 1969, probably when Alice is preparing to retire. The chart also shows a proportionally smaller number of paintings treated by others during this time.

Of Mrs. Dibble's confirmed treatments at the Shelburne Museum, she lined at least twenty-five paintings: seven with glue, and eighteen with wax, and she laminated nineteen more paintings onto a Masonite-type board with glue or wax. She left old linings on when in good condition. She left paintings unlined when possible— she left at least twenty-three paintings unlined. She edge-lined at least five paintings and she may have loose lined at least one painting. She used patches on the canvases of approximately four paintings. She treated at least fourteen pieces on panel and seven on fiberboard.

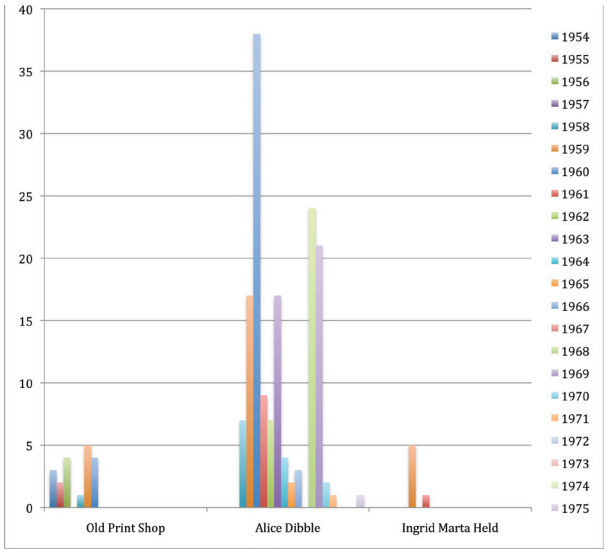


Figure 2. Chart representing the number of Shelburne Museum paintings treated by Alice Dibble and other restorers per given year (1954 to 1975).

Alice usually provided very brief examination and treatment notes, every once in a while adding more detail regarding her thought processes. It is known from a presentation lecture that she gave that she took photographs before and after treatment, and occasionally during some intermediate phases. Early mentioned photographs were taken in black and white, and later in color slides; unfortunately these photographs are now lost. Some examples of her treatments on paintings in the Shelburne Museum collection follow:

George Henry Durrie, *Winter in the Country: A Cold Morning*, 1862 (Figure. 3)
Alice noted in her 1968 condition report that the painting was in poor condition (fig. 4). It was glue lined and there were "old repaired cracks breaking loose from old lining." Her advised treatment was to "remove the glue lining; reline with wax; fill and repaint; clean and revarnish; all old glue will have to be scraped away and Jap(anese) tissue applied to face of canvas while this is done." No separate treatment report or invoice was found in the archives at this time, but the cost of this treatment was noted to be $175.

This painting was treated again between1986 and 1987 by Cynthia Kuniej, at the time a student at State University College at Buffalo. Kuniej's examination report noted that the painting was maroflaged to a 1/8" thick Masonite (estimated) board with a linen interleaving fabric.[6] The lining

Figure 3. George Henry Durrie, *Winter in the Country: A Cold Morning,* 1862, oil on canvas (mounted to board), 26" H x 36"W (66.0 x 91.4 cm). © Shelburne Museum, Shelburne, Vermont.

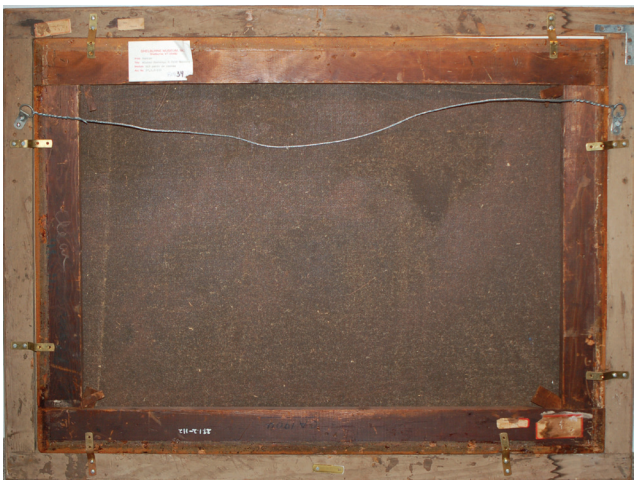
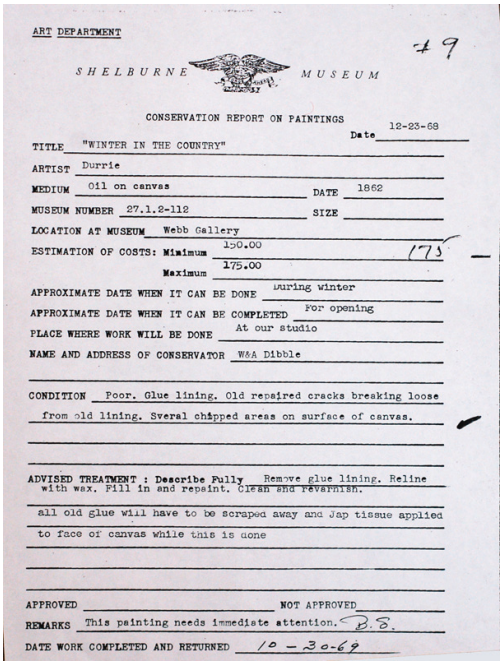


Figure 5. Verso of George Henry Durrie, *Winter in the Country: A Cold Morning,* 1862, oil on canvas (mounted to board), 26" H x 36" W (66.0 x 91.4 cm). © Shelburne Museum, Shelburne, Vermont.



ART DEPARTMENT

#9

SHELBURNE MUSEUM

CONSERVATION REPORT ON PAINTINGS

Date 12-23-68

TITLE "WINTER IN THE COUNTRY"

ARTIST Durrie

MEDIUM Oil on canvas DATE 1862

MUSEUM NUMBER 27.1.2-112 SIZE

LOCATION AT MUSEUM Webb Gallery

ESTIMATION OF COSTS: Minimum 150.00 175

Maximum 175.00

APPROXIMATE DATE WHEN IT CAN BE DONE During winter

APPROXIMATE DATE WHEN IT CAN BE COMPLETED For opening

PLACE WHERE WORK WILL BE DONE At our studio

NAME AND ADDRESS OF CONSERVATOR W&A Dibble

CONDITION Poor. Glue lining. Old repaired cracks breaking loose from old lining. Sveral chipped areas on surface of canvas.

ADVISED TREATMENT : Describe Fully Remove glue lining. Reline with wax. Fill in and repaint. Clean and revarnish.

all old glue will have to be scraped away and Jap tissue applied to face of canvas while this is done

APPROVED NOT APPROVED

REMARKS This painting needs immediate attention. B.S.

DATE WORK COMPLETED AND RETURNED 10-30-69

Figure 4. 1968 Conservation Condition Report on Paintings (and Treatment Proposal), Alice Dibble for Shelburne Museum. © Shelburne Museum Conservation Archives, Shelburne, Vermont.

adhesive was a water soluble (animal) glue. She noted there were two large repaired tears in the painting, minor planar distortions from an uneven application of glue lining adhesive, small scale tenting of the ground/paint layers around the perimeter of the painting, moating of impasto, extensive abrasion to paint layers, and excessive discolored retouching, particularly in the sky. The painting was coated with an even layer of synthetic resin varnish that fluoresced a milky white, and was somewhat discolored.

The various treatment campaigns on this painting make it hard to discern when various damages from intervention occurred. Kuniej had access to a photograph of the painting taken before the Dibble treatment. She noted that the repaired tears were visible in this photograph, which indicated that it had already been torn and lined prior to Dibble's treatment. Although Mrs. Dibble proposed removing the glue lining and relining with wax, it seems she did not want to undo the lined and extensively torn painting, but instead, it seems that she then laminated the lined painting onto Masonite (with a glue adhesive). Kuniej also had access to Mrs. Dibble's invoice for this treatment (now lost) that stated only: *cleaned and inpainted*. Analysis of the varnish with a Potassium Bromide salt disc for infrared spectroscopy identified the varnish coating to be a polycyclohexanone. The spectrograph compared almost exactly with synthetic varnishes such as Winton, MS2-A and AW-2. The varnish was soluble in xlyene. There were two campaigns of overpaint, some of which— presumably Mrs. Dibble's— were soluble in xlyene while the rest required more polar solvents to remove.

Perhaps most interesting about this treatment is that Mrs. Dibble retained the old stretcher, which is still physically with the painting, but detached and held against the Masonite

Figure 6. Thomas Hill, *Four Horse Hitch,* 1854, oil on canvas, 25" H x 30 ¼"W (63.5 cm x 76.8 cm). © Shelburne Museum, Shelburne, Vermont.

Figure 7. Verso of Thomas Hill, *Four Horse Hitch,* 1854, oil on canvas, 25" H x 30 ¼"W (63.5 cm x 76.8 cm). © Shelburne Museum, Shelburne, Vermont.

panel with framing hardware (fig. 5). Saving the stretcher shows some sensitivity to the historical object as a whole, and retained documentation in the form of old labels on the stretcher.

Thomas Hill, *Four Horse Hitch*, 1854 (Figure. 6)
Mrs. Dibble's 1961 report noted the condition of the painting as "dirty." She noted on her invoice that the painting was "cleaned, varnished, and strip lined." Also, the painting was framed, and that "additional repairs (were made) to old repair job where patched."

The patches on the verso of the canvas (fig. 7) correlate to tears and punctures in support. There is extensive repainting along the edges of the painting, retouching in the sky and along tears, and slightly discolored varnish layers. On the verso, there are stains and old adhesive residues around patches. It appears that Alice took off old larger patches and replaced them with smaller patches, and that she reduced the size of the green painted patch at right as well. Her choices to decrease the size of the existing patches and to attach a strip-lining, rather than attach an overall lining, show a more sensitive and localized treatment approach.

Orlando Hand Bears, *Sea Captain's Grandson*, c. 1835-1840 (Figure. 8)
Dibble's 1958 report reads: relined, cleaned, varnished. The deformations in the canvas (fig. 9) — presumably from the glue lining adhesive— can easily be seen even in the 1960 installation photograph (fig. 10). Alice seems to switch over from glue to wax linings around 1961. In all cases, paintings were hand lined and many of her linings are both lumpy, and show signs of localized delamination (which is both potentially hazardous and yet most likely easily reversible!).

Abraham Tuthill, *Benjamin West*, 1798
This panel painting currently exhibits two convex warps — one on each side of a long split at top (fig. 11). There are two vertical splits (one at top and one small one at the bottom of the panel). A thick layer of wax has been brushed on the reverse of the panel (fig. 12).

The treatment of this painting was described in 1961on a local Radio Show,[7] where the host of the show followed Mrs. Dibble around the Webb Gallery (fig. 13) and discussed paintings she had treated.

The following are excerpts of the radio show (please note, the method of framing she discusses has since been removed):

Radio Host: *Did you restore this painting (of Benjamin West by Abraham Tuthill)?*
Mrs. Dibble: *This is kind of my pride and joy, as a matter of fact. Mrs. Webb showed me this one day when they first had it and she had sent it to be straightened out. Its on a very badly, or it was a very badly, curved wooden panel that had warped…. This was so badly warped that I was kind of scared of it. I said to Mrs. Webb, 'I'll try it if I don't have to stay awake nights worrying about it'. Mrs. Webb*

Figure 8. Orlando Hand Bears, *Sea Captain's Grandson*, c. 1835-1840, oil on canvas, 46 ¼" H x 37 3/8"W (117.5 cm x 95.1 cm). © Shelburne Museum, Shelburne,Vermont.

Figure 9. Detail in reflected light. Orlando Hand Bears, *Sea Captain's Grandson*, © Shelburne Museum, Shelburne,Vermont.

Figure 10. 1960 Installation view. On right: Orlando Hand Bears, *Sea Captain's Grandson*, © Shelburne Museum, Shelburne,Vermont.

Figure 11. Detail. Abraham Gulielmus Dominy Tuthill, *Benjamin West,* oil on wood panel, 27 7/8" H x 21 3/8"W (70.8 cm x 54.3 cm). © Shelburne Museum, Shelburne, Vermont.

Figure 12. Verso. Abraham Gulielmus Dominy Tuthill, *Benjamin West,* oil on wood panel, 27 7/8" H x 21 3/8"W (70.8 cm x 54.3 cm). © Shelburne Museum, Shelburne, Vermont.

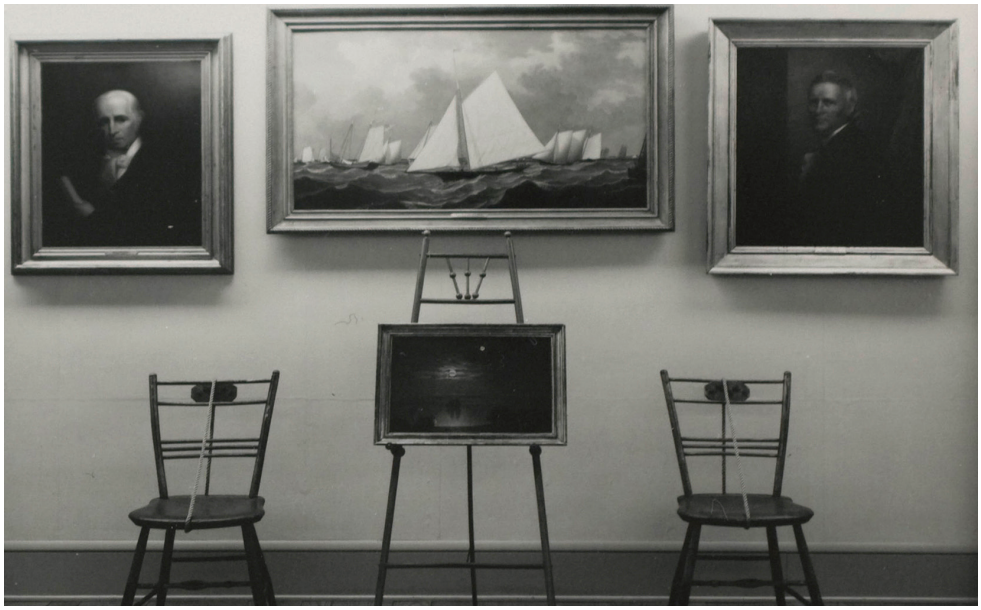


Figure 13. 1960 Installation view. On left: Abraham Gulielmus Dominy Tuthill, *Benjamin West*. 27 7/8" H x 21 3/8"W (70.8 cm x 54.3 cm). © Shelburne Museum, Shelburne, Vermont.

said, 'Go ahead,' you know she was wonderful that way, 'if it splits it splits— its no good to us as it is, it looks awful.'
Radio Host: *Well you couldn't put it in a steam box, because that would spoil the painting…*
Mrs. Dibble: *No, I don't like that…What we did – it's a little difficult to explain to you. We put some damp newspapers underneath it and we clamped it every three or four inches, and every day I turned the screws one screw, and I'm pleased as punch because it's flat as a pancake now, isn't it?*
Radio Host: *It certainly is, you'd never know it was on a curve at all. I can imagine you did it with fear and trepidation, though, that it might split.*
Mrs. Dibble: *Scared to death, all the time.*
Radio Host: *Did you restore the frame too?*
Mrs. Dibble: *We made a repair job on it when we restored the painting….*
Radio Host: *It's a nice heavy one so I suppose it really holds that board in place.*
Mrs. Dibble: *There is a brace in back….a regular frame behind it of very strong wood and its all toed-in so it will not warp again, I'm sure.*

Samuel Colman, *Yeatman Family* c.1850-1890 (Figure. 14)

A similar treatment to the one described above on the portrait of Benjamin West must have been done to this painting, a charming depiction of the Yeatman Family by Samuel Colman. Mrs. Dibble's 1960 report states, "The bowed panel was framed so that every once in a while, the wooden panel can be tightened slightly in the frame, thus (we hope) eventually taking the bow out of the board."

It appears that this framing method was also removed at a later date. There are numerous wide vertical cracks through the thickness of wood starting from the top, with a second series

Figure 15. Detail in reflected light. Samuel Colman, *Yeatman Family,* © Shelburne Museum, Shelburne, Vermont.

Figure 14. Samuel Colman, *Yeatman Family,* oil on wood panel, 23 ¾" H x 31 3/8"W (60.3 cm x 79.7 cm). © Shelburne Museum, Shelburne, Vermont.

Figure 16. Verso. Samuel Colman, *Yeatman Family,* oil on wood panel, 23 ¾" H x 31 3/8"W (60.3 cm x 79.7 cm). © Shelburne Museum, Shelburne, Vermont.

of cracks that has not opened as wide (fig. 15). The panel has a slight concave warp. On the verso (fig. 16), two horizontal cross braces apparently existed before the painting was sent to Alice, judging by a label on the top brace inscribed: *to be given to Alice Dibble for cleaning*. A white fill material was at some time applied to the cracks at verso. Losses to the paint layers can be seen at bottom along the wood grain.

The cracks were most likely not there when she began her treatment, and unfortunately, were likely the result of her treatment. They could have very well been filled in at verso at a later time, most likely by the Shelburne Museum's grounds keeper, painter, and maintenance man, Duncan Munroe: A 1959 memo from Assistant Director Bradley Smith to Electra states: *Mrs. Dibble has given Duncan her "secret formula" for filling in cracks and dents, which she obtained from an elderly Austrian repairer "years ago." He also has instructions on how to clean and repair canvases. She was very generous in giving us this information. Many in her trade would not.*

Mrs. Dibble (fig. 17) reached out to the public through lectures and demonstrations, educating about the preservation and care of paintings, an important part of our AIC Code Of Ethics today. Some quotes from her lecture, *Preservation and Restoration of Paintings,* held on the *Ticonderoga* at the Shelburne Museum on August 19, 1970, follow:

-Don't clean paintings yourself. They are much better dirty than when they are poorly done!

-You can dust them- that's a do-it-yourself job that I'll let you do. Use an architect's paint brush- nothing that is scratchy- never a nylon brush, never a rag- maybe a soft feather duster- but check first if paint is sticking up, (then) take it easy because it can catch on anything…

-Don't store your paintings in your attic. Store them somewhere where they won't get too cold, too hot, too damp….which means in the middle of the house! Nobody has controlled atmosphere in their homes. Even over at the Webb Gallery where we ***have*** *controlled atmosphere, there is a certain amount of maintenance that has to go on all the time*

- (The lamination process) is nothing in the world but a gluing down with the right adhesive, and museums used to be terribly against it, but I've noticed that variously so …they are putting them on sheets of aluminum, which I think is very bad, myself, because they are so very hard to get off.

-…(here is a picture) of a back of a painting where there are 2 little pegs that stick in each corner. And you are supposed to take your paintings down, about twice a year, and whack those little pegs. Oh, not whack them, just be a little gentle, but hammer them in. So much deterioration comes from a canvas getting loose on the stretcher.

-And that's the thing to remember, if you do key out an old painting, look and see that the canvas is not rotting and that it will stand a little pressure. We often do a thing you call strip lining— if the whole back of the canvas is in good shape—but you have to take it off (the stretcher). To get it back on the stretcher, we just put another 1 ½" of linen on it and that gives you a little purchase…

- (The painting) was really just in a wad when I got it from her. And a few pieces missing …had to be (painted) in. One does as little repainting as one can…but when there aint any paint, there aint any paint. You just have to do something about it…

-(Answer to a question regarding lining) *We use wax- a certain percentage of beeswax which I buy in fifty pound blocks from the bee-man in Middlebury. We use beeswax, Venice turpentine, and rosin*

Figure 17. Clipping from *The Burlington Free Press*, Thursday, August 20, 1970. p. 21. Shelburne Museum Archives, Shelburne, Vermont.

and we melt it in a— I used to melt in a double boiler, all of a sudden I got smart…, and now we melt it in a great big electric deep fat fryer and it works just great. The heating degree is very high for melting wax, and the bees wax has to be purified first so you dump it in the great pot, these great lumps, full of pieces of bee and all kinds of things, and you boil it with vinegar which clarifies it. And then I fill old two quart milk containers with it, and its like cream, the pure beeswax rises to the top, and all the gunk lands on the bottom. And you peel the container away and then you have a lovely nice clean square with beeswax, and you heat it and then we brush it on the back (of the painting).

CONCLUSION

After moving to a fairly remote location in the 1950s, where she lived until her death in 1979, Alice Dibble kept up the best she could at least with the theories of modern restoration/conservation. In her lectures, she discussed reversibility of materials, new types of synthetic varnish, and localized as well as less invasive treatments such as edge lining. She considered lining a painting not a routine operation but an option to be used in a case-by-case scenario. It seems she laminated vulnerable paintings only when she knew they were going to be exhibited for extended periods in unclimatized spaces, such as the *Ticonderoga* and the Beach Gallery, another exhibition space at the Shelburne Museum. In recorded interviews and lectures, she showed sensitivity and dedication to her craft. Recordings reveal that she really cared about the preservation of paintings and that she worried and deliberated about the condition of the paintings and her treatment options. Alice provided brief treatment proposals and reports, and her lectures reveal that she documented treatments with photographs. She also recorded any signatures she found on the canvas verso with photographs. Through her lectures, demonstrations and interviews, Alice increased the public's awareness of the preservation of paintings.

On the other hand, a survey of her treatments reveal that Alice did not always evenly clean the grime and discolored varnish layers, and now disfiguring remnants of varnish and dirt can be seen in paint interstices. A positive spin on this observation is that survey reports of paintings she has worked on mention these discolored remnants more than they mention paint abrasion. Alice's linings often appear lumpy, with unevenly distributed lining adhesive, and many now exhibit localized delamination, at once a hazard and an indication (glass half full) of easy reversibility. In many instances, it has been observed that Alice's fill and retouching materials tend to lift and flake, perhaps from too high of a glue content, and her retouching has discolored to varying degrees (her inpainting media has not been analyzed). Alice did not fill all losses to paint layers, potentially exposing canvas and adjacent ground and paint layers to uneven responses to environment. There are scratches in the varnish layer of many paintings she treated, most likely from a high wax content in the final layers. Unfortunately, Alice did not attach backings to paintings, which would have been very beneficial to their preservation. And the worst aspect of her treatments was without a doubt the flattening and restraining of wood panels which reflects an older mentality, developed before the wide use of climate control in buildings, and has proven to be very detrimental in several instances.

Were her treatments remarkably good, or remarkably bad? Perhaps not, but they speak of one restorer's efforts, accomplished in waves as the collection grew and as needs arose, to stabilize a collection before climate control was put in place in the buildings housing paintings. With the exception of the treatment of paintings on panel, her work shows an increasing sensitivity. Many paintings were stabilized by Alice Dibble, and, because there has never been a permanent position for a painting conservator at the Shelburne Museum, it is the only stabilization treatment many paintings have had since they entered the collection. As late as 1979, some of the paintings were still displayed outside on the covered deck of the *Ticonderoga*, according to paintings conservator Mark Bockrath who completed a summer internship at the Shelburne Museum.

A conservation survey of the collection in 1980 by five prominent conservators, instigated by the museum director Benjamin Mason, resulted in unanimous recommendations for a full time conservator, and Richard Kerschner was hired in December 1982. Thus, the daunting job of initiating preservation and conservation measures for this immensely varied collection began. In Kerschner's honest opinion, many paintings would not have lasted had Alice not done some of the structural work that she did.

Looking back on Mrs. Dibble's treatments, one may ponder, as does the author, how his or her treatments will fare when scrutinized in the future, and how, in general, today's preconceptions will be viewed by future conservators.

ACKNOWLEDGMENTS

The author would like to thank Shelburne Museum conservators Richard L. Kerschner, Director of Preservation and Conservation, and Nancie Ravenel, Objects Conservator, for their kind support. The observations made by other paintings

conservators who have worked at the Shelburne Museum, especially the late Kathryn Hird who completed a major and thorough survey of the paintings collection in the late 1980s and early 1990s, as well as Sara McElroy and Suki Fredericks have been of great assistance to this project. Thank you also to conservators Mark Bockrath, Susanne Sack, Jean Portell, and Carolyn Tomkiewicz for their helpful contributions. Special thanks also go to Shelburne Museum Archivist Polly Darnell, as well as Richard H. Saunders and Douglas Perkins of the Middlebury College Museum of Art, Danielle M. Rougeau of Middlebury College, Prudence Doherty of University of Vermont Libraries, Margaret M. Tamulonis, of the Robert Hull Fleming Museum, University of Vermont, Eric Bessette of Shadows and Light Design, and Mary Volk, Shelburne Museum volunteer.

ENDNOTES

1. Charles Bornenti. "Alice Dibble is an artist for artists." *Bennington Banner*, July 31, 1971. p.7. Presumably, Alice was referring to the lack of classes when she was apprenticing prior to the 1950's, but she may not have been aware of the established conservation programs by the time of this interview.
2. "Shelburne Museum Lecturer to Discuss Restoring Paintings" Burlington Free Press, August 19, 1970. p.8 (announcement). Although no records have been found documenting Bentz's work at the Brooklyn museum, if he did indeed work there, it must have been before Sheldon Keck started Brooklyn's conservation lab in 1934. (Personal communications with Carolyn Tomkiewicz and Susanne Sack)
3. Alice Dibble's treatment of works of art on paper have not been surveyed and are not discussed in this paper.
4. The majority of the Havemeyer collection was given to the Metropolitan Musuem of Art, New York, in 1929. Several paintings inherited by Electra are exhibited at the Shelburne Museum in the Electra Havemeyer Memorial Building.
5. Weitzenhoffer, p. 188. Letter dated March 11, 1909.
6. Although Kuniej describes the canvas as interleaving fabric, it is most likely the old linen lining that Dibble chose not to remove.
7. Alice Dibble interview, 1961. Carol King Radio Show, Audio Tape # 23, Shelburne Museum Archives. The exact date of the interview and the broadcast is unknown. Several radio stations ran the show, and this recording is possibly from the radio station WDEV. The host's real name was Ellie Nowlin.

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KATHLEEN MARTIN, BONNIE RIMER,
JOSEPH BARABE, AND CAROL INJERD

A New Approach to the Treatment of Fatty Acid Crystals on Modern Oil Paintings

ABSTRACT

Fatty acid crystals found on the surfaces of modern oil paintings are thought to be the result of the migration of free fatty acids through a paint layer followed by exudation at the surface. The exudates may then crystallize, resulting in disfiguring white patches on the paint surface. The crystals are generally identified as palmitic acid, stearic acid, oleic acid and/or azelaic acid, and originate from the paint medium or from additives in the paint. Past attempts by conservators to remove the crystals have been shown to be only temporarily effective in most cases resulting in a return of the crystals over time. Treatment may result in damage to the paint layer or be inconsistent with the artist's aesthetic. This research focuses on a new approach, inspired by both skincare and food industry models, to permanently treat the appearance of fatty acid crystals by solubilizing and/or dispersing them thus rendering them less visible without perceptibly altering the surface of the paint layer.

INTRODUCTION

White fatty acid crystals may occur on the surfaces of certain modern oil paintings in as little as a few months upon completion of the painting (fig. 1). The crystals are disfiguring and previous attempts to remove them are generally not permanent. This work is in its earliest stages, and thus this paper is presenting the hypothesis and initial experiments only.

The crystals have been identified by infrared spectroscopy and gas chromatography/mass spectrometry as free fatty acids, primarily stearic and palmitic (saturated acids), oleic (monounsaturated acid) and azelaic (saturated diacid). Free fatty acids are an intrinsic component of the paint and are generated upon the hydrolysis of triglycerides. While polyunsaturated

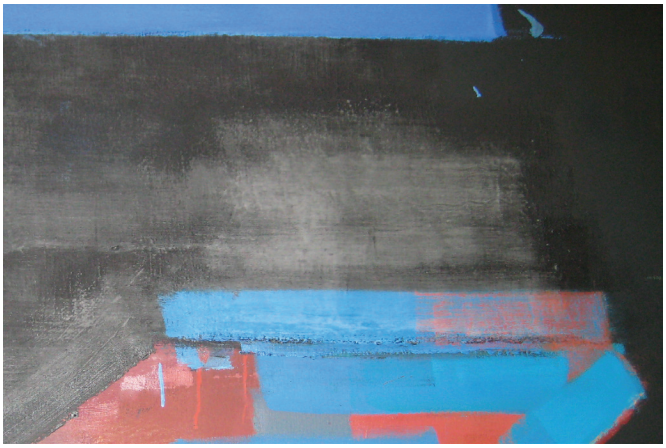

Figure 1. White fatty acid crystals on the surface of a modern oil painting.

acids such as linoleic and linolenic cross-link within the paint and are thus immobilized, saturated acids cannot cross-link and thus may migrate to the surface. Oleic acid does not fully cross-link and thus some amount of oleic acid is also mobile. Azelaic acid can form via oxidation of oleic acid and as a saturated acid, is also mobile within paint. Certain additives may contribute free fatty acids, as well. It is not known how migration may occur, whether through cracks and channels within the paint or whether by diffusion. The free fatty acids are exuded at the paint surface and can then crystallize around unidentified nucleation points (possibly dust or elements of the paint).

The phenomenon of fatty crystals has been known for some time. Many articles in the conservation literature have offered possible mechanisms and sources for the occurrence of fatty acid crystals on the surfaces of art objects. [1-5] To date, no one set of circumstances or mechanisms has been determined

to cause the phenomena and the occurrence from object to object varies. Further research is required to determine which variables are likely to lead to the presence of disfiguring crystals. Due to the complexity of the issue this paper will focus on treatment.

Past treatments for removing fatty acid crystals include mechanical means (brushing), aqueous treatments, organic solvents, heat treatment (with and without buffing), varnishing locally or overall, and the application of beeswax. In the case of brushing, aqueous treatments, organic solvents, and varnishing, crystals have been observed to recur in many cases. Furthermore, many of these treatments raise concerns about possible damage to the paintings. Repeated applications of organic solvents to the surface of paint films can result in leaching of the free fatty acids which act as plasticizers in the film. Leaching can lead to embrittlement of the paint layer, which can result in cracking and loss of paint. The use of heat, particularly on new paint films, may cause a breakdown of the paint and may lead to the creation of more free fatty acids. The effectiveness of beeswax is unproven and because a large proportion of beeswax is composed of wax esters, may provide a source of more free fatty acids.

Thus, it is necessary to identify a new approach to the elimination of the appearance of fatty acid crystals. In addition to being permanent, that approach must be aesthetically compatible with the artist's vision and must not damage the painting. Any treatment should also be reversible for future conservation efforts and ideally should be non-toxic and consist of readily available materials.

RESEARCH

This research was inspired by comparable research carried out in two industries, skincare and food. In skincare, moisturizers are used to treat the symptoms of dry skin, which include a dry rough feel and appearance of whitish flakes at the surface. Different mechanisms of action have been invoked, including humectancy, occlusion, and plasticization of the protein chains and phase modifications of lipids. An example of the latter is the addition of glycerol to skin lipids to transform a rigid crystalline structure (dry, cracked skin) to a more plasticized structure, leading to improved feel and appearance. [6]

In the food industry, the manufacture of chocolate offers a possible parallel. Fats can crystallize in many polymorphs, with some forms less desirable for mouth feel and texture as well as appearance. The gray/white bloom that can occur on the surface of chocolate is kept in check by careful control of processing temperatures and also by the use of additives that retard or stop the formation of certain crystal structures. [7, 8] Thus, both industries offer examples of using additives to control crystal structure to affect appearance. The effect is cosmetic, as the fundamental natures of skin and chocolate are unaffected.

TREATMENT TESTS

The proposed treatment for reduction of the fatty acid crystals on paintings is a two-step process. The first step is a traditional treatment to remove excess fatty acid crystals from the painting surface via mechanical means or mild solvent. The second step, and the focus of this paper, is the application of a non-volatile agent to the painting surface that can act upon fatty acids as they arrive at the surface and prevent formation of the unwanted crystal structures. In this way, fatty acids are not fully removed, but remain on the paint surface without forming unsightly crystals that interfere with the aesthetics of the painting. Agents may act either by dissolution of the fatty acids or by dispersing / disrupting the fatty acid molecules so that they cannot form solid white crystals.

Preliminary tests with several possible agents were conducted. One of these is oleic acid, which is attractive because it is an intrinsic component of the paint, but it is not inert and will oxidize over time, and thus may have limited applicability. Silicone oil and mineral oil are inert and may act to disperse fatty acids, but there are concerns about a possibly unacceptable level of gloss and uncontrolled flow into surrounding areas. Multiwax is another agent, which may be of interest. Like mineral oil, it is a hydrocarbon material, but has a higher molecular weight and thus is a solid and needs to be delivered via an organic solvent. Glycerol, which, like oleic acid is an intrinsic element of the paint, is also a possible agent, although glycerol is a humectant and thus would need to be evaluated for potentially drawing water to the paint surface. In addition, there are several surfactants, such as those used in the food and skincare industries, which may be of interest.

Proof-of-principle experiments were conducted, (and are still being conducted), using glass slides, which are coated with a film of fatty acid crystals. To prepare the slides, a mixture of fatty acids was made that mimicked the composition of fatty acids in crystals removed from paintings (stearic, palmitic, oleic and azelaic acids), the mixture was dissolved in organic solvents, and allowed to dry on glass slides, leaving a film of white solid crystals. The slides were then tested with a variety

of treatments and examined by light microscopy under both normal lighting (brightfield) and under crossed polarizers (where crystalline materials show up brightly).

The addition of oleic acid to the fatty acid crystals serves to dissolve them, as is apparent under both brightfield and crossed polarizers (fig. 2). Mineral oil behaves in a different manner. Under brightfield, the fatty acid crystals appear to disappear after mineral oil is added, but under crossed polarizers, it is apparent that crystalline material is still abundant (fig. 3). The apparent disappearance suggests a possible refractive index effect. Analysis of the material by x-ray diffraction suggests a very different crystal structure is present when mineral oil is added to the fatty acids. A third example is glycerol. When glycerol is added, the crystals are much less evident and under crossed polarizers, it is apparent that the amount of crystalline material is greatly reduced (fig. 4). Thus, the fatty acids may be dispersed and either no longer crystalline, or in the form of much smaller crystals.

Potential agents were also tested on oil paint paintouts (courtesy of Steven Prins, Steven Prins and Company) and on an oil painting painted in 2005 that developed disfiguring crystals within a year of completion. These substrates allowed us to test the aesthetics as well as performance in eliminating the crystals. All of the tests are recent and thus it is too soon to determine whether any of these agents will work in the longer term.

The paintouts consist of four panels, representing four paint manufacturers, each with several paints. Each paintout area in turn consists of a white acrylic ground with a stripe of black acrylic paint along the right encompassing a third of the paintout area. Paint was applied in three stripes: straight from the tube relatively thickly, spread thinly to mimic a glaze but without the addition of a diluent, and mixed 1 to 1 with titanium white. Several of the paintouts showed white crystals, (seen in both the thinly and thickly painted stripes but not the stripes with the titanium white mixture), identified by infrared spectroscopy as fatty acids (figs. 5-6). The paintouts are roughly ten years old and have been in storage with little interference since they were made. [9] The amount of crystals present varied by manufacturer with one manufacturer showing crystals on all colors, two with only some colors affected, and one with no crystals apparent on any of the paintouts. In some, the presence of the underlying stripe of black acrylic paint appears to have reduced the amount of fatty acid crystalss present on the surface (fig. 5).

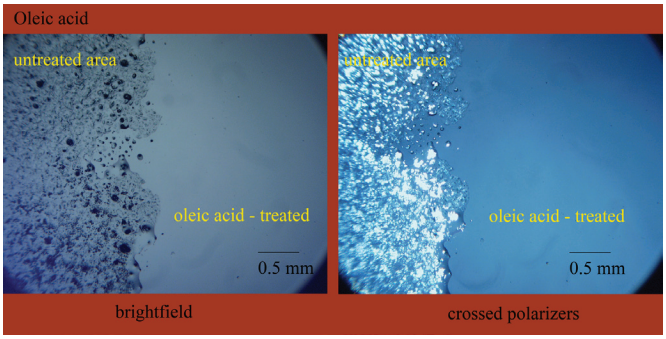

Figure 2. Application of oleic acid to fatty acid crystals deposited on glass slides and viewed under a polarizing light microscope. Left: under brightfield illumination, no crystals are visible in area treated with oleic acid. Right: under crossed polarizers, no crystals are visible in area treated with oleic acid.

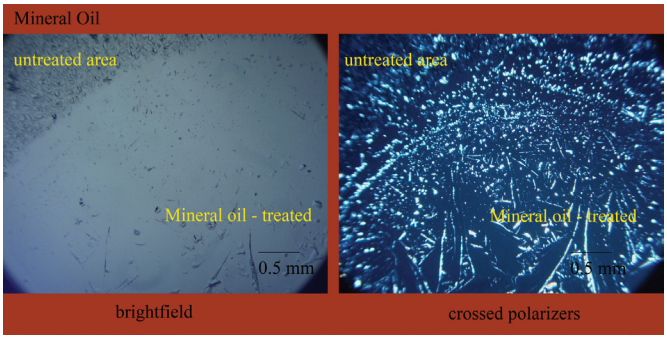

Figure 3. Application of mineral oil to fatty acid crystals deposited on glass slides and viewed under a polarizing light microscope. Left: under brightfield illumination, no crystals are visible in area treated with mineral oil. Right: under crossed polarizers, crystalline material is visible in area treated with mineral oil.

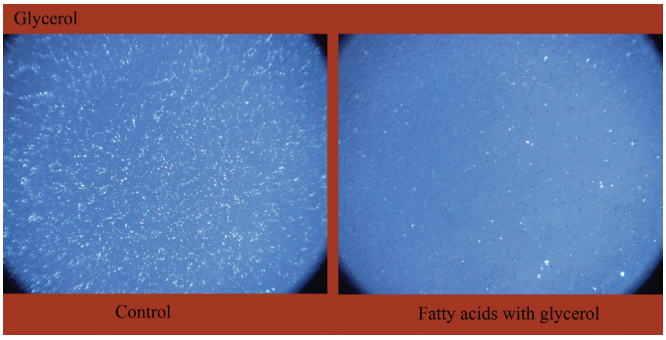

Figure 4. Application of glycerol to fatty acid crystals deposited on glass slides and viewed under a polarizing light microscope. Left: under crossed polarizers, crystals are visible in untreated area. Right: under crossed polarizers, fewer crystals are visible in area treated with glycerol.

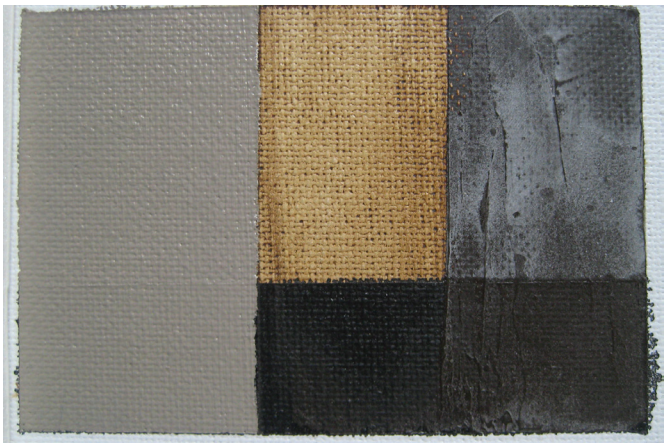

Figure 5. Paintout of raw umber (est.) from Steve Prins; fatty acid crystals are visible in area where paint was thickly applied. The presence of the stripe of black acrylic paint reduces the amount of crystals present on the overlying paint.

Figure 6. Paintout of alizarin from Steve Prins; fatty acid crystals are visible in area where paint was thickly applied.

The selected paint areas were treated with the two-step process, consisting of swabbing with naphtha or isopropanol to remove excess crystals followed by either brushing on a layer of oleic acid straight or multiwax 2% or 5% in naphtha (figs. 7-9). Silicone and mineral oil were eliminated as testing material as preliminary testing suggested that they may result in an unacceptable gloss, and silicone, in particular, may spread in an uncontrolled fashion. Based on very early examination, it appears that neither oleic acid nor multiwax have a negative impact on the aesthetics.

This research is still in the early stages and there are still several questions left unanswered. It is unknown why the crystals

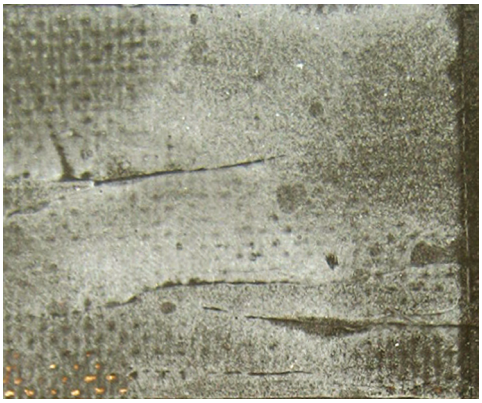

Figure 7. Close-up of fatty acid crystals formed on raw umber paintout prior to treatment.

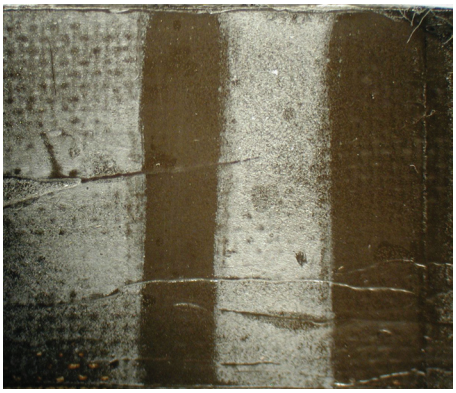

Figure 8. Close-up of raw umber paintout after treatment with naphtha followed by multiwax; the number of crystals is greatly reduced after treatment.

Figure 9. Close-up of alizarin paintout. Left side shows untreated area with a large concentration of fatty acid crystals; remaining area shows paintout after treatment with naphtha followed by oleic acid.

form, for example, and how factors such as the artist's techniques (including the use of diluents, an absence of varnish, layering techniques or lack of an adsorbent ground), paint composition (type of drying oil, additives, stabilizers, modifiers), or storage conditions (temperature, humidity, light) affect the appearance of crystals. It is suspected that the impetus for fatty acid crystals may be a combination of two or more factors. In addition, there is concern that conservation treatments, including solvents or heat, may exacerbate the problem of crystal formation.

In summary, the hypothesis shows some promise in proof-of-principle experiments that are currently being tested on real paints. Further work will include following these experiments further and exploring the mechanisms of fatty acid crystal formation.

ACKNOWLEDGEMENTS

The authors are indebted to private painting conservator Steven Prins for his donation of the oil paint paintouts used in our research. We would also like to thank Joe Swider of McCrone Associates for his XRD analysis of the crystals. And we are very grateful to several individuals within the conservation community that have provided advice on treatment options and information regarding the occurrence of fatty acid crystals in oil paints, especially, Jay Krueger (National Gallery of Art), Kristin Lister (Art Institute of Chicago), Jim Bernstein (Private Practice, San Francisco), Peter Schoenmann (Private Practice, Chicago), Rob Proctor (Private Practice, Houston), and Brad Epley (Menil Collection).

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JEAN DOMMERMUTH AND HELEN SPANDE

Two Portraits by Giacomo Ceruti, an Examination

ABSTRACT

Two paintings by Giacomo Ceruti (1698-1767), in the Acton Collection, Villa La Pietra, New York University, Florence, are considered. As part of a basic maintenance treatment these oil on canvas portraits were examined using only simple, inexpensive, non-invasive methods. Before the examination, the paintings were notable for their high quality, large scale and unvarnished surfaces, but on closer inspection also displayed a wide variety of virtuosic paint handling. It was decided to compare the observations made during this examination with published information on painting materials and techniques. While Ceruti himself has been little studied technically, the extensive information about related artists proved enlightening. This research, in combination with close visual comparison with other works by the artist, has created a good picture of the painting materials and methods used.

Called *il Pitocchetto* (the Little Beggar) for the depictions of peasants and workers for which he is best known, Ceruti also painted a large number of aristocratic portraits such as the Acton pair. However, a relative lack of written evidence about the artist leaves considerable gaps in his biography and understanding of his oeuvre. In light of this, the physical evidence of the paintings themselves may provide a key to understanding them as well as the painter's training, development, and influence. From this study, Ceruti emerges as not only a facile and fluent painter but also one with a sophisticated and innovative approach to materials.

Figure 1. Giacomo Ceruti, Portrait of a Hunter, c. 1740, oil on canvas, 119" x 86" (300.5 cm x 217.5 cm), Acton Collection, Villa La Pietra, New York University, Florence, LXI.B.2.

Figure 2. Giacomo Ceruti, Portrait of a Man on Horseback, c. 1740, oil on canvas, 119" x 86" (300.5 cm x 217.5 cm), Acton Collection, Villa La Pietra, New York University, Florence, LXI.C.3.

This paper presents an examination of two portraits by the 18th-century Italian painter Giacomo Ceruti. As the names of the sitters are not yet known, they will be referred to as the *Hunter* and the *Horseman* (figs. 1 and 2). As part of a maintenance treatment, these paintings were examined using only the most basic methods. This study can be seen, in part, as an exercise in *really looking*, in what can be learned about a painting through close visual examination, as well as comparison with other works—more than twenty of the artist's paintings were visited in museums—and with a study of the published literature.

The paintings, clearly a pair or part of a larger set, are quite striking both because of their high quality and their large size, measuring 300 by 217 centimeters or nearly ten feet high by over seven feet wide. The paintings are currently displayed in the ball room of Villa La Pietra, a fifteenth-century villa on the edge of Florence which houses a collection of artwork put together by the Acton family in the early 20th century. Villa La Pietra now belongs to New York University and serves as its Florentine campus.[1] It is not known where these paintings were before about 1925, but this was not their original location.

Because the entire Acton Collection is listed as Italian cultural property, everything done with it requires official permission from the *Soprintendenza*, or Italian Cultural Ministry. This would include taking any samples for analysis and, in general, Italians are quite hesitant about sampling. As this was never intended to be a full technical examination no samples were taken.

The paintings have many small losses overall. There are no plans for extensive treatment of them; they read well from a normal viewing distance and fit in well with the rest of the Acton Collection. They have been lined and put onto new stretchers, probably in the 1950s, and some losses are compensated for with toned fills. But the alterations through treatment are minimal and, quite significantly, the paintings have never been varnished. Their relatively untreated condition is ideal for studying their technique.

Giacomo Ceruti was born in Milan in 1698 and died there in 1767.[2] He is known to have worked in Brescia, Venice and Piacenza as well as in his native city. However, there is an unfortunate scarcity of documentation about the artist, and it is not known where, or with whom, he studied. Ceruti is sometimes called *il Pitocchetto* (the Little Beggar) for the depictions of common people for which he is best known. One set of a dozen paintings of peasants, beggars and workers was originally painted for the Avogadro family of Brescia and so is sometimes called the Avogadro Cycle.[3] During his career, Ceruti also painted a large number of aristocratic portraits, in the long tradition of Lombard portraiture. But even among these, the two Acton paintings are particularly grand in scale, complexity, and quality.

The support is a plain-weave canvas with ten warps and seven wefts per centimeter, which is relatively coarse.[4] From its macro appearance it seems to be a bast fiber, either linen or hemp. Most of Ceruti's known works are on canvas, but he also worked in fresco, on copper [5], and rather more unusually, did reverse paintings on glass.[6]

Many of Ceruti's canvas paintings are on a similar hefty weight canvas with a few exceptions on finer weaves. For example, there are two still lifes at the Brera, which are fairly small and detailed so that working on a finer canvas makes sense. But Ceruti also used a finer canvas for the *Spinner and Shepherd* at the Pinacoteca del Castello Sforzesco in Milan, which is relatively large (218 x 143 cm), so that the correlation between size and canvas weight does not seem to be direct.

To make up the width of the painting, three pieces of canvas have been sewn together; the seams are now clearly visible (fig. 3). The center section measures 78 cm wide and is the full width of the canvas, with each selvage butt-joined and whip-stitched to the selvage edges of the side pieces. These side pieces have been trimmed; the ground and paint extend onto

Figure 3. Giacomo Ceruti, *Portrait of a Man on Horseback*, detail showing vertical seam through the sitter's glove.

Figure 4. Giacomo Ceruti, *Portrait of a Man on Horseback*, detail showing edges of the painting.

the tacking edges and there is a lack of both scalloping and other tack holes (fig. 4).

Seventy-eight centimeters seems like a fairly narrow canvas and certainly wider ones were available to Ceruti. The *Spinner and Shepherd* (Pinacoteca del Castello Sforzesco in Milan) – 143 cm wide, does not appear to have a seam, although possibly there is a seam but it is better hidden. But by using three sections of narrow canvas, Ceruti cleverly avoided having a seam running through the center of the composition where it would be most noticeable.

The large size of the paintings could well suggest they were intended for a specific location. [7] Over the course of his career, Ceruti was involved with several decorative schemes for public buildings and private palaces. The best known is the Avogadro Cycle mentioned earlier. Also, for the Avogadro family Ceruti painted a portrait of a young girl of the family, which was incorporated into an elaborate molding. He also created decorative schemes for the *Broletto* (or Town Hall) of Brescia and for a church in Gandino near Bergamo.

If the present portraits were part of a larger cycle, could others in that cycle be indentified? A clue may have been found in a common condition issue. Both canvases have rectangular losses near the bottom in the center. This could, of course, be coincidental or could plausibly relate to a previous installation.

Quite interestingly, there is a very similar damage in *Spinner and Shepherd*. In raking light, a rectangular protrusion is visible, which has the appearance of a patch on the reverse that has come forward over time. If this is not a further coincidence, it could indicate a common link between all three paintings. Possibly there are four in the group, as the *Spinner and Shepherd* has what is considered to be a pendant, a *Shepherdess*. [8] This pair looks different from the *Hunter* and the *Horseman* although they clearly echo each other's pose, but this is at least in part a matter of condition. If the present pair was extensively inpainted and varnished, they would look much more similar to the shepherd pair. Against this theory is the fact that they are painted on different canvas weights, but perhaps this is so that the shepherd pair could be on a single width of canvas and not have a seam through the center.

The idea that Ceruti accepted, maybe even sought, variety among paintings in a set is suggested by the different colors of grounds used in the Avogadro Cycle, a large set of paintings with a relatively muted palette. *Shoemakers* has a reddish ground while *Women Sewing* has a deep beige one. This variation of ground color within the group of paintings would give the entirety a certain liveliness. [9]

All that can be said about the ground of the present portraits is that it is light-colored and fairly thin. Interestingly, there are white particles that seem to be associated with the ground. It is unclear, without further analysis, if these are particles of coarsely ground lead white, perhaps intentionally used to create a slightly grainy surface or if they are lead soap aggregates. [10] Such aggregates can occur when a ground or paint layer contains a lead-based pigment such as lead tin yellow or red lead. The particles in the paintings do slightly fluoresce in ultra-violet radiation, as lead soap aggregates do, but do not have the opalescent appearance generally, but not always, associated with such aggregates.

For designing compositions, Ceruti sometime used prints, particularly those of the seventeenth- century French artist Jacques Callot. [11] Sometimes these are direct quotations, as with a detail taken from Callot's the *Fair at Impruneta* [12] that is used in the background of the *Porter* at the Pinacoteca Tosio-Martinengo in Brescia. In other instances, Callot is more of an inspiration as when a tiny detail from the tiny etching *Little Trellis* (measuring only 3 1/8" x 6 ½") is transformed by Ceruti into the monumental *Laundress* at the Tosio-Martinego. [13] Some background details in the two present paintings seem possibly inspired by prints, but exact references have not yet been found.

In the portraits, no underdrawing is visible to the naked eye, even under magnification; and during the examination of these paintings no infra-red equipment was available. The relatively few drawings by Ceruti that have been published give a sense of what the artist's drawing style is like.[14] How exactly Ceruti used drawings in his process is not clear. Just as some of Ceruti's compositions are inspired by prints, but are not direct copies of them, the same is true of his drawings. In working out ideas for a painting, another step may have been small studies on card (such as the one at the Brera described in endnote 5).

It is in the handling of paint that Ceruti shows his sophistication and virtuosity. Many art historians writing about the artist speak admiringly of his brushwork, using such terms as "fluent," "free," and "refined."[15] In these two portraits, the paint is generally quite thinly applied allowing the texture of the canvas and ground to remain apparent, but they are also examples of how Ceruti created a wide variety of effects in an economical manner.

The basic order of painting is clear from a close examination. First, the background was blocked in leaving space for the figures in reserve; there is a small gap behind the horse's tail where this reserve was not fully used. This same technique was used by Ceruti for other portraits for example in the *Two Sisters* at the Tosio-Martinengo and, of course, by many other portrait painters. However, he chose a different process with *Hunters on a Hill* (private collection) in which a pentimento cutting across the dog clearly shows that the hill was painted first, then the figures painted over it, perhaps because the dogs are changes from the print by Abraham Bloemaert that inspired the composition. [16] With the two Acton portraits the figures were then painted in this reserve. The main figures are painted in a naturalistic way; the paint of the faces is well blended to create the illusion of three dimensions. This is very much in the Lombard tradition of Moretto da Brescia (Alessandro Bonvicino or Buonvicino, 1498 –1554) and Giovanni Battista Moroni (c.1520/24 – February 5, 1578).

The wide variety of textiles is painted with slightly less finish, the highlights and shadows blocked in *alla prima* or "wet-in-wet." Here again, there are clear similarities with the *Spinner and Shepherd*. These paintings also show Ceruti's keen attention to the details of how clothing works, for example how the buttons are sewn onto the gentleman's pocket or how the string is tied in a bow around the spinner's waist.

After the figures were complete the background was reinforced, outlining the figures; this is visible where a thick, assured stroke of light-colored paint follows and slightly overlaps the front legs of the horse. Ceruti used a similar bold stroke to cleanly define the outline of his *Spinner* from the Avogadro Cycle, now at the Tosio-Martinengo.

At this point, a few adjustments now visible as *pentimenti*, were made, for example the cuff of the proper right arm of the Horseman has been made a little smaller. It was not uncommon for Ceruti to make slight alterations at this stage; another *pentimento* is seen in the *Soldiers Playing Cards* (Tosio Martinego) where the foot of the soldier has been moved. But Ceruti was not a particularly indecisive painter—when painting in fresco as he did, large changes would have been difficult if not impossible.

Finally, details such as the small background figures behind the Hunter were sketched in on top. In the foreground of the Horseman, a few stones are briefly suggested with fluid strokes. Such a progression of painting is fairly standard procedure, but when he was working on reverse glass, Ceruti would have had to work in exactly the opposite way—details such as eyebrows first, then overall flesh-tones with no changes possible.

The paint medium is presumed to be a drying oil. Macroscopic examination, in combination with UV and magnification, provide some evidence about the painter's pigment choices. [17] For example, after the main layer of paint was dry, glazes were added, notably in the Hunter's waistcoat and possibly the Horseman's coat and breeches. In UV, several of the red and pink areas fluoresce, indicating the use of a natural red lake such as madder.[18] This is particularly striking in the brocade waistcoat of the Hunter, where red glazes were brushed on in "squiggles" to enrich the color of the red silk between the gold.

Ceruti made extensive use of red glazes in other paintings as well. For example, in the *Two Sisters* (Tosio-Martinengo) both the silk flowers on the younger girl's dress and the "real" flowers her sister carries in her apron are glazed in red. And the small figures (quoted from Callot) behind the *Porter* (Tosio-Martinengo) are made entirely of glazes, including red, which gives them a sketchy quality that adds to the sense of distance.

Interestingly, while the pink lining of the Horseman's coat fluoresces, the mauve saddle cloth does not seem to fluoresce

Figure 5. Giacomo Ceruti, *Portrait of a Hunter*, detail of impasto.

Figure 6. Giacomo Ceruti, *Portrait of a Hunter*, detail of dripped paint.

indicating that either the fluorescence is masked by other pigments in the mixture or another red pigment was used here. In several of his works, Ceruti seems especially fond of using different hues of red together to subtly play off each other.

As a final step in the painting of the textiles, details such as embroidery and lace were added with touches of impasto (fig. 5). This is more pronounced here than in other works by Ceruti, perhaps because the portraits have gone through fewer iterations of linings.

Ceruti's foliage is generally, as here, suggestive rather than illustrative. This kind of fluid, gestural foliage is found throughout his work, for example in the *Laundress.* The leaves of the tree behind the Hunter were painted with a translucent paint allowing the light-colored background to shine through, as sunlight would in nature. This paint was used so fluidly that it has puddled into round drips, creating the tips of the leaves. [19]

While these leaves are not atypical for Ceruti, they are strikingly close to those in *The Smoker* (Galleria Nazionale d'Arte Antica, Rome). And it too seems to have a pendant, *The Sleeping Pilgrim (*Roberto Longhi Foundation, Florence). Intriguingly, they are almost exactly the same size as the shepherd pair mentioned earlier. Most art historians have dated these individual paintings to different decades, but certainly this group of three pairs would make a cohesive group of six. Perhaps further technical analysis could establish a firmer link.

Returning to the handling of foliage, in the portraits the paint was allowed to drip quite dramatically creating a twig of striking naturalism (fig. 6). This is similar to the way that James Abbott McNeill Whistler (1834-1903)—more than a century later—would use drips in *Symphony in Flesh Colour and Pink: Portrait of Mrs. Frances Leyland* at the Frick Collection, New York.[20] Of course, there are also earlier instances of dripped paint, for example, they have been noted in the paintings of Diego Rodriguez de Silva y Velazquez (1599-1660).[21] Here Ceruti can be seen as part of this international lineage of virtuoso painters, as much as he is part of the Lombard tradition of realism.

Where it is used more thickly, as in the shadow of the tree behind the Hunter, this dark translucent paint has "mounded up" and acquired drying cracks. This probably indicates the use of an organic brown such as bitumen. While often associated with nineteenth-century painting, this colorant is believed to have been used in northern Italy at least since the sixteenth century. [22]

One of bitumen's many problems—its vulnerability to solvents—was not an issue with the portraits. Because they have never been varnished, they have never needed to be cleaned with organic solvents. This complete lack of varnish is evident in visible and specular light, under magnification, and in UV.

The historical use of varnish is still being studied, but it is clear that some artists never intended their works to be varnished. [23] Much of the evidence for that is documentary, such as

the writings of the Venetian art theorist Marco Boschini. These portraits are rare physical evidence of that practice.

Ceruti may have chosen not to varnish these paintings for at least two reasons. First, it would not have been very helpful. Saturation of colors is more important on paintings, including other works by Ceruti that depend on the contrast of the light figure and the dark background to create the illusion of three dimensions. The Acton paintings, however, have relatively little tonal contrast and instead use differences in hue and scale to give the appearance of depth. [21] This is not a unique instance in the artist's work. Gregori has noted that the removal of varnish from the *Laundress* in the 1980s particularly improved its appearance because of the painting's low tonal contrast.

Also, because of the size of the paintings, it is clear that they were meant to be seen as they are in the present hanging from a good distance. At this range, the effect of varnish on the light transmitted through it, is diminished by the light reflected off it, thus making a varnish less important.

The second reason not to varnish is that it would have caused problems. If such large paintings were glossy, it would be difficult to find a viewing angle where the specular reflection did not interfere with seeing the image. Ceruti's work in fresco would have shown him the usefulness of a matte, even grainy, surface when painting on a large scale. And, thinking back to his reverse paintings on glass, which would have been extremely smooth and glossy, it could be suggested that the artist had a particular interest in surface.

Through this study, quite a lot was learned about Ceruti and his technique, even if the study was limited to just really looking. He can be seen not only as a fluent painter, but also one with a sophisticated approach to materials. Where he gained those skills remains, like the identities of the sitters, a mystery—at least for now.

ACKNOWLEDGMENTS

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ENDNOTES

1. This pair of paintings has been displayed here since the early twentieth century when they were acquired by Arthur and Hortense Mitchell Acton. Their son, Sir Harold Acton, bequeathed the villa and its collection to New York University in 1994. The collection is thus called the Acton Collection.
2. The main source for biographical information on Giacomo Ceruti is Mina Gregori's 1982 monograph.
3. It is also referred to as the Padernello Cycle after the place where they were rediscovered in the early twentieth century.
4. This is coarser than all but one of the contemporary samples in Carbonnel's 1980 study of French painting canvases. See also Villers, an important source for information on artists' canvases.
5. The small *Portrait of a Gentleman* on paper laid down onto canvas at the Pinacoteca de Castello Sforzesco in Milan is thought to be a study for the *Portrait of Benedetto Martignoni* on copper in a private collection.
6. The authors would like to thank conservator Karen Thomas for discussions on a reverse glass painting by Ceruti that she recently treated. Davison writes that there was a tradition in Lombardy, dating back to the Renaissance, of reverse painting on rock crystal (quartz) for reliquaries and other pieces, but that reverse painting on glass in the middle of the eighteenth century was often associated with the "Augsburg style" of artists such as Johann Wolfgang Baumgartner; this technique spread to Bavaria and Bohemia and these paintings were exported to Italy, Spain, and the New World. Ceruti's paintings on glass may also relate to the transparent paintings of the middle and late eighteenth century described by De Bernardis.
7. In fact, when they were first published by Roberto Longhi in 1960, he believed they were part of the decoration of 1728 of the Broletto in Brescia. Gregori argues against this theory noting that the costumes and wigs are somewhat later—dating to the middle of the century and the middle of Ceruti's career.
8. This second painting, current location unknown, is illustrated in Gregori 1982. These two paintings are considered something of anomalies in Ceruti's oeuvre. They are different in tone, both in spirit and color than, for example, the Avogadro Cycle. The figures are dressed in "picturesque" clothes, very different from the ragged dress of the earlier "peasants." Gregori has noted their similarity to French painting, such as works by Boucher.
9. By contrast, Ceruti's slightly younger Roman contemporary, Pompeo Batoni, almost always used a pink ground. Primarily a portraitist, Batoni may have chosen this as a flattering color for his sitters. Batoni's painting technique is described at length in Bowron. For the grounds of other eighteenth-century paintings, see O'Donoghue on Boucher and Holubec on Kauffmann.

10. These are well described in Keune and Boon.
11. This was noted by Gregori in 1982.
12. This is a well known example of print making at its finest dating from 1620 and measuring 395 mm x 672 mm; it is catalogued as Lieure 361/III M 624.
13. There is an example of the print at the Metropolitan Museum of Art, accession number 57.650.322.
14. One is illustrated in Gregori, 1982, p.187. A different drawing at the Metropolitan Museum of Art (accession number 2002.575.2ab) was examined during this study. This two-sided drawing presents two individual figures, perhaps meant as studies to be used later, although neither of these relates to a known painting. Ceruti began with a sketch in charcoal, then went over the whole drawing with a pen and iron gall ink, with the contours such as the edge of the skirt being particularly defined with thick strokes. The authors would like to thank Rachel Mustalish for bringing this drawing to their attention and in examining it.
15. See Bayer, Lucchesi and Stradiotti, and Spike for art historical receptions of Ceruti's work.
16. See Gregori 1982 p.60.
17. While there is no published information on Ceruti's pigments, his Venetian contemporary Canaletto has been well-analyzed. See Effmann, as well as Pemberton-Pigott.
18. See Schweppe and Roosen-Runge, as well as Kirby.
19. One can find remarkably similar transparent leaves, with mounded tips in the paintings of Francesco Guardi. See Spande 2006 for Guardi's use of Van Dyck brown.
20. This is discussed in Hermens, 2009.
21. See Brown and Garrida. They note drips in the landscape of *The Surrender of Breda* as well as in *Equestrian Portrait of Prince Balthasar Carlos.*
22. Bothe. See also Massing.
23. See Glanville. Much of the following on the optics of varnish is from that excellent article.
24. Bois discusses the idea that paintings with low tonal contrast have less need of varnish. He is discussing Ad Reinhardt but also he cites Poussin.

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TOMAS MARKEVICIUS

The Triumph of Mordecai at The National Gallery of Canada: New Findings on Botticelli's Role and Direct Involvement in Extraordinary Collaboration with Filippino Lippi in the c.1475 Cycle Depicting the Story of Ester

ABSTRACT

Around 1475, one of the most significant Renaissance nuptial chamber cycles depicting the *Story of Esther* was executed by Sandro Botticelli with the help of his young apprentice and collaborator, Filippino Lippi. The six panels now distributed between Canada, France, and Italy, originally decorated a pair of now dismembered *cassoni* or marriage chests. The authorship of the cycle has been the subject of hot debate since the late 19th century and continues today. Evidence from technical examination was not explored systematically in the past and was not considered in the attribution debate. The new findings obtained during the first comprehensive technical study shed new light on the attribution and on early Botticelli studio practices. They highlight the role of multidisciplinary studies, introducing a further perspective to our appreciation, and adding critical dimension to the *Virtù d'Amore: Nuptial Paintings in the 15th Century Florence* exhibition at the Galleria dell'Accademia in Florence, where most of the renowned cycle was reunited for the first time in more than 200 years.

INTRODUCTION

Two highly important Quattrocento panels at the National Gallery of Canada: *Esther at the Palace Gate* and *The Triumph of Mordecai* constitute the beginning and the end of one of the most important nuptial chamber cycles executed at the workshop of Botticelli around 1475. The cycle depicts the Old Testament story of Esther, which by praising the virtues of the Jewish heroine, suited well as a moralizing lesson for the Renaissance bride. [1] Recent studies [2] suggest that the cycle, which consist of two oblong and four smaller nearly square panels [3] more likely adorned two marriage chests, the type known as *cassoni*, than any other type of furnishing or

Figure 1. (top) Sandro Botticelli and Filippino Lippi *The Story of Esther* Cassone I dedicated to the bride: Panel I *Esther at the Palace Gate* National Gallery of Canada, Ottawa.

Figure 2. Sandro Botticelli *The Story of Esther* Cassone II dedicated to the groom: Panel III "The Triumph of Mordecai" National Gallery of Canada, Ottawa.

wall embellishment. This claim is also supported by presence of semicircular areas with multiple indentations identified in the upper central part of Louvre and Chantilly panels, which could have been left by the pendulant key set engaged in the lock above. As suggested recently by J. K. Nelson, however, its revolutionary spatial composition had become a landmark where the spalliera paintings started. [4]

The iconography, the history and the attribution of the cycle has been a problem to scholars since the later 19th century and many questions about this highly discussed Renaissance cycle still remain to be answered. [5] Nothing is know about the commission and the documented history of the cycle starts only in 1816 when the *Mordecai Weeping*, commonly known as the *Derelitta,* was acquired by the prince Giuseppe Rospigliosi as work by Masaccio and a few decades later the other five panels were noted at the Palazzo Torrigiani and were published in 1855 by Jacop Burkhart [6], appeared in the diary of Otto Mündler [7] in 1856, and in the notes of Sir Charles Eastlake in 1864. However, only in 1930, C. Gamba and E. Wind reconnected the *Derelitta* to the rest of the cycle and since then the discussion was centered on the attribution: who was the author of the six panels—Botticelli or Filippino?

The creation of *cassone* was obviously a highly collaborative process involving structural carpentry, carved and running moulding, *pastiglia* and punched gilding, as well as decorative paintwork and actual inset or in-situ paintings. This would involve extended workshops and in such close collaborations the attempt to distinguish the contributions in terms of program, design, construction and execution is very difficult, as noted by N. Pons. [8] Additionally, as convincingly argued by J. K. Nelson, in the 15th century the final credit was usually given to the major master. [9]

Art history, however, has not been content with that logical convenience and the authorship of the panels of the *Story of Esther* has been the subject of fierce debate since the late 19th century and continues today. Starting with Burkhart [10], the majority of scholars adhered to the concept of giving the execution of the whole cycle to Filippino Lipi, working from the ideas, design, and cartoons of Botticelli. [11] Based on stylistic differences, noted already by Horne, this notion was contested by M. Laclotte [12], E. Fahy, J. K. Nelson, A. Paolucci and A. Cecchi, who considered one or two panels as autograph works by Botticelli. [13]

Evidence from technical examination, which could have provided a great deal of useful information was explored very little in the past and could not be considered. Recently, triggered by the unusual findings with infrared reflectography, a comprehensive comparative study was undertaken by the National Gallery of Canada: the initiative in course joined enthusiastically those with responsibility for the elements of the cycle: Palazzo Pallavicini, Le Centre de Recherché e des Restauration des Musées de France (C2RMF) and the respective museums. Current technical study provided new findings [14] and has allowed an exploration of the *Story of Esther* from a very practical perspective. [15] The unusual findings revealed by infrared reflectography give us a sense of the nature of the collaboration, and the different approaches within the underdrawing are the main focus of this study.

EXAMINATION WITH INFRARED REFLECTOGRAPHY (IRR) AND X-RAYS

While IR photographs and XR images of some elements of the cycle existed and had been studied (Louvre, 1972, and NGC, 1996), the evidence had not been considered seriously in the attribution debate. In 2009, the cycle was re-examined using the new generation IRR equipment with InGaAs sensor (900-1785 nμ). [16] Two principal types of underdrawing were identified in all six paintings. Principal figures were initially located with a dry, now faint, charcoal and then affirmed with wet brushed ink-like paint (charcoal with binder in aqua). [17] Linear elements of architecture and other features were incised or indented into the gesso using a straight-edge and some form of compass. On the frontal panels with more complex settings, initial drafting was laid out with a soft metal stylus before the incising (feature not indentified in lateral panels) and additions or relocations to architecture seem to have been made with further incisions into the paint film. The approaches to underdrawing is various and quite different in individual panels, as outlined below.

ESTHER AT THE PALACE GATE (OTTAWA, NATIONAL GALLERY OF CANADA)

IR reflectography (IRR) revealed freehand gestural underdrawing applied with a fine brush and ink-like paint. Most of the linear underdrawing was concentrated in the figure, while the landscape was outlined with a few loose lines and washes. Esther's profile was delineated with "dry," but much finer lines and with more precision than the rest, likely using a different material, such as *pietra nera*, a method described by Cennini and identified in other works by Botticelli. [18] The revealed stylographic features are similar to those in drawings by Filippino and the dynamism and looseness recall his post

1475 drawings. The underdrawing in the figure delineates the principal shapes and has numerous searching, gestural marks in comparison to the cohered painted form. The tower above Esther's head shows a conical roof in the earlier version. The guidelines for the architecture were indented into the gesso (before, and in one instance also after the application of the imprimatura) using a straight-edge and stylus and a pin-and-string tool for the convergence of perspective. [19] Digital reconstruction of space and perspective provided unexpected results, indicating multiple convergence points with only a few of the converging rays running towards the pin hole. Such an approach, contrary to the laws of Albertian space, seems characteristic also of some other works by Filippino. [20]

Procession of the Maidens before Ahasuerus (Chantilly, Museé Condé)

Freehand underdrawing for figures and a combination of drafted and indented lines for the architecture were identified. The first step was the marking of a central vertical line from which the architecture was drafted using a soft-metal stylus, which left the lines visible in IRR only. The overall creative approach excludes the use of cartoon, but preparatory drawings may have existed. The next step was outlining the figures with charcoal, reinforcing the drawing with the ink-like paint, and reducing the unnecessary lines. Once the composition was established, the lines for the architecture were indented, avoiding the figures. Some figures, like the female on the far left side, were indented through (likely by mistake).

Vashti leaving the Royal Palace (Florence, Museo Horne)

Linear drawing for the figure and indented lines for the architecture were revealed. The underdrawing of Vashti appears very different from the underdrawings found elsewhere and is unexpectedly detailed and monotonous. The drawing was enlivened with more vibrant freely drawn lines, and the underdrawing was reconsidered in the painting process. One scenario that suggests itself is that a cartoon was used on this panel though not followed in all detail. The indented lines correspond to architectural elements and two horizon lines were indented, opposite to single central vertical lines noted in frontal panels.

The Mordecai Weeping, known as the *Derelitta*, (Rome, Collezione Pallavicini)

Affirmative, yet elegant freehand underdrawing was found in the figure, while the architecture was marked with the detailed indentations in the ground. While the drawing was followed closely during painting, we could identify minor pentimenti in details, such as a change in the toes of the left foot, extension of the right leg, correction of the shape of his right elbow and other. The indented lines were applied in a rather sophisticated and adept way, using a straight-edge and compass, and multiple auxiliary lines. The incised lines just minimally cross the drawn lines in the figure, indicating that the figure was outlined prior to the final setting of the architecture. Plotting the lines revealed two central convergence points and the corresponding pin-holes were identified.

Intercession of Esther before Ahasuerus (Paris, Museé du Louvre)

The Chantilly and Paris paintings share a very similar approach and nearly all observations made on the underdrawing in the Chantilly panel are valid also here. Of particular interest is the embracing group in the centre. The XR examination revealed significant changes in the figure on the right and in the initial version the group had a lot in common with comparable embracing figures in much later Botticelli's *Mystic Nativity* at the National Gallery, London. As with the Chantilly painting, the steps were planned in the initial version, but the setting was changed at a later stage covering the steps with the panels with grotesques.

The Triumph of Mordecai (Ottawa, National Gallery of Canada)

Affirmative yet elegant freehand lines in the figures and the indented lines for the architecture were identified. The underdrawing bears resemblance to the underdrawing in the Pallaviccini painting and to other underdrawings by Botticelli. The indented lines were applied using same methods as before, but any initial lines drafted in metal-point (like in Paris and Chantilly paintings) could not be seen at all here. Instead, of particular interest are the 3-4 pin holes used to construct the perspective. Only two or three correspond to the actual convergence points and this looks like a conscious decision—a feature also seen in the Pallavicini painting, but not in the frontal panels.

CONCLUSIONS AND DISCUSSION

This comparative study, exploring the technical modalities of the cycle revealed important differences between the individual panels. All panels but *Esther at the Palace Gate* (NGC) share a coherent and structured approach to architecture in

the underdrawing, characterized by multiple indented lines, meticulous drafting and the sophisticated application of Albertian space, which are generally considered characteristic of Botticelli. The approach in the *Esther at the Palace Gate* is very different. The painting has some indented lines, but unlike the other five panels, which essentially employ central point perspective, the converging rays run from multiple, imprecisely placed points, and most of the cityscape was outlined without the use of linear convergence. This approach, in essence, using the rules of perspective rather loosely, and ultimately working intuitively within the system and relying as much on aerial perspective as on linear, is a developing feature for late 15th-century art and is perhaps more easily associated with Filippino than with his teacher. While all six paintings give an impression of correct central point convergence, the actual approach differs from panel to panel.

The logic and rhythmic effect of the setting is more important to the construction of *Mordecai in Triumph* (Ottawa, NGC) and *Mordecai Weeping* (Rome, Pallavicini). Both panels show subtle and knowing adjustments to convergence points to achieve more compelling and potentially expressive effect. This competence and subtle use of Albertian space will become crucial in Botticelli's later works. Further interesting distortions of Albertian space were revealed in the frontal panels, where the central convergence point was placed above the visual horizon line and the figures appear unnaturally elongated when observed at eye level. When viewed from above, however, the proportions are more satisfactory and this indicates the paintings were indeed panels on the *cassone*, rather than *spalliera*, as argued by J. K. Nelson. [21]

The overall method of drawing, its frequent adaptive approach and the nature of the pentimenti seem to not support earlier arguments that cartoons were comprehensively used; only the Horne painting shows features we may associate with cartoon use and then only to a limited degree. The freedom of line and the degree of creativity revealed in the underdrawing indicates the strong overall presence of the master, which is not characteristic of many other Botticelli workshop pieces. They often have little freehand underdrawing and minimal adaptation beyond the drawing stage. A comparison might be made with the Nastagio degli Onesti cycle, where the approach to drawing is less cohesive and where scholars attribute sections of the drawing to Botticelli, *pentimenti*, and a comparable freedom of line are characteristic. [22]

The comparison of underdrawing of the panels of the *Story of Esther* revealed contrasting differences, which indicate the involvement of at least two, maybe more, hands. In the frontal panels, the collaboration of at least two artists could be observed. In the lateral panels (except of Horne painting), the underdrawing indicates a single hand in each panel, but not the same hand for all four of them. Method, approach, and style link Ottawa's *Mordecai* and the Rome panel and to some degree makes them stand apart from the other panels in terms of precision, subtlety, and quality of rhythm and line. Likely, these panels are where we see most of the master's hand. The underdrawing on the two other lateral panels also forces a link between those two, but it is notable that the approach between these two panels is fundamentally different and at the same time is also different from anywhere else in the cycle with its intuitive means of construction, exuberant and gestural approach to freehand drawing, and later reliance on suggestive painterly effect to stand in for the lack of structure in the drawing in *Esther* (Ottawa, NGC) or the use of cartoon in case of Horne painting.

On the issue of the painting, the findings within the underdrawing support historic separations of hand within the cycle that where of course based on the final appearance of the panels, which include paint of course. And indeed, recent technical examination to some degree supports these distinctions, revealing, as it does, fundamental differences in painting approach between some of the panels. While this technical information can not be reported in this article with any depth, it is hopefully enough to say that they support and confirm intelligent reading of the different approaches in the underdrawing. [23] That is to say that the Pallavicini and one of Ottawa lateral panels appear to be solely by Botticelli, while the frontal panels show more his input in ideation, underdrawing, and supervision. In the finishing, however, the heads and hands bear more resemblance to Filippino, and in other areas—the draperies, for example, there appears to be a further hand from the workshop. *Esther at the Palace Gate* (Ottawa, NGC) stands out from the cycle in almost every respect and may be entirely by young Filippino, while the Horne panel possibly shows an assistant working after a cartoon with corrections in the underdrawing by Botticelli.

One interesting practical note is that on these last two lateral panels the presence of bole and gold leaf beneath the paint from a now lost attached framing element show that the setting was gilded before painting started and these panels may have been already incorporated into the gilded structure while blank. This is not the case with the other four panels, which were all completed before the gilding and bear traces of original gold leaf over the paint layer.

This is another reminder of the complexity in practical coordination and a further indication of what a collaborative endeavour *cassoni* were. Overall, the scenario delineated here seems to indicate Botticelli's strong presence as a supervisor and active participant, but with significant use of assistants, as one would expect. It may be that it confirms an earlier proposition by C. Gamba and M. Laclotte that Botticelli received the commission, started the work, painted himself the Pallavicini painting and one of Ottawa's panels, but, also—as this study shows—did a significant part of the underdrawing on the other panels, and as soon as the project was on the right track left the rest to Filippino and other assistants. Many more questions associated with this extraordinary Renaissance cycle remain unanswered and go beyond the scope of this paper. The study has, however, by revealing the different approaches in *modus operandi,* contributed to our understanding of the *Story of Esther* and added further dimension to our appreciation. [24]

ENDNOTES

1. See detailed description in Jonathan K. Nelson entry in *Virtù d'Amore, Pittura Nuziale nel Quattrocento Fiorentino*, exhibition catalogue (Galleria dell'Accademia, Florence 7 June – 1 November, 2010) Florence 2010, pp. 204-208
2. Jonathan K. Nelson *Le rivoluzionarie composizioni di Botticelli e Filippino Lippi per i dipinti da cassone e da spalliera* pp. 139-147 and Tomas Markevicius *The Invisible Story of Esther: Revealing Botticelli and Filippino Collaboration and Approaches to Underdrawing* pp. 210-213 in *Virtù d'Amore, Pittura Nuziale nel Quattrocento Fiorentino* exhibition catalogue (Galleria dell'Accademia, Florence 7 June – 1 November, 2010) ed. Claudio Paolini, Daniela Parenti, Ludovica Sebregondi, Florence 2010
3. First cassone, dedicated to the bride: Panel I *Vashti Leaves the Kingdom* (48,5 x 43,2-4 x 3,3-5 cm) Museo Horne, Florence; Panel II: *Procession of the Maidens before Ahasuerus* (47 x 131 x 3.5 cm) Museé Condé, Chantilly; Panel III: *Esther at the Palace Gate* (48.4 x 43.2 x 3.2 cm) National Gallery of Canada, Ottawa. Second cassone, dedicated to the groom: Panel I - *Mordecai Weeping*, known as the *Derelitta* (47 x 43 x 1, 9 cm – painting; 2.5 cm extra with attached cradle) Collezione Pallavicini, Rome; Panel II - *Intercession of Esther before Ahasuerus* (48 x 132 x 3.5 cm) Museé du Louvre, Paris; Panel III - *The Triumph of Mordecai* (48.3 x 43.2 x 3.5 cm), National Gallery of Canada, Ottawa
4. Jonathan K. Nelson *Putting Botticelli and Filippino in their Place: the Intended Height of Spalliera Paintings and Tondi.* In "Invisible agli occhi. Atti della giornata di studio in ricordo di Lisa Venturini", ed. Nicoletta Baldini, Florence, Fondazione Roberto Longhi, 2007, pp. 53-63.
5. On the attribution debate see: Patrizia Zambrano *Storie a figure piccole: Filippino Lippi e la narrazione di storie* in P. Zambrano and J.K. Nelson "Filippino Lippi", pp. 141-179 and pp. 313-317
6. J. Burckhardt, *Der Cicerone Eine enleitung zum Genuss der Kunstwerk Italiens*, Basel 1855, p. 803
7. Otto Mündler at the Palazzo Torrigiani mentions "two companion pictures – cassoni" that form "long and narrow representing of the history of Esther, by Filippino Lippi (instead of Botticelli). Besides some little *defuctuosities* (want of taste) they are extremely fine and in good state. Three similar ones (must be Ottawa and Florence panels - TM) are inferior and seem to be by Pinturicchio" in *The Traveler Diaries of Otto Mündler*, 1856, Book 1, Walpole Society, Vol 51, 1985 p. 131
8. N. Pons *L'unita delle arti in bottega* "Maestri e botteghe - Pittura a Firenze alla fine del Quatrocento" 1992, pp. 251-58
9. J. K. Nelson "*Botticelli" or "Filippino"? How to Define Authorship in a Renaissance Workshop*, "Sandro Botticelli and Herbert Horne" 2010, pp. 137-167
10. See note 5
11. From 1899 till 1933 the cycle was given to *Amico di Sandro* by B. Berenson; an attribution contested by Horne and by eventually by Berenson himself.
12. See M. Laclotte in *Defense du Patrimoine national: Oeuvres acceptées par l'État en paiement de droits de succession, 1972-1977*, catalogue of the exhibition (Paris), Paris 1978.
13. See J. Nelson entry in *Virtu d'Amore* and P. Zambrano in P. Zambrano and J. K. Nelson *Filippino Lippi*, 2004, pp. 141- 55; 313-17
14. A great deal of important information was obtained during the focussed visual exam. Non destructive analysis, using the x-rays (XR), ultraviolet light (UV), infrared reflectography (IRR) and other non invasive methods exiting provided information, unavailable before.
15. Microscopic samples were taken from both NGC paintings, and painting materials were identified and compared at the Canadian Conservation Institute (CCI). The examination of the Pallaviccini painting was accomplished by C. Falcucci in Rome; the Horne painting was examined by R. Lari, conservator in Florence, and the IRR image was provided by L. Pezzati at C.N.R INOA group in Florence. The initiative of N. Garnier, curator at Museé Condé and of D. Thiebaut, curator at the Louvre, and B.

Mottin, director at the C2RMF resulted in the comprehensive examination of the frontal panels. The study day at C2RMF, provided the unique opportunity of comparing the elements of the cycle, technically and otherwise.

16. The two NGC paintings were examined with a Hamamatsu InGaAs IRR camera; InGaAs high definition scanner was used examining the Pallavicini panel and the painting in Museo Horne was examined using the high definition infrared scanner. Louvre and Chantilly panels were examined using an Osiris IRR camera.
17. Similar two-phased approach is very apparent in Botticelli illustrations for Dante's Divine Comedy, where the first step was outlining the figures and other elements with a metal stylus, reinforcing the drawing with the ink and reducing or wiping away the unnecessary lines.
18. Ezio Buzzegoli *Osservazioni tecniche dalla lettura comparata di indagine ottiche su tre opere del Botticelli* in "Il tondo di Botticelli a Piacenza" 2006, pp. 90; 81-91
19. A tiny pin hole identified behind the head of Esther, suggests the use of the pin-and-string method for the converging rays in linear perspective.
20. Digital reconstruction revealed multiple convergence points and accidental use of linear perspective in the following paintings by Filippino Lippi: *Samian Sibyl, Cumanean Sibyl, Hellespontine Sibyl, Phrygian Sibyl, Tiburtine Sibyl* Christ Church Picture Gallery, Oxford; *Annunciation,* Musei Civici, Pinacoteca, San Gimignano; Essentially correct linear perspective with single point convergence and closely located points was identified in paintings by Sandro Botticelli: 1. *Persian Sibyl, Libyan Sibyl, Delphic Sibyl, Cimmerian Sibyl, Erythraean Sibyl*, Oxford, Christ Church Picture Gallery 2. *Calumny* Firenze, Galleria degli Uffizi. 3. *St. Augustine in the Studio*, Firenze, Galleria degli Uffizi, *The Story of Lucretia*, Isabella Stewart Gardner Museum, Boston; *Three Miracles of St. Zanobi,* National Gallery London and others.
21. See notes 1, 2, and 4
22. See Gabriele Finaldi and Carmin Garrido *La Historia de Nastagio degli Onesti, Cuadro III, E Banquete en el Pinar (K183)* in "El Trazo Oculto" 2006, pp. 138-147
23. Overall, the painting technique and materials are consistent with Botticelli and his workshop practice reported also by other studies. Interesting differences, however, were revealed in the layering in the composition of chromatically similar areas and in *ductus* of the brushwork between the two NGC paintings.
24. My most sincere gratitude goes to numerous individuals and institutions whose contribution made this research possible and meaningful. In first place, many thanks go to my home institution and to Stephen Gritt, Chief Conservator at the RCL, whose observations, advice, and dedication were the keystone in this research; and to Kate Helwig and Kenza Kahrim at the Canadian Conservation Institute for the most useful findings examining the painting materials. My gratitude goes the Princess Maria Camilla Pallavicini for her interest and generous support, and to Franca Falletti, Director at the Galleria dell''Accademia in Florence, to Duncan Bull, Head Conservator at the Rijksmuseum in Amsterdam, to Elisabetta Nardinocchi, Director at Museo Horne, to Lucca Pezzati and the C.N.R. - INOA group in Florence, to Dette Gabriel, Curator at Städel Museum in Frankfurt, to Angelo Tartuferi, Curator at the Uffizi, to Andrea di Lorenzo, Conservator at Museo Poldi Pezzoli in Milan, and to other institutions and researchers, who shared valuable information and supported my search. I am in greatest debt to Bruno Mottin from the Le centre de Recherche e des Restauration des Musées de France for his extraordinary findings and most amazing images, and with Dominique Thiebaut, curator at Louvre and Nicolle Garnier, curator at Museé Condé, for their genuine interest and support. I am most grateful to Claudio Falcucci, researcher in Rome and to Rosella Lari, conservator in Florence, for the valuable findings examining Horne and Pallaviccini paintings. Lastly, my very special thanks go Jonathan K. Nelson, whose expertise and advice guided my search.

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Figure 3. Underdrawing revealed by IR reflectography (Hamamatsu InGaAs 1750 nm): *Esther at the Palace Gate* (National Gallery of Canada, Ottawa). Image by F. Jong and T. Markevicius.

Figure 5. Underdrawing revealed by IR reflectography (full spectrum CCD, Nikon D40X with B&W 093 filter 900 - 1100 nm): detail of Esther's head in *Esther at the Palace Gate* (National Gallery of Canada, Ottawa). Image by T. Markevicius.

Figure 4. Underdrawing revealed by IR reflectography (Hamamatsu InGaAs 1750 nm): *The Triumph of Mordecai* (National Gallery of Canada, Ottawa). Image by F. Jong and T. Markevicius.

Figure 6. Botticelli's *The Triumph of Mordecai* (National Gallery of Canada, Ottawa): detail.

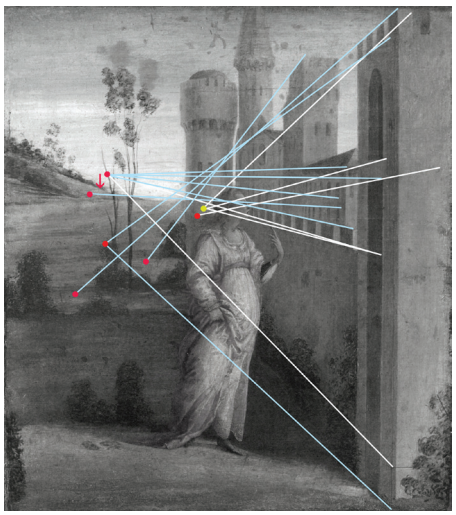

Figure 7. Reconstruction on the linear perspective in *Esther at the Palace Gate* (Ottawa). White rays indicate the extension of the indented lines; blue rays indicate non indented converging rays; Pin hole marked yellow; other points of convergence marked red. Image by T. Markevicius.

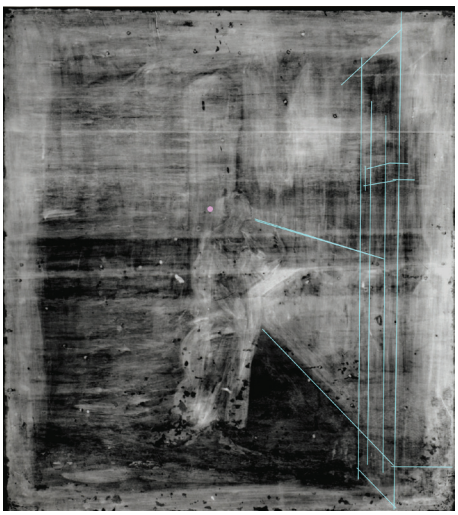

Figure 9. Reconstruction over the x-ray, comparing the use of indented lines in *Esther at the Palace Gate* (Ottawa). Indented lines marked in blue, pin holes marked pink. Image and reconstruction by T. Markevicius.

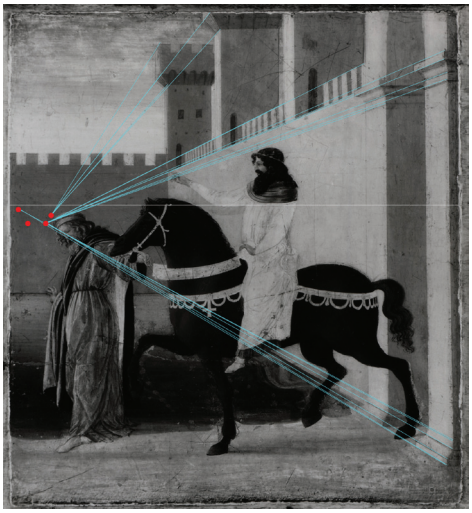

Figure 8. Reconstruction of Albertian space and linear perspective in Botticelli's *The Triumph of Mordecai* (National Gallery of Canada, Ottawa) indicating the prevailing central convergence and consciously introduced multiple points. Reconstruction by T. Markevicius.

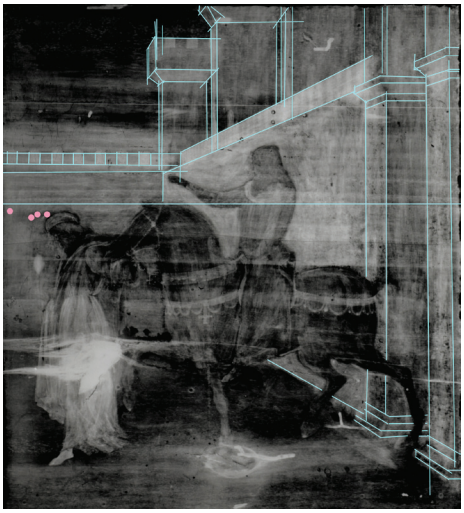

Figure 10. Digital reconstruction over the x-ray, comparing the use of indented lines in *The Triumph of Mordecai* (Ottawa). Indented lines marked in blue, pin holes marked pink. Image and reconstruction by T. Markevicius.

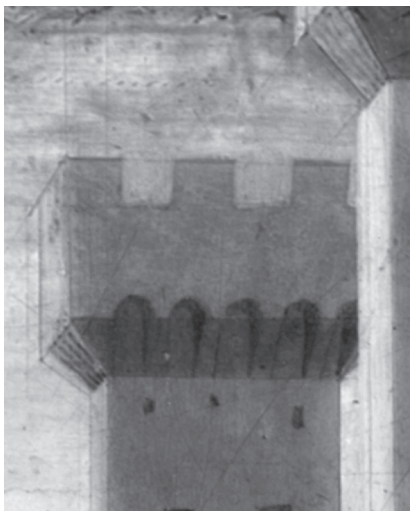

Figure 11. IRR image of Botticelli's *The Triumph of Mordecai*, detail showing the drafting of the architecture.

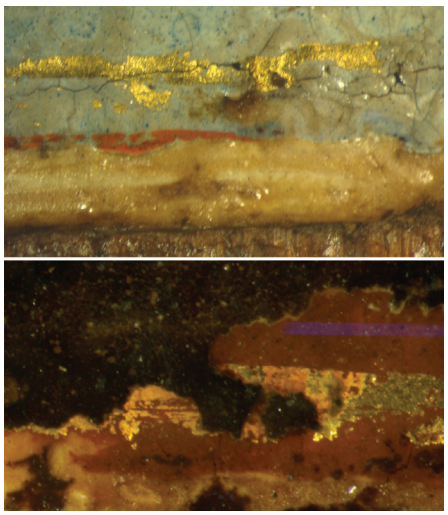

Figure 13. Detail of gilding from the now lost framing element. Above: *The Triumph of Mordecai* (National Gallery of Canada, Ottawa), traces of gilding above the paint. Below: *Esther at the Palace Gates* (National Gallery of Canada, Ottawa): gilding beneath the paint layers. Image by T. Markevicius.

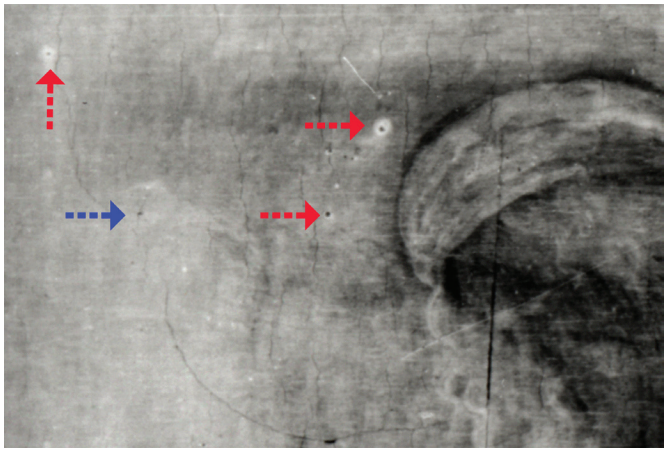

Figure 12. Pin holes left by the pin-and-string tool revealed by x-rays: 3 pin holes (red arrows) correspond to the actual convergence, 1 pin hole (blue arrows) was not used. Image by T. Markevicius.

SERENA URRY

Technical Examination and Treatment of Three Panels of a Predella by Sassetta

ABSTRACT

The Detroit Institute of Arts owns three of four Passion scenes from one side of the predella of Sassetta's two-sided altarpiece for Borgo San Sepolcro. Remnants of original carpentry allowed extrapolation of the original length and appearance of the predella, and contributed to the whole reconstruction of the altarpiece. Accessioned separately, *The Agony in the Garden*, *The Betrayal of Christ* and *Procession to Calvary* are in disparate states of preservation. The conservation treatments were aided by having contemporaneous panels by the same artist as references, and by the fact that the *Agony* and the *Betrayal* are closely sequential scenes.

INTRODUCTION

The topic of this lecture began as part of a reinstallation project at the Detroit Institute of Arts a few years ago. A closer look at the DIAs three predella panels by Sassetta from the altarpiece for Borgo San Sepolcro began as a technical examination, evolved into treatment, and was later absorbed by a larger reconstruction project undertaken by the Villa I Tatti – The Harvard University Center for Italian Renaissance Studies and the Opificio delle Pietre Dure in Florence.[1]

This paper presents a brief history of the altarpiece, from its well-documented commission, to its dismantlement and dispersion, to the current scholarship regarding its reconstruction. The Detroit panels will then be discussed, their disparate states of preservation, and how information gleaned from the technical examinations contributed to the reconstruction of the altarpiece as a whole. Finally, the recent conservation treatments will be described, including how they were aided by the fortunate circumstance of the three panels being treated simultaneously.

HISTORY OF THE ALTARPIECE

In 1437, the Franciscan friars in Borgo San Sepolcro commissioned Sienese artist, Stefano di Giovanni, called Sassetta, to produce a large double-sided altarpiece for the Church of San Francesco. A commission document, or scripta, describes the program for the altarpiece. [2] On the front, or nave side was to be a Virgin and Child Enthroned, flanked by three saints and the Blessed Ranieri, a local holy man who was entombed beneath the altar. On the other side was to be St. Francis Enthroned, along with eight particular scenes from his life. On the predella the scripta stated were to be "on the front side stories of the Passion those that are the most devout and are four."[3] On the other side were to be scenes of the miracles performed by the Blessed Ranieri. In this manner the local holy man would be visible on both sides, and his life would be linked to St. Francis's. The central pinnacles were to have a Crucifixion on the front, and an Annunciation on the reverse. The other pinnacles and piers were to be painted with a number of specific saints. All told, the individual figures and scenes of the altarpiece numbered more than sixty. It is no wonder that the price for the commission, 510 florins, is among the highest known in the Italian Renaissance. At the time, that sum would have bought five respectable houses.[4]

Sassetta declined to use an existing blank altarpiece in the Church of San Francesco, fabricated over a decade before. Instead he committed to producing the same structure at his workshop in Siena. Accordingly, five years later, in June 1444, he brought the altarpiece to Borgo San Sepolcro in a number

of large sections, and installed it on the massive stone altar that dated from 1304, the year of the Blessed Rasini's death.

It appears that Sassetta's altarpiece was removed from the high altar about 135 years later, between 1578 and 1583. Documents of an apostolic visit in 1583 describe placement of some of the large main tier panels in side chapels of San Francesco. The account suggests that the upper panels were still double-sided, so that one painted surface would have faced the wall. Indeed, the Virgin and Child Enthroned is mentioned on as being on display, while its reverse side, St. Francis in Glory has some losses suggestive of mold damage, which might be a result of its proximity to a wall.[5] The church also likely retained the predella panels. The Ranieri panels were in fact used as source material for a later account of his life and miracles. In the mid-18th century the Church of San Francesco was remodeled so extensively as to be almost unrecognizable. The only constant appears to have been the stone altar over the Blessed Ranieri's tomb, probably because it was too massive to consider moving. A document dating from 1763 mentions an image of the Blessed Ranieri being in proximity to the high altar; this is likely Sassetta's figure from the nave side of his altarpiece.[6] In 1810, in the Napoleonic era, the convent in Borgo San Sepolcro was suppressed, and around this time individual, single-sided panels began to appear on the market. The provenance for all three Detroit panels begins in England in the early 19th century.

At present, twenty-six of the sixty-plus panels have been identified, one as recently as 1988. All but one are in public collections. Apart from Detroit, the works are located in Berlin, Chantilly, Cleveland, London, Moscow, New York, and Paris. *St. Francis in Glory*, *Blessed Ranieri* and *Saint John the Baptist* are in Bernard Berenson's collection at the Villa I Tatti outside Florence. Berenson and his wife Mary were among the first modern art historians to attempt a reconstruction of Sassetta's altarpiece for Borgo San Sepolcro. As more pieces and documentation surfaced, other reconstructions were proposed. In the early 1990s the question of which side each panel came from was answered definitively by the discovery of the scripta. By the time the recent I Tatti project began, almost all that remained to determine were the order of the narrative scenes, in other words, the life of St. Francis and the predella scenes. In answering these questions, the overall carpentry of the altarpiece and thus its probable dimensions and ornamentation was determined.[7] The Detroit panels contributed significantly to the findings.

DETROIT PANELS: RECONSTRUCTION OF THE PREDELLA[8]

The Detroit panels were acquired over a span of almost 30 years, from 1924 to 1953. Before the recent treatments, they had remained largely unexamined and untreated. Evidence that they had traveled separate paths for some time before they entered the museum's collection is starkly apparent in their disparate states of preservation. This is particularly visible when assessing the structural condition of each panel.

The Agony in the Garden retains its unpainted margins, once covered by engaged gilded moldings, and its original thickness of about 3 cm (fig.1). In the early 1950s before it was purchased by the DIA, it underwent some structural treatment along a horizontal join near the bottom edge and was coated with wax. When the wax was removed from the front margins, fibrous remnants of the moldings were revealed, as well as cut marks that showed the moldings had been cut *in situ*. In the 1950s treatment two modern screws were inserted in existing nail holes along the bottom, in order to reinforce the join. There are three areas under the paint and ground where nails were originally hammered though the front surface of the panel; only the bottom nail remains. Each area is covered with a small isolating piece of fabric.

Figure 1. Sassetta, *The Agony in the Garden*, 1439-1444, tempera and tooled gold and silver on panel, 48.5 x 63.3 cm. Detroit Institute of Arts, Founders Society Purchase, Ralph Harman Booth Bequest Fund, Detroit. After treatment.

The Betrayal of Christ has obviously been trimmed not only of its margins, but also a significant portion of the image at the top (fig. 2). About 7 cm of the sky is missing. It does however retain its original thickness. Two of the interior nails remain present. The reverse shows where they have been clipped off, as well as the original adze marks. The *Betrayal* panel also has the same join near the bottom edge, though is far more stable than in the *Agony*.

Figure 2. Sassetta, *The Betrayal of Christ*, 1439-1444, tempera, gold and silver on panel, 37.5 x 59.2 cm. Detroit Institute of Arts, Founders Society Purchase, General Membership Fund, Detroit. After treatment.

Procession to Calvary has been thinned and cradled in a grid that covers most of the reverse (fig. 3). The same join is present near the bottom edge. The x-radiograph shows the three nail heads under the paint and ground. The *Procession* retains much of its original engaged molding, along the top and bottom. The top piece has never been removed. The left molding, while not originally part of this scene, has been re-used from elsewhere in the altarpiece.

Unlike the main tiers of the Borgo San Sepolcro altarpiece, in which a single panel was painted on both sides, the predella had an important structural function in the freestanding work. It provided a solid base on the stone altar on which the upper portions of the altarpiece rested. A single-sided predella of this period was usually an open-backed box, reinforced with interior struts. The double-sided predella box for the altarpiece would have been a similar structure, with a plank on both

Figure 3. Sassetta, *Procession to Calvary*, 1439-1444, tempera, gold and silver on panel, 48.7 x 64.0 cm. Detroit Institute of Arts, City of Detroit Purchase, Detroit. After treatment.

front and back. The presence of the join near the bottom edge of all three Detroit panels suggests that they were all painted on the same long continuous plank made of two pieces. When the x-radiographs of the *Agony* and the *Betrayal* are butted together, such that the painted areas align horizontally, it can be seen that the wood grain matches (fig. 4). The gap between them is roughly twice the width of the *Agony*'s unpainted margin.[9] In the Passion of Christ cycle, the *Betrayal of Christ* takes place a matter of moments after the *Agony in the Garden*. As their subjects suggest, these two scenes were adjacent to one another in the predella, on a single plank.

When the predella box was taken apart, the Passion cycle plank was pulled off its vertical struts, leaving the nails protruding from its back. These were then clipped off and prob-

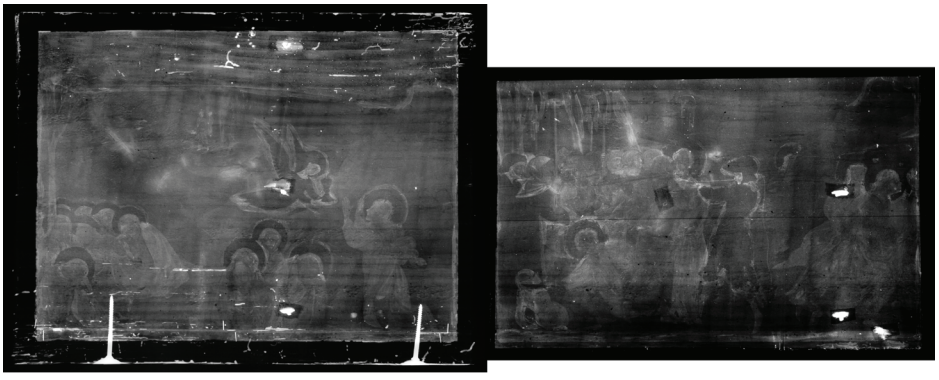

Figure 4. X-radiographs of figures 1 and 2 butted to show continuous wood grain.

ably at the same time, the plank cut into separate panels. Thus the nail heads remaining in each scene mark where a strut supported the predella plank. The reverse of the *Betrayal* shows the vertical palimpsest of the strut.

The nails in the *Agony* and *Procession* are regularly spaced in the vertical direction. In the abutted *Agony* and *Betrayal*, the nails align horizontally as well. It is likely that the struts within the predella box were likewise evenly spaced. In the joined x-radiograph of the *Agony* and *Betrayal*, the interior nails are approximately 77 cm apart (fig. 5). Using this measurement it

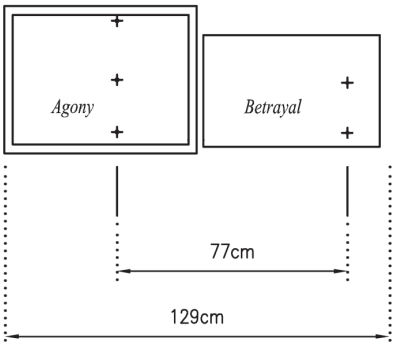

Figure 5. Butted panels with the positions and distance between nails (+) in figure 4 (drawn to scale).

is possible to extrapolate the rest of the predella box: additional struts can be projected that are 77 cm apart on center. If the *Procession* is put in chronological sequence, that is to say, to the right of the other two scenes, it can then be placed such that its three interior nails are against one of the projected struts. In addition, since it is likely that the predella scenes were originally the same size, the position of the fourth scene specified in the scripta can be posited.

Keeping in mind the width of the extant original altar and the total width of the five panels in the main tier above the Passion (around 344 cm), it seems likely that there were either four or five equally spaced struts inside the predella box, and that the *Procession* was nailed to either the third, fourth or fifth of these. The two possibilities employing four vertical struts are shown Figures 6 and 7. Figure 6 is clearly too short for the upper panels, while Figure 7 allows little space for framing elements between the upper tier panels. Furthermore, neither predella box would span the stone altar. While the evidence rules neither of these configurations out absolutely, they do appear to be highly unlikely. The two more probable extrapolations employ five vertical struts (figs. 8-9). Of these two, Figure 8, with the *Procession* on the fourth of five struts, fits the dimensions of the individual panels better. More importantly, it seems more likely with respect to the load-bearing integrity of the predella box. It has a strut at dead center, and the first and last struts are equidistant in from the ends. That distance is about 37 cm, or about half the 77 cm interval. This symmetry would serve best to distribute the weight of the superstructure evenly across the predella box, another good reason it would be preferable to Figure 9.

Figure 8 then was the configuration taken by the I Tatti group as the foundation for determining the width of the reconstructed altarpiece. The configuration of the Detroit panels also helped in determining the sequence of the Blessed Ranieri scenes, on the other side of the predella, which are of course far more obscure than the Passion cycle.

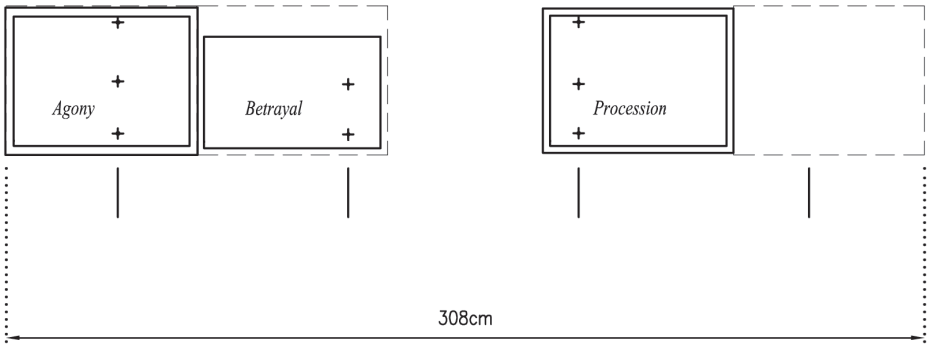

Figure 6. The predella plank with the *Procession* on the third of four struts (drawn to scale).

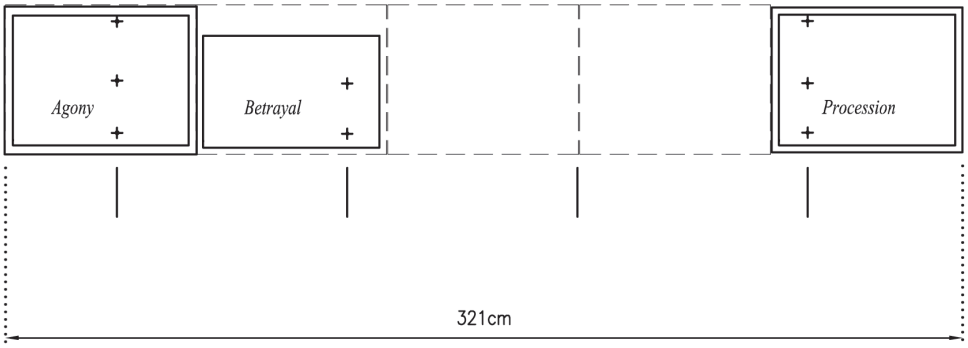

Figure 7. The predella plank with the *Procession* on the 4th of four struts (drawn to scale).

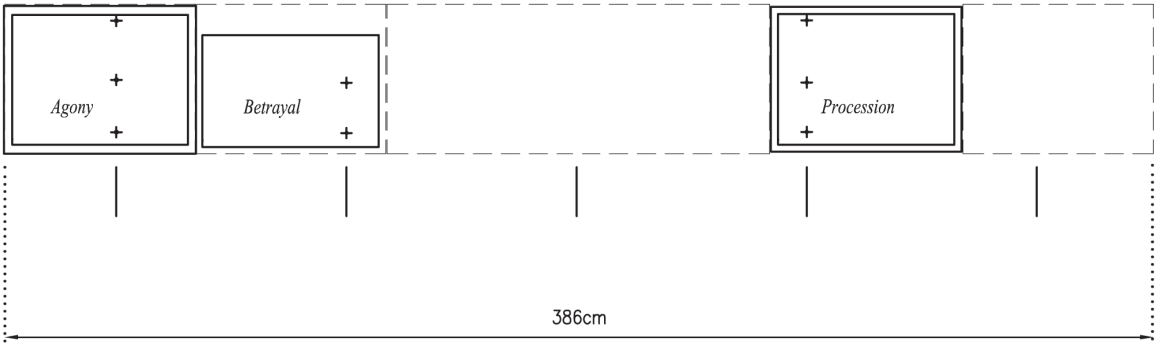

Figure 8. The predella plank with the *Procession* on the 4th of five struts (drawn to scale).

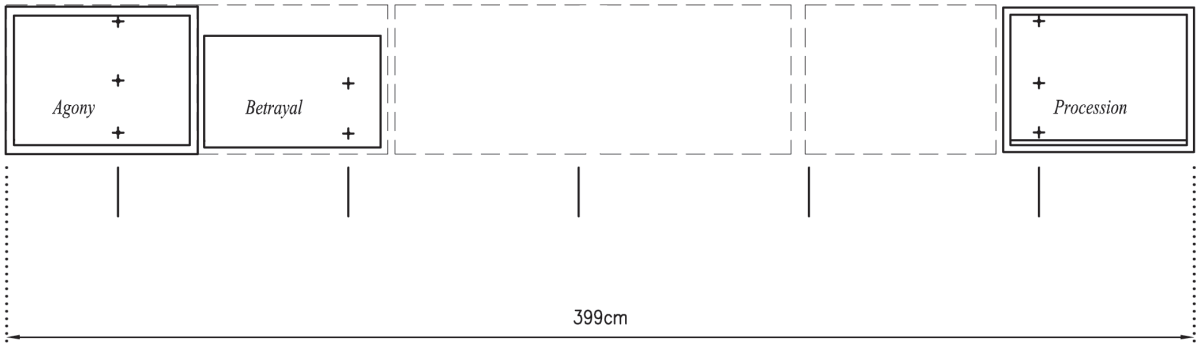

Figure 9. The predella plank with the *Procession* on the 5th of five struts (drawn to scale).

DETROIT PANELS: TREATMENT

As noted before, in the Passion cycle, the Agony in the Garden is closely followed by the Betrayal of Christ. This is clearly shown in the two Detroit panels (figs 1-2). In far background of *The Agony in the Garden*, Judas is shown escorting two soldiers into the garden of Gethsemane. A few moments later, in the foreground of the same landscape of the second panel, Christ is betrayed: the same soldiers seize him as Judas kisses him. Meanwhile the apostles seen sleeping soundly in the foreground of the *Agony*, have awakened, and except for Peter, in the lower left corner, are fleeing en masse out of the scene at the right. They wear the same bright colored garments in both scenes. A similar effect is found in Sassetta's *Journey* [and] *Adoration of the Magi* (1435). Now unfortunately divided into two paintings, it shows the three kings approaching on horseback in the background and then again, dismounted and paying obeisance, in the foreground. The duplication in the *Agony* and the *Betrayal* was a great benefit during conservation, so these two panels will be discussed together, before the treatment of the *Procession*.

The Agony in the Garden and *The Betrayal of Christ* have the same problematic damage in the night skies, heavily abraded and tarnished silver water-gilding. In the *Agony*, the overpaint was readily soluble and appeared to be dated from the 1950s pre-acquisition (and largely undocumented) treatment. When all the overpaint was removed, all that remained were traces of tarnished silver leaf amid the round, punched stars (figs. 10-11). The sky in the *Betrayal* had been dealt with by trimming off the affected area, that missing 7 centimeters at the top of the scene. The figures in the *Betrayal* are the same size as those in the *Agony*, but the claustrophobic effect of the trimmed off sky has made them seem larger (figs. 12-13).

It is clear that Sassetta had an interest in the atmospheric effects. *The Journey of the Magi* has a boldly toned sky. Predella scenes from the dismantled Arte della Lana altarpiece (1423-25) are likewise very dramatically atmospheric. Somewhat like the *Agony* and the *Betrayal*, one of them, *The Burning of the Heretic*, seems to take place in the evening, after the sun has set, though the sky does not seem to have been gilded or punched. In Sassetta's Madonna della Neve altarpiece (1430-32), the snowy weather plays an prominent role in the story shown in the predella, and the skies clearly reflect that. In the Borgo San Sepolcro altarpiece, the *Procession to Calvary* has a sky banded in two tones of blue. The sky also features prominently in the scenes from the Life of St. Francis that take place outdoors. All four skies are toned carefully and quite differently, as if distinct hours, or perhaps even seasons, were to be evoked. It is highly probable that Sassetta rendered the two night skies in the Passion predella in an equally careful and specific manner, perhaps with some sort of differentiation that showed the brief passage of time. Given his use of paints and glazes on silver, present in spectacular examples throughout the 26 separated panels, it is like that there were pigmented layers on top of the water-gilded silver sky. Perhaps only the stars were silver. Unfortunately, the current condition of the two panels offered no evidence of his original technique. After some experimentation, with the consent of the curator, it was decided that the damaged skies would be covered with a layer of a deep shimmering silver mica powder. The same powder was used to inpaint other areas of damaged silver leaf, such as under the red and blue glazes in the garments of the two figures at the left edge of the *Betrayal*.

Compensation of the rest of the damage to the *Agony* and the *Betrayal* was more straightforward (figs. 1-2, 10-13). The *Agony* had significant loss along the join. The garments were reconstructed using other examples in the same scene, while the bare foot at the lower left was copied from the two above it, and also from the bare feet in the *Betrayal*. The other prominent damages in the *Agony* are the two large fills that suggest the top and center interior nails were pulled out through the front of the panel. The one through the angel was inpainted with gold-colored mica pigments after the fill had been sculpted with punch-like marks. Missing glazes on the figure were too damaged to be reconstructed. The background figures of Judas and the soldiers were also too damaged to be credibly reconstructed. However, when the losses around them were inpainted, legibility was much improved. The same soldier appears in the center of the *Betrayal*. His abraded armor was minimally inpainted with gold-colored mica powder. Legibility also improved when the losses around him were inpainted.

The most significant area of damage in the *Betrayal* is actually in the faces of both Christ and Judas, which are abraded. But because the previous retouching was so well done, it was not removed during cleaning. The faces of every other figure in the scene are in very good condition so the abrasion appears to be the result of too many local cleanings. Another type of damage in the *Betrayal* is apparently chemical, seen in the losses in the dark green garments. Again, other drapery in other figures here and in the *Agony*, served as sources for a better reconstruction of these garments. The fantastic swirls and loops in Christ's mantle in the *Agony* were particularly useful, along with the garments of the apostles fleeing at the

Figure 10. Sassetta, *The Agony in the Garden*, 1439-1444. Before treatment.

Figure 11. Sassetta, *The Agony in the Garden*, 1439-1444. Filled.

Figure 12. Sassetta, *The Betrayal of Christ*, 1439-1444. Before treatment.

Figure 13. Sassetta, *The Betrayal of Christ*, 1439-1444. Filled.

Figure 14. Sassetta, *Procession to Calvary*, 1439-1444. Before treatment.

Figure 15. Sassetta, *Procession to Calvary*, 1439-1444. Filled.

right in the *Betrayal*. Finally, the back wall or hedge in the *Betrayal* is heavily damaged, and was left largely untouched in a previous restoration. Comparison to the *Agony* provided good guidelines for the hedge, while observation of Sassetta's technique helped to reconstruct the open garden gate. The stripe of white around the gate was not meant to be seen. Rather it was applied to cover silver leaf from adjacent gilding and to provide a better surface for painting. Similar applications were observed throughout all 26 panels, at the paint and gilding interfaces.

Even having undergone thinning and cradling, the *Procession to Calvary*, in comparison to *The Agony in the Garden* and *The Betrayal of Christ*, is in far better condition with respect to its paint surface.[10] The fact that it retains much of its original framing is surely a reflection of this less fraught history. The most serious damage in the *Procession* appears to be the result of vandalism. The faces of the two antagonists assaulting Christ have been gouged out (figs.14-15). Given the good condition of the rest of the scene, no explanation other than deliberate damage makes sense. The nearby soldier in the blue helmet served as a model to recreate the lost faces in a more credible Sassetta-like style. The vermilion areas of the *Procession*, and in the *Betrayal* as well, have suffered extensive flake loss apparently because of the technique. Most of these areas correspond to areas of shadow, where a red glaze was been applied on top of the vermilion. Other losses are as expected, general abrasion in the gilding, paint losses near the gilding and along the join, and damage over the top and bottom interior nails. The banner at left is comprised of a red glaze over silver leaf. The inscription is applied on top of the red with gold leaf on a transparent mordant. Both metals were retouched with the mica powders.

CONCLUSION

The technical examination and treatment of three predella panels from Sassetta's Borgo San Sepolcro altarpiece served a number of purposes. For the public in Detroit, it returned three popular paintings to a fine exhibitable state, each restored to a degree of finish consistent with the other two. For the DIA, it answered a number of questions about how these three important works in their collection formed the large part of a whole predella. For the art historical field, admirably represented by the I Tatti group, it provided a basis for reconstruction of the larger whole, the altarpiece itself. For the field of paintings conservation, it offered a good opportunity to see how treatment history can significantly impact a work. After all, these panels likely survived for three and a half centuries as an intact predella. Only in the last two hundred years have they been handled as individual paintings.

Most importantly, the project demonstrated the importance of recording the most obscure technical information of both structural and surface matters when working on a separated wood panel. All the nail holes, nail heads, frame fragments, trim marks, joins, fabric, gilding traces, and more, on the front, back and sides of each of these panels was used as data for the reconstruction of the Borgo San Sepolcro altarpiece. Certainly having three large fragments of the predella was an advantage, but it's clear that even information from just one panel would have been of use when used in concert with the data from other pieces in other collections. These measurements and observations should be an integral part of any conservator's examination report.

ACKNOWLEDGEMENTS

For the history and reconstruction of the altarpiece I am wholly indebted to the many scholars of the Borgo San Sepolcro altarpiece reconstruction project, as well as those whose research came before. I would also like to thank the Detroit Institute of Arts, Villa I Tatti – The Harvard University Center for Italian Renaissance Studies, and the Kress Foundation for providing the opportunity to work on such a rewarding project.

ENDNOTES

1. The project was published as *Sassetta: The Borgo San Sepolcro Altarpiece*, ed. Machtelt Israëls, Villa I Tatti – The Harvard University Center for Italian Renaissance Studies, Primavera Press, Leiden, 2009. In addition to a number of art historical and technical articles, it includes transcriptions of archival documents and technical entries for each of the existing separated panels.
2. Dated 23 January 1439, the scripta was discovered and published by James R. Banker in 'The Programme of the Sassetta Altarpiece in the church of S. Francesco in Borgo S. Sepolcro", *I Tatti Studies*, vol. IV, 1991, pp. 11-58.
3. Nella predella del canto dinanze le sto[r]ie della pasione quelle che sono più devoto e sono quatrto.' Author's translation.
4. Israëls, M." Introduction", *Sassetta: The Borgo San Sepolcro Altarpiece*, p 14.
5. R. Bellucci and C. Frosinini, Opificio delle Pietre Dure, Florence. Personal communication. Bellucci and Frosinini

performed the project examinations of the Villa I Tatti panels.

6. Document XLII. *Sassetta: The Borgo San Sepolcro Altarpiece*, p. 581.
7. M. Israëls, J. R. Banker, R. Bellucci, R. Billinge, G. Bisacca, C. Castelli, C. Frosinini, C. Gardner von Teuffel, B. Hartweig, E. Ravaud, A. Santacesaria, C. B. Strehlke, D. Thiébaut, S. Urry, "The Reconstruction of Sassetta's Borgo San Sepolcro Altarpiece", *Sassetta: The Borgo San Sepolcro Altarpiece*, pp. 161-202
8. For a more complete discussion of this subject, see S. Urry, 'Technical Evidence for the Construction of the Predella of Sassetta's Borgo San Sepolcro Altarpiece in the Panels of the *Passion of Christ* in the Detroit Institute of Arts', *Sassetta: The Borgo San Sepolcro Altarpiece*, pp. 337-341.
9. There is some play with the gap, of perhaps one or so centimeters either way. More or less than that and the grain match disappears.
10. Overlapping paint and some minor changes to the composition, as well as noticeably different handling in the drapery in the *Procession to Calvary*, suggest that it was painted by a different hand than that of *The Agony in the Garden* and *The Betrayal of Christ*. Though a consistency among all three panels with respect to the materials and techniques demonstrates that the better condition of the *Procession* is not related to this suggestion.

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PATRICIA M. DILLON

The Conservator as an Expert Witness, or Party in Litigation

ABSTRACT

Conservators become entangled in art law litigation involving claims of authenticity or damage and loss. In either instance, conservators are the key witnesses upon whose testimony jurors and/or judges will base their verdicts. Acting as an expert witness can be financially rewarding and enhance a professional's resume. It can also be draining, humiliating, and potentially derail a promising career. While it is said that appraisers are arbiters of value, they are unable to designate value without the input of a conservator. The conservator must identify the type and extent of the damage; determine if the piece can be conserved; the financial cost of the same; and make a final determination of the overall loss of percentage value to the work. Sometimes a conservator will testify as a "pure expert"—someone who reviews the work of others or who reviews a hypothetical. Sometimes a conservator must testify as the professional who rehabilitated the piece. Increasingly, conservators can also be parties to a lawsuit. In each instance, the testimony and approach to the witness is different and the conservator must be prepared for his testimony and cross-examination. Moreover, litigation is unpredictable. If you sign on for a project and a paycheck you must be prepared to write the report, ultimately testify, and to stand by your words and actions. The paper examined how a conservator should prepare for testimony, how to prepare the attorney, how to write a report, and how to be prepared for inevitable pitfalls such as cross-examination or pitfalls in your paperwork. VARA was also reviewed with consideration of what to do when a living artist is not supportive of your conservation efforts.

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LASZLO CSER

Reflections on the Primacy of the Image in Connoisseurship and Conservation

ABSTRACT

In 2002 Canadian businessman Ken Thomson set in motion one of the most significant acts of philanthropy in Canadian history when he agreed to donate his priceless art collection to the Art Gallery of Ontario in Toronto. The Collection of over 2,000 Canadian and European paintings and objects will be housed in a series of magnificent galleries in a transformed AGO designed by the world-renowned architect, Frank Gehry. © The Thomson Collection 2008

Since meeting this remarkable man, Kenneth R. Thomson, in 1983, I could not have anticipated the depth of his influence, personally and professionally. His private world as an art collector nurtured a love of beauty that has now been presented to the world as The Thomson Collection, an expression of beauty entrained by his humility, gentleness, and capacity for understanding the human spirit.

Over the course of 18 months during 2007 and 2008, over 600 works of art, mostly Canadian paintings of the highest cultural and heritage values, were examined and treated in preparation for the Thomson Galleries at the Art Gallery of Ontario. David Thomson, his son, envisioned and directed innovations in framing and installations in the galleries that are revolutionary in their concept and presentation of historical paintings and First Nations artifacts. During these months of intense focus, much time was spent in solitude at the bench reviewing the dynamic and interactive relationship between connoisseurship and conservation, always present with the spirit of one of the greatest collectors of the 20th century.

The many conversations and observations with Ken and David Thomson, and subsequent internal dialogues, became an exploration of what locates us as conservators in the landscape of aesthetics and historicity. Alongside the trajectories of subjective assessments and diagnoses are the implications and ethical reckonings of treatment interventions. As the primacy of the image gives value to the immediacy and meaning of the aesthetic experience, so does authenticity give value and meaning to the deliberations of historical materiality and contextual relationships. Is there an altar of sacrifice if faced with choosing one over the other?

In any given situation, whether one sides for the primacy of the image or authenticity, or settles in the space between, the decisions taken become a testament of the relationship between the collector and the conservator. The general aspects of the Thomson Project will be outlined from inception to completion during the course of the presentation, with examples and commentary on a new vision for the presentation of historical art that will impact the coming generations.

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EUGENIA GUIDOBONO

Education as the Basic Tool of Conservation in the 21st Century

ABSTRACT

At the beginning of the 21st century, priorities in the field of Conservation of Cultural Heritage have changed worldwide. Not many years ago people believed that the best way of preserving heritage was to restore, especially in Latin America. But with the new trends of Preventive Conservation professional Conservators have understood that priorities have to do with collections as a whole. Preservation is no longer exclusively for Conservators but a shared responsibility of the community. We are all responsible for the transmission of our culture to the future.

INTRODUCTION

The present research was motivated by concern which arose after working in a museum of the city of Concordia, Entre Ríos, and it is also part of my thesis project.

Preventive maintenance was carried out, as well as tasks that resulted from a project that I presented in the museum as a collaborator. The project aimed at improving the conservation of the collection through preventive conservation tasks that were part of a plan of action.

The first part of the plan was fulfilled completely, but the activities planned to take place in the following stages (such as documentation, storage organization, etc.) were dismissed. Given the circumstances, some doubts came up and pushed me into further thoughts.

In order to tackle my doubts I decided to carry out an investigation about conservation in public museums in the Province of Entre Rios, with the objective of finding out if the rest of the province was facing similar circumstances. The main part of the survey was to visit one museum in each department of the province, developing a visual, photographic and written survey. Museum workers were interviewed for specific information about their situation within the institution. An educational legal and public administration survey - as well as a research in the historical background of conservation were included.

PREVENTIVE CONSERVATION IN ARGENTINA

The beginning of Preventive Conservation in Argentina was a slow and gradual process of updating that resulted from conservation progress around the world: it was a phenomenon which arrived in the country from abroad. At the beginning of the 80s, the news about Preventive Conservation began to arrive in the country from abroad due to exhibitions coming from other countries that set standards for conservation by means of conditions imposed to provide their works. These requirements were usually related to security, not only against theft and fire, but against agents of deterioration in general, with special emphasis on environmental conditions, documentation, support materials, lighting, etc. Thus, our institutions had to adapt gradually to these demands and had to begin to train their professionals in the field of preventive conservation.

In the 90s, the 'Antorchas' Foundation and the Smithsonian Institution developed a series of conservation courses in Argentina for museum personnel all over the country. When talking about education, the background of formal training in the country was a course to graduate as technician in Restoration of Works of Art (ROA), which was a two-year course that emerged in the 1980s in an institution then called National

School of Ceramics. This degree was the first official one in restoration for technicians who graduated until 2000.

In the late 90s and early 2000s, conservation ideas crystallized, driven by local professionals, giving birth to university courses in heritage conservation. The courses in ROA were the first formal educational background in conservation, which then gave way to the tertiary and university courses in Conservation and Restoration that are delivered today in two universities in the city of Buenos Aires, which have been recognized by the Ministry of Education. There are postgrades courses in some universities, which are mostly aimed at restoration and recycling of buildings.

CONSERVATION IN THE PROVINCE OF ENTRE RÍOS

Most of this background happened in the Capital City of the country except the case of 'Antorchas' Foundation, which was spread nationwide. For example, in the field of museums, the province of Entre Rios took the first step towards concrete action for the conservation of heritage in 1994 as a result of the survey conducted by the 'Antorchas' Foundation. A program for training museum staff in preventive conservation was created. Several courses were delivered, the first was a Paper Conservation course in 1994 which introduced theory and practice and was completely free. This led to the creation – in 1997 - of the Conservation Area in the national museum 'Palacio San Jose'. In 1998 the conservation workshop was opened and a year later the Area of Technical Reserve was made available as a deposit of cultural objects.

In 1996, 'Antorchas' Foundation and the Smithsonian Institution offered a training course in conservation at the Museum of 'Colonia San Jose' for museum staff in historical museums around the country. This course lasted 18 months; it began in 1998 and it involved over 20 staff members from different museums. The course was taught by national and international professionals: James Volkert, Carolyn Rose, Vincent Kirby Beggs, Claudio Muro, María Esteva, and others.

Universities of the province of Entre Rios that teach museology started including in the 90s, at least one subject on conservation of cultural heritage in their curricula.

ENTRE RÍOS MUSEUMS

The province of Entre Rios has more than sixty museums: public and private. Approximately 80% of museums belong to the Town Hall and were created due to the initiative of the inhabitants of various cities and towns with Town Hall support.

In order to determine the types of museums in Entre Ríos the classification used was the one proposed by the American Institute of Museums (ILAM), which divides the type of museums according to the collections they have: Art Museums, Museums of Anthropology, Museums of Science and Technology, Natural Science Museums, General Museums and History Museums.

For the sake of this investigation, it was decided to shortlist one museum in each department of the province. In each department, the museum which was considered more relevant by the community of the place was taken into account. In some cases, there was only one option as some departments have a single museum. In other cases art museums were selected deliberately in order to include variations to the majority group which were the historical type. Thus a broader vision of different types of museums and collections could be obtained. A total of sixteen museums were shortlisted: ten History Museums; three Art Museums; two General Museums and an Anthropology Museum.

The museums are:

- Regional Historical Museum 'Colonia San Jose'
- 'Palacio San José' Museum and National Monument 'Justo José de Urquiza'
- Concordia Town Hall Museum of Visual Arts
- 'Diamante' Regional Museum
- 'Federación' Settlements Museum
- Town Hall Museum of Anthropology and Natural Sciences 'Conscripto Bernardi'
- Regional Historical Museum 'Gualeguay'
- City of 'Gualeguaychú' Museum
- Historical-Regional Museum of 'Villa Paranacito'
- 'La Paz' Museum of Fine Arts
- 'Nogoyá' Town Hall Museum
- Provincial Paraná Museum of Fine Arts
- Rice Museum of 'San Salvador'
- 'Rosario de Tala' Historical Town Hall Museum
- City of 'Victoria' Museum
- Natural Historical Museum of 'Villaguay'

The only department in the province that has no museums is Feliciano, so the survey was not carried out in that particular place.

GENERAL FEATURES OF MUSEUMS

All museums surveyed belong to the State. They depend on a higher institution which - in most cases - is the Town Hall; the provincial government or the Ministry of Culture of the Nation in the case of the national museum (fig. 1).

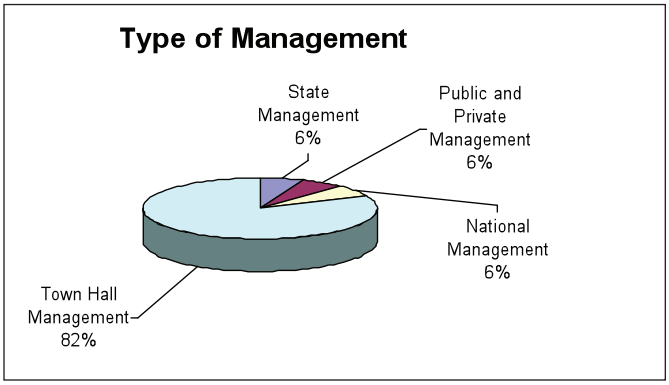

Figure 1.

Regarding the internal organization of museums surveyed, they can be divided into:

- government museums totally run by the State
- government museums with autonomous management

In the museums totally run by the State, budgets and allocations depend directly and solely on the parent organization (other than contributions of associations of friends) and all profits generated by the museum are administered by the parent institution or by the museum itself. The museums with autonomous management depend on a superior organization–which is generally the State–which provides administrative guidelines, but allows self-management and self-financing (fig. 2).

Another issue to take into account is that 81% of museums surveyed do not have a fixed budget allocation for their management: administrative costs, exhibitions, educational activities and purchasing of materials for conservation, among others. In most cases, the employees interviewed said that the budget requested for specific activities is rarely allotted because the parent institution does not have the suitable budget to spend on museums.

Museums that have no fixed budget mostly belong to the Town Hall and are totally run by the State, while those with fixed annual budget allocation are the National Museum, and the provincial museum. Due to the lack of this economic contribution, the institutions cannot plan their activities annually and depend on the interests of various political efforts to obtain their budget. Most museums depend on the Culture Secretariat in the different Town Halls (fig.3).

MUSEUM STAFF

Due to their state condition, museums do not have the power of choosing their own personnel who–in most cases–are Town Hall workers who had been sent to the museums because they were transferred from other Town Hall buildings. Few of those interviewed–who work in city museums–joined the institution out of their own interest.

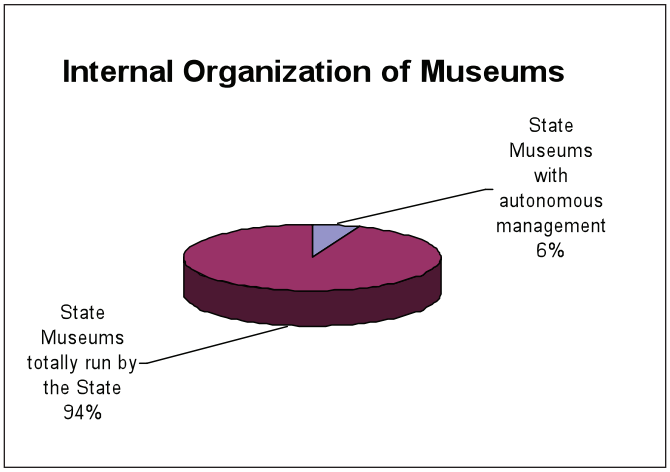

Figure 2.

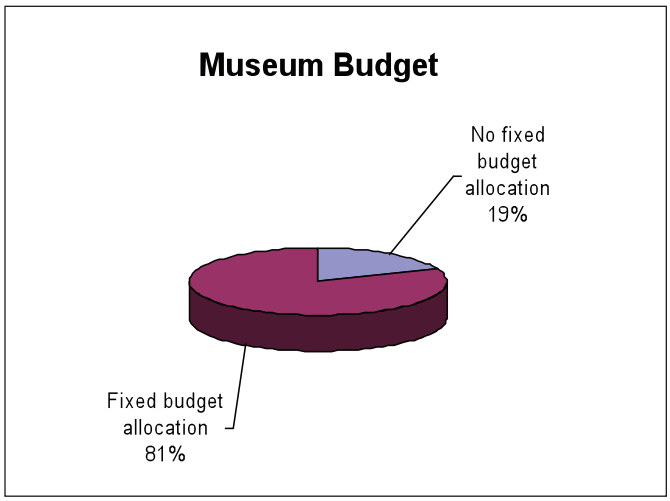

Figure 3.

There are some cases in which the situation is different. For example certain staff members have joined museums on their own initiative and without prior Town Hall employment. Usually these people have degrees related to Arts such as Art History; Visual Arts; among others. In all cases of Town Hall museums, the cleaning staff is listed in the payroll of the Town Hall but is not formally allotted to the museum and it permanently rotates so it is difficult to train staff in a formal and informal way with basic knowledge of preventive conservation in order to develop their activities according to these basic principles.

In most Town Hall museums surveyed, there are no regulations requiring professional training for their staff on a regular basis. According to employees, in addition to avoiding the requirement of qualifications or updating courses, seminars, etc., Town Hall government rarely promote training. Motivation and publicity are scarce. The only motivation for training is a set of regulations of the Town Hall ranking, which establishes a scheme of promotion for Town Hall personnel. This scheme is arranged according to the amount of accumulated score qualifications obtained in certain training courses attended. Besides there is poor academic offer in Conservation within the province since only official courses and extension programs can be regarded as academic education. Universities in Entre Ríos only have Museology courses, which has a subject about conservation. The courses, seminars and meetings on this subject are carried out on an infrequent basis.

Taking into account the analysis of staff training in museums, the gathering of data such as the level of education and specific training in conservation in a formal or informal way was a relevant issue. All this information was obtained with the objective of gathering data that could be expressed in statistics, not only including the lack of training in conservation as the target of our analysis but also the lack of elementary education and academic training in general.

According to data obtained in this survey in the 16 visited museums, there are an amount of 133 employees working here. 11% of these workers have completed primary education level; 24% have completed secondary school education level; 29% have completed tertiary education level and 4% have completed a university education level. 32% of employees surveyed would not specify their level of education. Among these 133 employees all the personnel is included: from cleaning staff to directors or managers of museums (fig. 4).

As for training in conservation itself, 11% of the staff has attended regular courses lasting several months or annual courses organized by the 'Fundación Antorchas' and by the Ministry of Culture of the Nation. The 16 museum workers who have completed these courses belong to nine institutions so we can deduce that more than 50% of surveyed institutions have staff that has done some kind of training in the Conservation Area (Fig. 5).

PROBLEMS IN MOST MUSEUMS

Using data from the survey conducted in the museums of the province, it is easy to identify some common problems. Most institutions do not have a clear idea of the amount and types of their collections due to lack of documentation. Therefore, they do not know the overall condition of them. The prob-

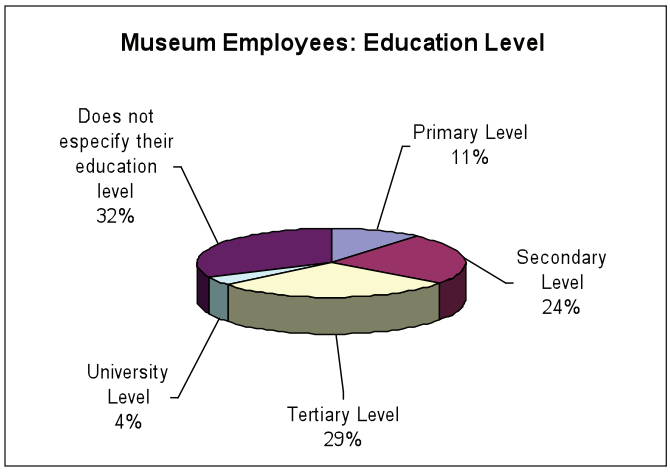

Figure 4.

Figure 5.

lems are focused on lack of basic strategies to tackle the most common and well-known agents of deterioration.

These specific problems are the result of more general issues such as lack of well determined conservation policies within the Town Hall institutions and lack of trained personnel to perform tasks on conservation, research, management, education and museology.

All these museums are ruled by national laws which protect heritage. Some of them are:

- National Act No. 25,743 for the Protection of Archaeological and Paleontological Heritage: passed in 2004.
- Articles 2339 and 2340 of the Argentine Civil Code: It specifies that ruins and archaeological/ paleontological sites of scientific interest are part of the public property making up the National State.
- Act No. 24,663: which regulates the international movement of works of art.

Besides, the institutions of the province are also governed by their own laws as regards the provincial level and the town hall level.

Part of the survey carried out in the museums shows that regulations exist but, in most cases, authorities do not enforce them or penalize those who breach them. This lack of efficiency or awareness of the authorities coexists with lack of publicity of regulations and, as a consequence, the effects of lack of information for the common people. Most of employees working with cultural heritage are not aware of the existence of these regulations. In very few cases, they know about them, but they have no idea on how to act to enforce them or how to complain against their violation.

These legal instruments are barely used in Town Hall institutions housing cultural heritage, with the exception of archaeological and anthropological museums. Most of these museums have inventoried archaeological objects and they have been listed in the National Registry of Storage, Collections and Archaeological Objects.

As a conclusion we can say that while the causes are obviously directly related to the lack of training of museum workers who handle collections, it is also true that Town Hall authorities neglect the importance of educating those who guard heritage and avoid the spreading of awareness about the importance of preserving their own cultural heritage and history. There are also some faults regarding legislation and policies on the part of the government about protection of heritage. Human factor happens to be the most influential in collection health of museums surveyed.

Deficiency in institutional policies–which should encourage training of museum employees in order to value cultural heritage and in order to establish damage prevention strategies for the conservation of collections–has a direct impact in accelerating the processes of deterioration seen in museum collections around the province.

Incorporating trained staff in conservation to the institutions is an isolated measure which is, by no means, a complete solution to the problem of lack of awareness and deterioration of the collections. We must understand that heritage is not something naturally appreciated and valued. Thus, it is necessary to implement educational policies in the Town Hall level, aimed at raising awareness of education to the community and the training of professionals and employees currently in service in museums, as well as school teachers who will pass this knowledge to school kids, the future conservators. This plan could be the foundation of a long-term schedule to change the mindset of the whole society for the caring of heritage. Conservation must be the responsibility of everyone in order to avoid reaching interventional repair.

Risks can be minimized only if there is a common understanding of existing problems and of the long- term benefits resulting from steps taken to solve them.

This achievement would be obtained if all members of the museum staff become aware of how their work affects the collections directly or indirectly. Common people awareness is essential as well.

Preventive conservation should stop being the concern of conservators only. Such concern should expand to all staff members in museums, from authorities, whose decisions have an impact on all areas of the museum, to cleaning and security staff, who collaborate a great deal in keeping conditions for the conservation of collections with daily work.

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Dare Great Things: [1] Questions on the Restoration of a Series of Colonial Paintings

ABSTRACT

This paper presents a critical post-reflection about a relevant restoration project on colonial painting. Seventeen paintings (200 x 250 cm) from the late XVII century were studied and restored, based upon another series conserved in Santa Teresa's Convent in Cusco that were painted by Espinoza de los Monteros, who used Flemish engravings as iconographic source. Several topics are treated on the basis of the experience of the authors as buffers of different interests. Interdisciplinary work, the role of conservators over every stage of the project, co-financiers, the multiplicity of actors over the same objects, the symbolic meaning of colonial series of paintings, and the dissemination to the general public are the main subjects. Purposes of each actor are discussed, and how their motivations were guided during the execution. The extended research time that took place simultaneously with restoration, allowed us to guide analysis, encouraging new aesthetic and historic questions. Conclusions and remaining questions have given us a good starting point for further investigation on colonial art.

INTRODUCTION

Big restoration projects used to be focused on technical solutions, forgetting that there are several actors around the objects, who do not necessarily share the same goals, aspirations, and symbolic meaning of cultural objects. Owners, financiers, curators, conservators, scientists, historians, and last but not least, the community, all tried to assert their own vision upon the objects.

The restoration of the "Serie Grande de Santa Teresa" was partially financed by a private bank (fig. 1) and executed and also partially financed by a governmental conservation center. The private donation was possible making use of the National Law of Cultural Donations, which made the Chilean Central Government also a financing party.

Figure 1. The president of the financing bank, the restoration team, and the paintings

The paintings, representing the most important episodes in the life of Santa Teresa de Avila, are part of the rich patrimony owned by the Monasterio del Carmen de San José in Santiago de Chile (fig. 2). There are seventeen paintings of large format dating to the late XVII century and belonging to the Cusquean School.

The objects the cloister nuns preserve are of exclusive use to them and have been this way for more than 300 years. Given this, we had to wonder who we were restoring for—as well as, who the public was that could enjoy and learn from them. We were called as conservation team by the nuns, so despite being a national center who works with public collections, we could not ignore the legitimate expectations of the owners. One

Figure 2. The nuns (owners of the paintings,) and the project coordinators, in Monasterio del Carmen de San José in Santiago

important fact for us, as specialists, was that this is one of the few complete colonial series in Chile; it would be a unique opportunity to work and learn from this artistic period.

Just as the project, this paper is also a challenge, as Saint Teresa said: *Dare great things*. Presenting this work, so far from our reality, we look for bringing into light the questions and difficulties we had to confront as a restoration team in the middle of several actors.

THE PAINTINGS

The paintings are deeply linked to the colonial religious mission in Chile, and therefore, they should be understood beyond their aesthetic value in their historic and religious dimension. Here are involved very different cultural conceptions of the contemporary systems of representation. The originality and transcendence of these canvases are a cultural value and not only aesthetic, insofar as they express the confluence of the occidental artistic tradition with the Creole and Indian artists' need of expressing their own universe and perception of reality. Salvador Muñoz-Viñas proposed an idea that resume some of the topics presented in this paper, saying:

> "...all of them are symbols of something, that is, they mean something: they are signs, emblems, symbols. No material circumstance can explain that we care about them, because their value lies elsewhere. It is a conventional value, a value that has been agreed upon by a group of persons, or even in some cases, that has been cast by a single person" (Muñoz-Viñas, 2003).

We ignore the path the paintings followed to get to Santiago, because no commitment or any kind of documentation was found in the archives, and this series is not mentioned in colonial sources, and is not signed by any artist. We have no explicit confirmation that this series was painted in Cusco, nevertheless, all the aesthetic, historic, and material investigation allow us to say that it comes from there; especially because they are based on another series, conserved in Santa Teresa's Convent in Cusco (Mebold, 1987), which was painted by the colonial artist José Espinoza de los Monteros (fig. 3) who used the Flemish engravings by Collaert and Gallé (PESSCA) as an iconographic source. Both series are very similar (fig. 4); nevertheless, the one in Chile is anonymous. What does it mean? Is it therefore less valuable? Is it not original?

Figure 3. The Convent of Santa Teresa in Cusco

Figure 4. *Apparition in front of Avila's Bishop* by Espinoza de los Monteros; The Convent of Santa Teresa in Cusco

Figure 5. Painting conservation team

Figure 6. Non-destructive analysis

RESTORATION

One of our main questions was what intervention criteria we should assume and how far could we go investigating history and materiality versus restoration deadlines. Nobody would tell us how to restore, how much analysis to do, how much dirt to remove, or if to line or not line each painting. However, all the eyes on the canvases and their symbolism, all of them would have an opinion and something to say by the end of the project.

The objectives of restoration were to restore the mechanical-material stability of the paintings and the aesthetic and iconographic aspects, to learn about history and technology of colonial painting, and to understand the creation period and their original religious function. The restoration took 20 months with 16 graduate and more than 20 undergraduate professionals working together (fig. 5). Our interdisciplinary approach was that of a group conducted by conservators and assisted by conservation scientists, historians, and photographers. All the studies were made during the intervention and considering that we were studying a workshop creation without a single artist behind it with material and aesthetic inconsistencies that should be analyzed in the light of its history and devotional function.

Science had as an objective to identify the materials and to complement the historic investigation; that is, to provide those pieces that history cannot (fig. 6). Thanks to an adequate budget and to international cooperation with institutions in Europe and Latin America, we could use several techniques that not always are available for our field in Chile. Standard techniques well known in conservation science were used such as electronic and optical microscopy (fig. 7), gas chromatography, radiography, IR reflectography, and several photographic techniques. From the scarce technical literature on restoration of colonial art, this is one of the most analyzed as a complete series; besides helping us to understand and to restore the paintings, it gave to the project a specific weight for the specialized and general public, including the national press.

Conservation discipline allowed us to put together scientific studies with aesthetics and history and to understand the values that these paintings transmit from each area of knowledge. We found a rich iconographic study that gave us new clues to the paintings, discovering that one of them had

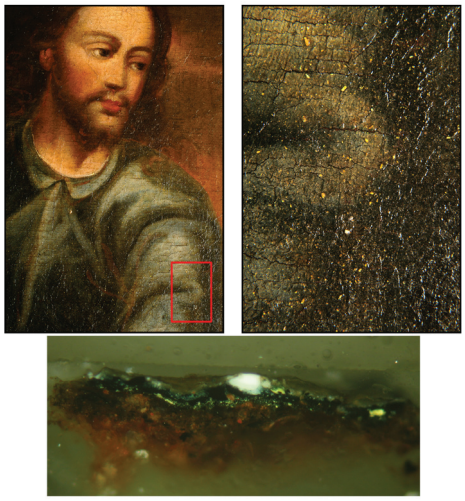

Figure 7: Detail of green layer showing orpiment inclusions by macrophotography; cross section under the microscope

as a source a Rubens painting (Salinger, 1949). Thanks to the nuns' stories and their archives we soon discovered that there were four paintings sold in the 1970s, and it was possible to put all the series back together since the current owners acceded to give the paintings back to the Monastery.

The project was also of interest for colonial art historians from South America. Some of them visited us during the restoration. All of them agreed on the importance of such a complete work on a full group of paintings because of the little specific existent information on the period, hard to believe for the enormous and rich colonial heritage in the Andes. The major part of the investigations is on religious iconography of colonial art, but very few on materials, or about history of specific paintings. So many times we find inductions based on tradition, subjective observation and artistic European sources, but missing the scientific analysis tools and the archivist researches. In this line we'd like to highlight the book by Carrillo y Gariel, *Techniques of the Painting in New Spain*, published in Mexico in the 1960s, and the work of the Argentinean group headed by Gabriela Siracusano and Alicia Seldes, who over the last 20 years have investigated Alto Peruvian painting with a strong scientific and historic effort.

THE EXHIBITION AND THE BOOK

During August and September of 2009, all the paintings were shown to the public at a big exhibition at the National Fine Arts Museum (fig. 8), involving new actors in this project: curators, graphic designers, video-makers, journalists, and all kinds of professionals trying to make their own contribution.

Figure 8: The National Fine Arts Museum of Chile announcing the exhibition

At this point, the paintings were out of our control and we became consultants for the exhibition in matters of lighting, transportation, and didactic material. The exhibition included videos and animations showing the conservation processes and analytical results. The balance between accuracy and legibility of the information given to the general public was hard to set and required hours of negotiation with the video editor, who insisted on his point saying "everyone has to understand this." Then we wondered how to make the general public understand

Figure 9: The exhibition at the National Fine Arts Museum of Chile

an illustrative but technical video about restoration? How illustrating and how technical one should be?

Communication wasn't easy preparing the exhibition. Looking back we see ourselves as a buffer between many people who didn't know the paintings like we did, because of our close contact with them over two years.

After the exhibition, a book was published that brings together all the research that was done on the paintings (Krebs et al., 2009). Four chapters are included: one of which is about the Flemish engravings on which the paintings are based. One is about the Carmelo Order and another is about Santa Teresa's spiritual life. And, of course, there is a chapter about the restoration and the material and historic investigation, which, in fact, opens the book.

Both the exhibition and the publication are enormous achievements for us, for the development of conservation in Chile, and of main impact for the public to understand the restoration of paintings that have not been out of the monastery in 300 years.

CONCLUSIONS

We learned to understand these paintings, leaving aside the rigid and static concept of "series," to adopt one more flexible with several conducting threads as thematic, materiality, technology, palette, and iconography.

The corpus of information is large and diverse, giving a good idea of the material composition and technology used. In most cases results are coherent with historic and scientific references for colonial Peruvian art. Some exceptions and unanswered questions are still under discussion.

The seventeen painting are now together in the monastery. Before this project four of the paintings were in private hands, but now we can say that the series is complete as far as we can now. Among other positive externalities we now have a new trained group of young professionals working on our permanent teams.

This project was a great opportunity and a big challenge for us. We proposed to restore the material to bring back the historic, aesthetic, and spiritual message. About the Carmelitas expectations and reactions, one of them shocked us by expressing her initial distrust to our project. She thought "it was not worth the effort to recover those big canvases, broken, darkened, unpleasant to the sight, and therefore meaningless and with no value." However, when she saw how the paintings had recovered their structure and colors and allowed a new reading of the episodes of Santa Teresa's life, she thought that "if it was possible to restore these lifeless objects, how much times more possible could it be, with faith and dedication, to restore a soul."

During the exhibition several attitudes were observed about the visitors. There were those who prayed in front of the images, those who were called by iconography, those interested in historical facts, those who admired the monastical-like museography and script, and also who enjoyed the didactic material (fig. 9). We consider that despite being a private collection that has returned to the monastery, who knows for how many years, the national public at least is now aware of the existence of this hidden heritage through the exhibition, the book, and the local press (fig. 10).

The bank that financed the restoration looked mainly for marketing in the context of the 200th national birthday celebrations. The book was made essentially as a gift for the bank's VIP customers. They wanted lots of nice pictures on every page, while we looked for a deep and accurate study of the paintings and their time, because the book would also be sent to public and specialized libraries in Chile and worldwide. This was one more of the battles to fight, as well as the necessary presence of the bank on the exhibition and written press, sometimes highlighting the institution's name over the works of art.


E 22 ARTES Y LETRAS

Patrimonio

EL MERCURIO

DOMINGO 24 DE JUNIO DE 2007

MAESTRAS CHASQUILLAS.— Algunos de los cuadros presentan repintes y parches realizados por las mismas religiosas que intentaron protegerlos.

PROTECTORES.— Los apóstoles Pedro y Pablo de ordinario asisten y prometen ayuda a la santa, se lee en la leyenda que acompaña la obra.

APARICIÓN DE LAS DOS TRINIDADES.— Los ángeles celebran cuando a Teresa se le revela la Sagrada Familia, además del Padre, Hijo y E. Santo.

CONSERVACIÓN PATRIMONIAL | Cuadros del Convento El Carmen de San José:

RESTAURAN TRECE PINTURAS de la vida de Santa Teresa

Por primera vez en su historia los cuadros cuzqueños salen del convento que los custodia para ser restaurados por el CNRC y luego exhibidos en una gran exposición.

El proyecto financiado por BBVA contempla además realizar un libro con los pormenores históricos y estéticos, muchos de los cuales se ignoran, de esta valiosa serie del siglo XVII, de gran formato y única en Chile.

MAITE ARMENDÁRIZ AZCÁRATE

La Santa Madre reina en pleno corazón de la calle Pedro de Valdivia. En una casona blanca e inmaculada viven sus hijas. El silencio impera, el olor a cera brilla por los rincones. Una atenta portera llama a la priora. La sonrisa y paz de la hermana Lucía de la Cruz muy pronto traspasan la reja del locutorio. Hace menos de dos meses asumió su rol de priora, la que cada tres años se elige democráticamente. No hace mucho, siete de estas monjas de clausura partieron a fundar en Puerto Montt: "Quedaron las más viejas y las más chicas que todavía no cumplimos 50", dice riendo, a pesar de que les costó la separación.

Tras el pasado desconocido de la colección

La propuesta de tratamiento del área estético-histórica de estas pinturas permitirá aclarar las siguientes incógnitas de su pasado:
•Rastrear el paradero de las obras que faltan, dado el carácter incompleto de la serie.
•Situar las obras espacialmente. Indagar en el período y lugar en que fueron realizadas y verificar la exactitud en torno a la fecha que se atribuye su ejecución (hacia 1680 – 1690). (Análisis de fibras o pigmentos).
•Indagar en la leyenda particular de cada tela en qué momento de la vida de Santa Teresa ocurrieron tales episodios.
•Pese a que su autor es anónimo, lo que se confirma con la presencia de ciertas desigualdades plásticas, que indicarían la participación de varios oficiales o aprendices, como era habitual, se intentarán obtener datos sobre el taller cuzqueño de José Espinoza de los Monteros, cuyo trabajo concuerda con las características formales de los lienzos.
•Conocer la Serie de Santa Teresa, realizada por Espinoza de los Monteros en 1682 para el convento de igual nombre, en Cuzco, y en la cual se inspiran las obras en actual proceso de conservación.
•Conocer la totalidad de los grabados flamencos originales en que se basa la serie, ejecutados en 1613 por los artistas Adrián Collaert y Cornelius Galle en el contexto de la contrarreforma impulsada por la Iglesia. Los grabados fueron confiados a los artistas locales por las órdenes religiosas para su reproducción.
•Intentar completar las inscripciones gráficas de las cartelas que están inconclusas, que hacen referencia, a modo de traducciones libres, a las traducciones latinas apuntadas al pie de los 25 grabados flamencos.
•Hacerle un seguimiento general a la Serie para dilucidar, por ejemplo, cómo o en qué momento llega al país, o de qué modo fueron solicitadas al Cuzco.

Figure 10: One of the many articles in the press about the project

All the involved parties declared themselves very satisfied with the final results and products and with their presence in each step of this project. This satisfaction wasn't actually planned or even thought from the beginning, but evolved with the events. We know now better how to get involved in big projects like this, considering that especially with devotional heritage, the interests can be distant from material conservation.

As has been already said, it has been a challenge to try to communicate the importance for us of interdisciplinary projects on colonial art, and the many interests involved, despite sometimes being a forgotten heritage kept in the dark of old churches and convents.

ACKNOWLEDGEMENTS

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ENDNOTES

1. From the homonymous poem of Saint Teresa

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NINA OLSSON AND TOMAS MARKEVICIUS

Flexible Thermal Blanket and Low Pressure Envelope System in the Structural Treatment of Large Scale and Traditional Paintings on Canvas

ABSTRACT

Thermal applications are some of the most common treatments in the conservation of paintings. Increased area of treatment makes even heating problematic and since the 1950s metal heating tables have been used. In most cases, they constitute a heavy duty device, which is limited in its application size, can be used almost exclusively in a fixed location, and is relatively expensive. The often slow response, temperature fluctuation, and uneven heat distribution do not comply with the current treatment methodology, which demands increasingly accurate and selective heat application along with mobility and versatility. The proposed experimental method, using a mobile and fast responding thermal silicone rubber blanket, offers versatility and precision and could be successfully used as an alternative to heating tables. The paper examines the method in use and the results of diverse case studies.

INTRODUCTION

Throughout the history of conservation various methods have been employed in an attempt to gain the desired control over the heat distribution during treatments, achieving variable degrees of success: from the heated sand poured by Pietro Edwards in 18th-century Venice, to hand-held irons and various electrical and digitally controlled sources.

During the 20th century, the search for an efficient heating device seems to have been driven initially by the diffuse practice of impregnating paintings with wax resin, and later, from the 1950s onwards, this search was sustained by the introduction and the growing use of thermoplastic resins. In particular during the period between the 1970s and the 1990s the technologies developed rapidly to serve the increasingly common practice of lining.

Yet more recently, the key issues in conservation practice have become minimal intervention, retreatability and preservation of the multifaceted aspects of an object's authenticity and integrity. Extensive treatments such as the lining and relining of paintings have been replaced by more selective approaches, and a focus on preventive measures. While the methodology and philosophy of treatment has evolved dramatically, the heating devices themselves have not. Many of the treatment techniques applied today involve the application of sealed systems, such as an envelope, and application of heat and pressure in a combined form using a vacuum or low pressure heating table. The heating tables come in various models and sizes, but basically have not changed much since the 1980s. In most cases, the table is a relatively expensive piece of studio equipment, which is limited in its application size and can be used only in a fixed location.

What if you could roll up your heating device like a mat and store it when not in use, or take it to your work site when treating a large format painting?

An experimental method using a flexible silicone rubber thermal blanket offers versatility and precision when treating both large scale and conventional paintings and could be successfully used as an alternative to the heating table. In 2003, upon the advice of Al Albano (Intermuseum Conservation Association), a silicon thermal blanket was custom designed by Instrumentor's Supply for use in the onsite treatment of two large-scale New Deal murals in Portland, Oregon. Since then this method has been applied in the treatment of other paintings by the authors and other art conservators. From the

preliminary results it is apparent that along with the impressive versatility and unlimited size, the thermal blanket also offers considerably shorter heating and cooling times and a more uniform heat distribution over the surface, free of "hot" and "cold" spots, often so problematic in conventional heating tables.

APPARATUS

Background

The precursor of our device–an electrically heated blanket–was patented by Frank R. Whittelesey in 1913. [1] In the 1920s, the Thermega Underblanket was manufactured in Britain. Electric overblankets were introduced in the United States in 1937, and first thermostats were attached. [2] The early blankets were rather unsafe; the wiring would degrade and easily break, causing disruption in heating, and worse. Yet other new devices appeared on the market in 1940, when conductive rubber was used for electric heated USKON mats by US Electrical Company, first for military and later for civil applications. [3] The boost in development of high precision thermal blankets and of flexible heaters in general was originally linked to aerospace and military research as part of the active thermal protection system for the spacecraft and satellite controls. The great advantage of flexible heaters is their capacity to transfer heat to an object of almost any shape or configuration. Such heaters with attached high precision thermostats are currently applied as freeze protection for instrumentation and hydraulic equipment in the aerospace and military industry, in medical equipment, for battery heating, to keep traffic lights and the ATM machines going in cold climates, and even inside laser printers or any other application requiring a flexible shape or design.

It must be noted that electrically heated mats are not entirely new to art conservation, but they've had rather marginal use. Heat blankets were employed in early heating tables, and Helmut Ruhemann suggested an application similar to ours in 1959 using the Electrothermal Rubber Sheet. [4] In the same year, Alain Boissonnas described the USKON mat and its use in an early heating table [5] and perhaps even used by other conservators, but not documented. More recently, a silicone rubber heated mat, mounted on a solid support and controlled manually with a dimmer and external thermometer in combination with a low pressure ring, was used by Jos van Och (Stichting Restauratie Atelier Limburg) in Maastricht for the lining of the colossal Mesdag Panorama mural in The Hague (1990-1996). [6]

Technical

The design of flexible heaters employs a grid of wound wire or etched foil elements vulcanized between two layers of silicone rubber, Kapton, or neoprene and the size could vary from miniature mats to virtually unlimited size blankets.

The wound wire silicone rubber heater combines the excellent dielectric properties of silicone rubber and the strength of fiberglass. The heating element is manufactured by twisting fine nickel-chromium alloy wire over a center core of fiberglass, producing a fine, strong, flexible cord. The cord is then patterned in a dense grid, with elements no farther apart than 1/4" (now available also in 1/8") to provide uniform heat distribution. Once the heating element is positioned, a second layer of silicone rubber is laid over the wire. The layers are then vulcanized to permanently position the elements. The heating elements are connected to wire leads for power. The total thickness of the heating pad with the wire wound element is .055" (1.4 mm).

This type of heating pad was developed for applications where repeated flexibility is necessary, and to accommodate small radius bends (such as for heating drums and pipes). Because of the strength and flexibility of the wire element, this type of heater is most indicated if rolled storage of the blanket is desirable. The resistant nature of silicone to moisture, compression and solvents also adds to the durability of the heating pad as a studio tool. The pads may be bought in standard stock sizes up to 3' x 10', but may also be custom produced in smaller or wider dimensions, or in custom shapes with cutouts, perforations, etc. [7]

Etched foil heaters present a new development, and can be fabricated in an unlimited range of shapes and sizes as well. Their thin, lightweight design (0.007" thick) provides an even greater extension of the heated element surface within the external skin. The etched foil may be vulcanized to silicone rubber, or attached to Kapton®, a lightweight flexible polyimide film that has a proven performance record of maintaining outstanding mechanical, chemical and electrical properties over extreme temperature ranges. [8]

Electrical, performance and controls

To run the heater, the system includes a series of external controls neatly assembled within a box that also serves as a power outlet for the heater. The control box contains a precision digital temperature controller that drives a solid state relay to run the heating unit and a thermocouple to detect a single local temperature. (The relay is an electronic switch that opens

and closes the circuit and provides current to the heater.) The relay that was installed in the 2003 system has a 1/4-1 second time cycle for temperature correction, while the newer solid state relays, known as variable time base relays, have time cycles that number 20-40 times per second to maintain an extremely precise and continuous target heat, with an accuracy of +/- .1% C. [9] (The newest phase angle fired relays have even greater accuracy, but with negligible difference for our application.) Once the desired temperature is reached, it will stay steady for the duration of the treatment.

The entire system may be designed for either a 120V current or 240V, which will be determined by the watt density requirement (watts/square centimeter) of the heating element type (foil or wire) and the heating pad dimensions. For pads over 20" x 30" (50 x 70 cms), the 240V support is necessary. The control box also contains a fuse for the temperature controller, fuses for the "hot lines", and one GFI outlet for safety purposes (although the 2003 was not designed with a GFI outlet). The engineers have also designed the temperature parameters of the system to not exceed 160º F/70º C, both within the setting of the temp controller and in the wiring of the heating pad itself. [10]

The temperature in smaller blankets, like any other electrical device could be controlled also using the solid state dimmer, though with only approximate results.

The temperature is detected with a single external thermocouple that may be positioned as appropriate to the treatment. Of course, auxiliary use of an IR thermometer and thermopapers is useful to monitor the entire surface of the work during treatment.

Testing

Three critical parameters: the temperature fluctuations, heat distributions and heating and cooling time of three heat sources were comparatively tested during their operation. The fluctuation of the temperature of the surface of a multipurpose low pressure table with a grill type heating element, constructed in the 1990s (similar models like this are found in many museums worldwide) indicated as much as 10 times greater fluctuations when compared to the thermal blanket. Unexpectedly, the heating table of 1950 (with 13 internally fixed heating blankets) performed rather well in this respect, showing a stable curve, comparable to that of the thermal blanket. This testing also indicated the striking difference in heating and cooling times between the compared devices. While the heating blanket reached the set temperature in approximately 12 minutes, the multipurpose table and the heating table reached it in 20 and 22 minutes respectively. The differences were more dramatic, when comparing the cooling time: the thermal blanket reached the ambient temperature in approximately 14-18 minutes, the hot table in 180 minutes, and the multi-purpose table in 90 minutes. (This may be caused by the heat sink properties of the table surfaces and different mass of tested heating devices.)

The distribution of heat patterns in all three devices was also explored with FLIR 025 thermographic camera and the results, as suspected, indicated the most even heat pattern in the thermal blanket, showing less even distribution in the hot and the low pressure tables. Certainly, the results may differ from one model to the other, and since similar devices are present in most museums and larger conservation laboratories, we would encourage performing similar tests. Even heat distribution, minimal temperature fluctuation and considerably shorter heating and cooling times are critical factors, making any heat involved in treatment safer and less invasive.

Thermographic imaging was also used to investigate the heat distribution of the 2003 blanket during the initial heating up phase. The dense patterning of the wound wire elements resulted in an immediate and fairly uniform dispersal of current to all areas of the heating pad. Engineers at Instrumentor's Supply suggested that the uniformity of the heat distribution could be improved considerably by laminating a copper wire mesh within the silicone heater. This would not only provide a perfect distribution of the heat all the way to the edges, but would also allow the blanket to be grounded for safety purposes. For fixed locations such as in heat tables, an aluminum foil backing may be adhered onto one side of the silicone rubber heater. Since the foil is prone to wrinkling if rolled and unrolled, it is not advisable if rolled storage is desirable.

APPLICATION AND TREATMENTS

The thermal blanket presents a universal and versatile device that may be applied in variety of treatments: from flattening surface deformations, both overall and locally, to various consolidation treatments. However, most effectively, it may be implemented in lining treatments in combination with a low pressure or vacuum envelope systems. The great advantage of the blanket over the table is in the possibility of placing the heat source in various locations, under, or over the treated artwork, and also in vertical and applying in sections. It could be combined with mini Mitka type or with standard low pressure table and envelope system – loose, fixed to the surface or

loomed. While most of commonly fabricated vacuum pumps could be used, we have used the GAST 0523 rotary vain non lubricated pump, fitted with pressure gauge, vacuum relief valve and multiple suction cups. The vacuum or low pressure envelope could be assembled in variety of ways, depending on the need of each project. While the Nylon 6.6 Dartek membrane is most common in North America, PVC membrane, that is softer at operational temperatures, has been also successfully used. Polyethylene, though traditionally used for the cold "mist lining" technique developed by Jos van Och at Stichting Restauratie Atelier Limburg (SRAL), it may also be used in thermal treatments if the appropriate grade is selected. Polyethylene has the added advantage of being produced in much wider rolls than Dartek,

Howard S. Sewell *The Coming of the White Man Immigration*, 1937, oil on cotton, 153 cm x 690 cm each, Oregon City High School, Oregon City, Oregon, USA.

The prototype heater was created in 2003 by Instrumentor's Supply of Oregon City, Oregon and was manufactured for use in the treatment of two New Deal murals by painter Howard S. Sewell in Oregon City, Oregon. The silicone rubber heating pad has wound wire elements and was made to measure 36" x 66" (91 x 168 cms) in order to accommodate the height of the murals. The two murals were each composed of three separate pieces, originally marouflaged to the wall as a single image measuring 61 inches high by about 23 feet long. The works were lined onto a single continuous backing with a Reemay interleaf loaded with Beva-371. A vacuum envelope was created with Dartek with two out flowing points connected to the GAST pump. The works were then bonded to the backing by heating in sections, positioning the thermocouple between the heater and the backing surface. The heating pad allowed all of the work to be conducted on site at the school, with the simple installation of a 240V circuit for the heater.

Louis Bunce *Alice in Wonderland, 1001 Nights' Entertainment*, 1938, tempera on cotton, 183 cm x 274 cm each, North Salem High School, Salem, Oregon, USA

The silicone rubber heating pad was also used to bond two New Deal murals by painter Louis Bunce to aluminum honeycomb panels. The works had been, again, marouflaged to the library walls of an elementary school that, in this case, was destroyed soon after the removal of the murals. The works were positioned over the interleaf pre-tacked to the aluminum honeycomb panel in a vacuum enclosure, and in this case, the heater was positioned on the face of the work. The works were bonded to the panels in sections. The conductive properties of the aluminum facing skin of the panel no doubt aided in the diffusion of the heat.

This same method was more recently applied in 2009 to a series of six newly produced large works painted in acrylic on cotton canvas that were destined for the embellishment of the ceiling of a church in Portland.

Willem Van Aelst *Still Life with Peaches and other Fruits* 1650 Oil on canvas, 98, 5 cm X 112 cm, private collection Amsterdam

A second thermal blanket was designed and manufactured for T. Markevicius in 2005 (110 x 120 cm), again connected to a solid state relay with digital temperature control. This system was applied in the structural treatment of a 17th century painting by Willem van Aelst. This particular painting had been broken (horizontally) in two pieces right the middle and was wax resin lined in 1989, after having removed the marouflaged wood composite support from earlier restoration. The lining was carried out within the sealed envelope and fixed loose to the working surface.

Paolo Veronese: *Dead Christ Held by Angels* superior fragment of Petrobelli altarpiece, oil on canvas, 285 cm x 198 cm, Ottawa, National Gallery of Canada

The same thermal blanket was used in treating the fragment of the Petrobelli Altarpiece by Paolo Veronese by Stephen Gritt. While reconstructing the original format of the Ottawa fragment, lining was required. The loomed lining support and painting were enclosed in a Dartek envelope during the first phase of lining, which involved the painting without the cast lateral additions and was accomplished using the conventional heating table. During the second phase, the lateral pieces were attached using the thermal blanket, which enabled the National Galleries' conservators to perform a localized treatment, and eliminated the need to expose the whole painting to prolonged heating and cooling cycles.

Since the debut in 2003, several other thermal blankets were constructed for conservators in Europe and North America and we would be curious to hear about their experiences and results (See figures of San Diego blanket).

CONCLUSIONS AND DISCUSSION

Current conservation practices are moving towards ever more minimal and less invasive treatments. This thermal blanket may provide not only improved temperature control in terms of even heat distribution with minimal temperature fluctuations, but it may also be designed in a variety of sizes and configurations that allow it to be modified for specific needs. The heat blanket is easily transportable, storable and quite economically accessible. This versatility makes it a useful device for the museum laboratory and for those of us in private practice.

While it has been successfully used in its first imperfect iteration of 2003, later models have already improved the design, and naturally, new designs could be further improved. For example, the density of the wound wire grid was increased to 1/8' and the integration of the thermosensor into the heat blanket has already been incorporated into newer designs for recent requests, as has an upper-limit security setting. Other improvements, such as incorporating USB datalogger or IR non contact thermal sensor were also suggested and are possible, depending on individual needs.

From the "big picture" perspective, the future of heating devices in art conservation is clearly with highly mobile, versatile, accurate and cost effective devices. Our further research working on a concept of the new IMAT (Intelligent Materials for Accurate Thermoelectrics) [11] heating device is focused into the radically new design solutions, such as eliminating the internal resistance wiring, for example, which will open the doors to completely new class of heaters. While the first attempt at constructing film heaters without wires may be traced to the USKON conductive rubber heaters that were mentioned earlier, looking forward to the not so distant future IMATs may become available in ultra thin, stretchable, and even transparent forms. Our research and direct contacts with the inventors of relevant technologies, indicates, that these "smart" heaters could be designed using the most recent conductive rubber-like or even woven materials made with newly developed nanomaterials, such as carbon nanotubes (CNT) or silver nanowires (AgNW) and may represent one of the more exciting developments in this field and collaboration between art conservator, thermoelectrical engineer and scientist. While waiting for these innovations to reach the market, the flexible thermal blankets presented in this paper could find their place in current conservation practice, contributing to better results and more flexibility in treatment choices.

ENDNOTES

1. F.R. Whittlesey *Electric Heating Blanket, Pad, Robe and the Like* Brevetto no 1058825; Deposition of Request: 1 April 1912; Patent release: 15 April 1913; United States Patent Office; Google Patent Search
2. Rodney P. Carliste *Scientific American Inventions and Discoveries* John Wiley and Sons, Hobeken (NJ), USA 2004 p. 345
3. Anon. *Serving through science* Life 1944 p. 15
4. Helmut Ruhemann *Some Notes on Vacuum Hot Tables; Vacuum Relining Using a Heated Mat*, Studies in Conservation, Vol 5, No 1 (Feb 1960) pp. 17-18
5. Alain G. Boissonas *Some Notes on Vacuum Hot Tables; Fine Art Conservation Laboratories*, New York, Studies in Conservation, Vol 5, No 1 (Feb 1960) p. 18
6. Direct communication with Jos Van Och, Head of Conservation, Kate Seymour, Head of Education; Stichting Restauratie Atelier Limburg, Maastricht, The Netherlands.
7. See catalogues of Watlow Electric Manufacturing Company, USA.
8. See catalogues of Watlow Electric Manufacturing Company, USA.
9. See catalogues of Watlow Electric Manufacturing Company, USA.
10. Manufactured by Instrumentor's Supply, Inc., Oregon City, OR, USA.
11. IMAT acronym is suggested by the authors for the first time defining the new class of "smart" mobile thermoelectrical devices for art conservation

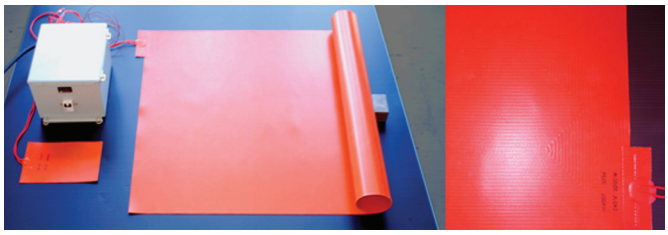

Figure 1. Thermal blanket and temperature control unit with thermocouple. Next to the control unit: mini thermal blanket. Right and below: details of thermal blanket.

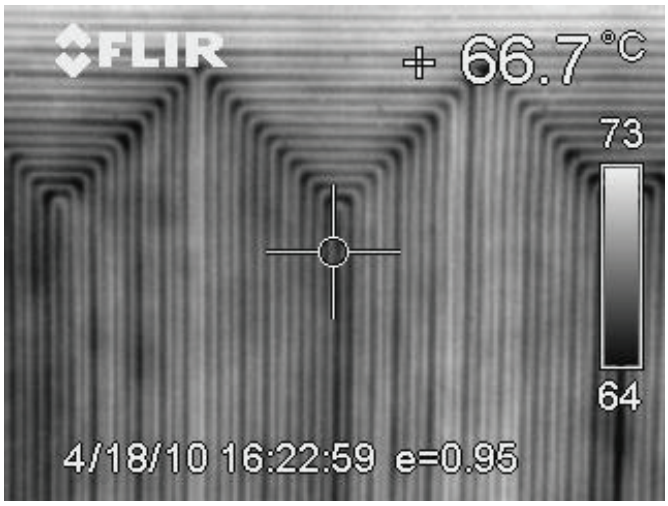

Figure 2. Thermographic image of wound wire element inside the thermal blanket

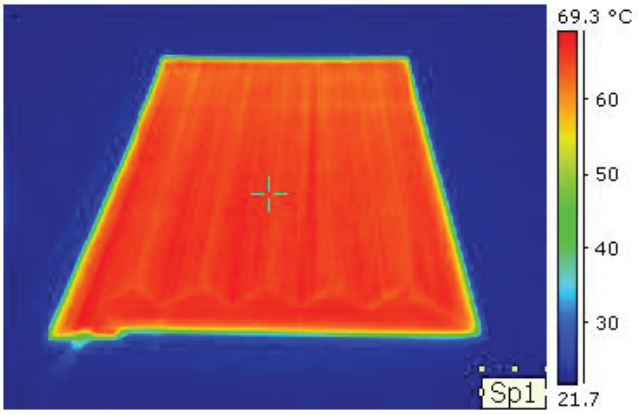

Figure 3. Thermographic image of thermal blanket showing even heat distribution

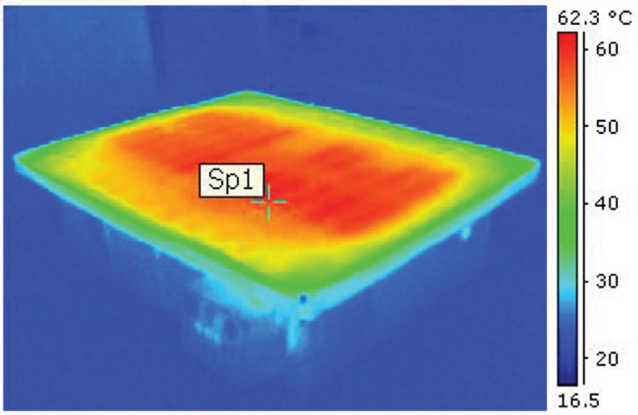

Figure 4. Thermographic image of 1990s multipurpose low pressure heating table showing uneven heat distribution

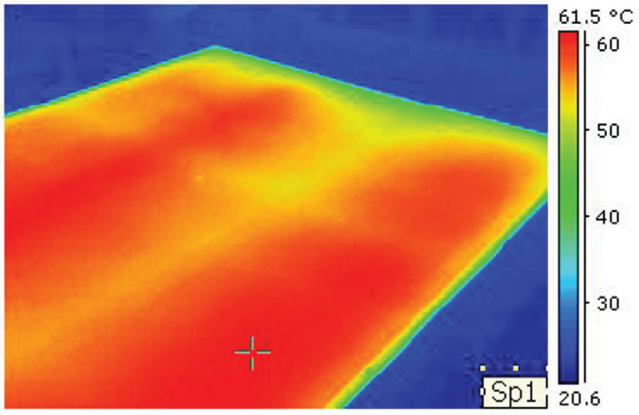

Figure 5. Thermographic image of 1960s vacuum heating table (detail) showing uneven heat distribution

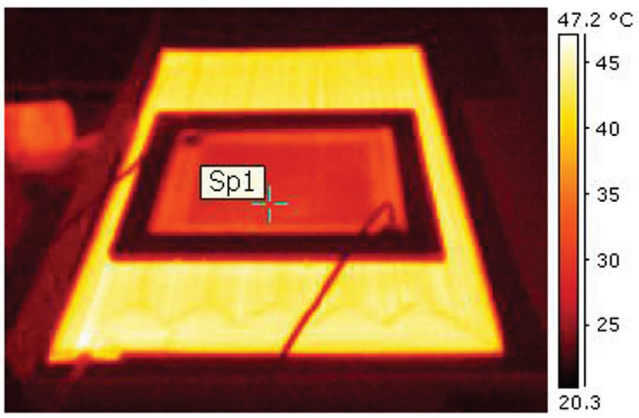

Figure 6. Thermographic image of a thermal blanket and of a test lining, showing even heat distribution. The pre-stretched lining fabric is enclosed in Dartek envelope and placed loose over the thermoblanket.

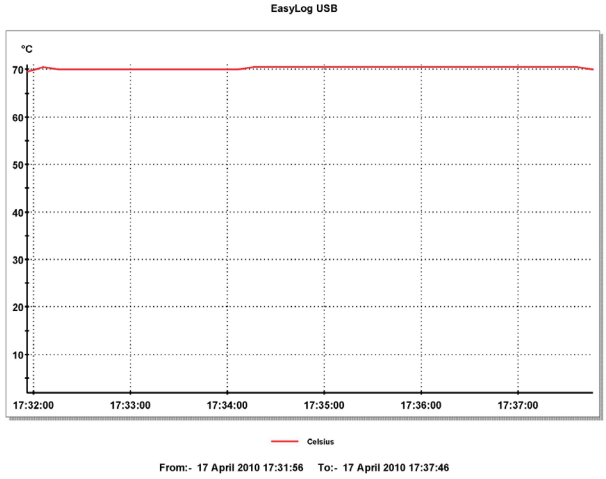

Figure 7. Graphic of surface temperature fluctuation: thermal blanket

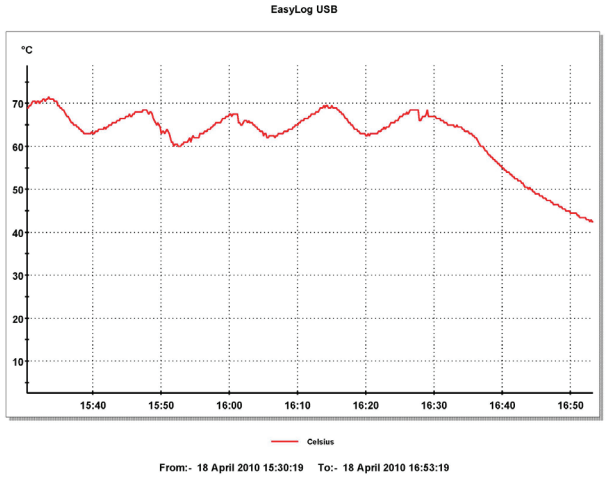

Figure 8. Graphic of surface temperature fluctuation: 1990s multipurpose low pressure heating table

Figure 9. Howard Stoyell Sewell (1899 – 1975) *Integration of Races: White Man's Settling of America* 1939 mural painting on canvas, 162 x 914 cm. Oregon City Senior High School, Oregon City (OR) USA. Above: after the treatment and installation in the Oregon City in 2003; below: lining one of the murals using vacuum envelope and flexible thermal blanket. Portland (OR) 2003.

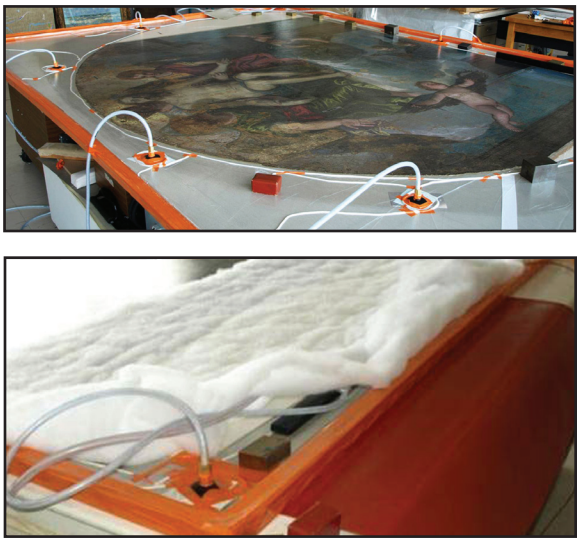

Figure 11. Paolo Veronese (1528-1588) *Dead Christ Held by Angels* 1563, oil on canvas, 295 x 398 cm during treatment at the National Gallery of Canada. Above: Overall view of lining in progress; below: local lining using silicone thermal blanket. Ottawa 2008-09.

Figure 10. Willem van Aelst (1626-1683) *Still Life with Peaches, Grapes and Other Fruits* oil on canvas, 98 X 112 cm, private collection, Amsterdam. Above: overall view after treatment; below: lining process using flexible thermal blanket. Amsterdam 2005.

Figure 12. Paolo Veronese (1528-1588) *Dead Christ Held by Angels* 1563, oil on canvas, 295 x 398 cm National Gallery of Canada. Above: after treatment. Below left: before treatment. Below right: detail during treatment. Ottawa 2008-09.

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VERONICA ROMERO, KELLY O'NEILL, AND RUSTIN LEVENSON

Up in Smoke: New Solutions for Treating Soot Damaged Paintings

ABSTRACT

After a fire destroyed the Harold Golen Gallery in Miami in 2007, 108 paintings were transported to the Rustin Levenson Art Conservation Associates Miami studio. After traditional methods of soot removal were exhausted, with only 40 paintings successfully treated, the conservators tested different solutions to remove the soot on the remaining works. The results of the tests, and observations made during the treatment of the paintings are reported in this article.

I. The Emergency Phase of the Project
Veronica Romero

On December 13th, 2007 in the early hours of the morning, firefighters arrived and tried to fight a fire from inside the building of the Harold Golen Gallery in Miami, but quickly abandoned the interior when the roof began to collapse. The fire was believed to have started when an advertising balloon attached to the building, specifically put up to promote the gallery during Art Basel week, came into contact with electrical wires due to heavy winds and sparked the blaze.

On December 14th, Harold Golen contacted the Rustin Levenson studio in hopes that conservation would bring some optimism to his hapless situation.

Inside the Harold Golen Gallery was over half a million dollars worth of Pop Surrealism art pieces. Pop Surrealism is also often known by the name Lowbrow Art. Lowbrow describes an underground visual art movement that arose on the west coast in the late 1970s. Its origins were conceived from the underground comic world, punk music, hot-rod street culture, and other subcultures. Lowbrow art often has a sense of humor: sometimes the humor is gleeful, sometimes impish or deviant, and sometimes it's a sarcastic comment. Most lowbrow artworks are paintings, but there are also toys, digital art, and sculpture.

The Harold Golen Gallery was located in a concrete building. The ceiling caused the main damage; after being engulfed in flames, the ceiling caved-in and collapsed on the artwork. Out of 178 rescued pieces, Rustin Levenson Conservation Associates assumed 108 potentially salvageable painted surfaces for possible treatment.

Thus began the battle against time and soot residue.
Soot is a general term that refers to impure carbon particles resulting from the incomplete combustion of a hydrocarbon. It is more properly restricted to the product of the gas-phase combustion process, but is commonly extended to include the residual pyrolyzed fuel particles such as charred wood that may become airborne during decomposition brought about by high temperatures (i.e. pyrolysis).

Soot, as an airborne contaminant in the environment has many different sources, but they are all the result of some form of pyrolysis. Soot can be formed outdoors from sources such as internal combustion engines, central steam heat boilers, waste incineration, local field burning, house fires, or forest fires. Interior sources can include smoking of cigarettes, fireplaces or furnaces, cooking, oil lamps and candles, and even quartz halogen bulbs with settled dust. It is not necessary to have a fire to have soot. In very low concentrations soot is capable of darkening surfaces or making particle agglomerates, such as those from ventilation systems, with a black appearance. Soot is also the primary cause of "ghosting," the discoloration of intersecting walls and ceilings or walls and flooring where

they meet. Soot normally forms at about 140°C (284°F). The composition of soot depends strongly on the fuel composition (the materials burned by the fire) and the substances used to extinguish the fire.

It was quickly realized that any handling or pressure that disturbed these soot particles could cause infiltration into the surface of a painting, making the soot nearly impossible to clean. It was also understood that efforts to remove the soot would become increasingly difficult over time, so the conservators had to move as quickly and as efficiently as humanly possible.

Before the arrival of the fire damaged pieces, the studio had to procure an adequate storage and work space to carry out the salvage operation. In addition to carbon from soot, surface deposits on the artwork contained potentially toxic and corrosive by-products, and could not cross the threshold of the conservation lab. It was an advantage that a few yards from the doors to the studio, Rustin's cottage would soon host some of the filthiest houseguests ever. The floors were lined with tarps and safety equipment was implemented, including the use of HEPA air filters. Harold Golen offered a rudimentary inventory and the conservators prioritized, documented, and organized the paintings. December in Florida has its benefits and the advantage of being able to work outside during the dry season was significant.

Throughout the salvage operation the studio was in constant contact with Harold Golen and the artists, gathering crucial information, entertaining visits, and even at times occupying the role of a therapist. There were encouraging recoveries coupled with discouraging moments. In some cases after countless hours and various cleanings, Harold would insist that the colors in a painting were not as vibrant as he remembered. Scot Olsen, who was preparing for a forthcoming retrospective, had most, if not all of his recent work up in the gallery during the Art Basel showing. Out of thirteen of his pieces that came to the studio, the conservators were able to salvage only one. In a recent conversation, he reported that he burns one painting every year, to "*appease the fire gods*."

II. Traditional Methods of Cleaning Smoke Damaged Paintings

Kelly O'Neil

Of the 108 paintings that were brought into the studio, the conservators were able to successfully treat 85; 61 of these were acrylic-based works (including silkscreen and enamel) and 24 were oil paintings. Their supports included canvas, Masonite, and wood panel. The many tested and established conservation treatments provided a broad foundation for soot removal from works carried out in oil medium. The complications of treating the acrylic paintings were more daunting. As a newer medium, there is still much research to be done on the long-term effects of surface cleaning applications. [1] The conservators were aware from research and personal experience of the sensitivities of acrylics to solvents regularly used for cleaning oil paintings. [2] Their susceptibility to accumulating surface dirt and of adhering to other surfaces made soot removal challenging. With their added exposure to heat and water in the fire, the conservators expected them to be even more complicated. They did not disappoint.

The first phase of soot removal began with the aid of a HEPA-filtration vacuum cleaner. The front and back of the paintings were vacuumed, holding the hose a safe distance from the painting's surface, allowing the loose soot particles to be removed without touching the painting.

The second step involved using dry cleaning: materials such as Groomstick and vulcanized rubber sponges were tested. Although the Groomstick removed some soot, it required too much pressure on the painting's surface, even with gentle rolling, so its use was discontinued. There was success with vulcanized rubber sponges on the reverse of the supports, stretchers, and tacking margins; there was also success with heavily varnished paintings, but the conservators abandoned its use for all other purposes. The painted surfaces, especially those that had visible interstices, such as thinly painted works on canvas, proved the sponges to be detrimental as the pressure from the sponges further lodged the soot between canvas threads and into the paint surface. Two years ago at the 2008 AIC Conference in Denver, Buffalo State's Dr. Aaron Shugar and graduate student Cynthia Albertson had a poster session on research on dry cleaning materials such as the vulcanized rubber sponge that revealed potential problems with scratching damage. This certainly would have been a possibility when rubbing against the heavy soot on these Pop Surrealist artworks.

The next step, cleaning, involved solutions recommended by conservators Chris Stavroudis and Dean Yoder; aqueous solutions with chelating agents and VM&P Naphtha emulsions. With both of these solutions, rinsing was an important step. Most solutions were rinsed several times. Unfortunately it was found that even after rinsing, residue was left on the paint surface. This led the conservators to carry out the final rinses with a PVOH sponge or to blot them dry with a paper towel.

In the next section, Rustin Levenson will discuss in more detail tests that were performed related to aqueous rinsing. As recommended, the use of chelating agents, such as dibasic ammonium citrate was successful with some of the paintings. The suggestion of VM&P Naphtha emulsion also proved very fruitful. It cleaned both oils and acrylics, and was especially successful with the oil paintings. In general, it was found that clearing the VM&P Naphtha emulsion with VM&P Naphtha seemed to remove the emulsion residue from the surface more effectively than water. As possible, the conservators, worked along design lines during the cleaning process. It was often found that a second application of solvent worked differently on a cleaned surface and the conservators wanted to prevent visible tide lines or overlapping cleaning.

Sometimes a combination or sequence of solvents proved successful. A good example of this is the cleaning of Niagara's *Snap Out of It*, an unvarnished acrylic on canvas. This work was treated first with ammonium citrate, followed by an application of VM&P Naphtha emulsion, and then rinsed with VM&P Naphtha.

Another success realized with VM&P Naphtha emulsions and sequences of solvents was Skot Olson's *Black Water Harvest*. An acrylic on canvas, *Black Water Harvest* was one of only a handfull of paintings in the warehouse that were varnished. After having the opportunity to talk with the artist, it was learned that the painting was 4-6 years old before the fire and had been varnished twice. In addition, this painting had an added and rather unconventional layer of protection, the floor. The work was discovered face down on the concrete floor in the Harold Golen Gallery. Having the painting face down on the concrete provided for 'some' relative safety from the elements, allowing debris from the caved-in ceiling to accumulate on its reverse rather than of the face of the painting. Despite the painting's orientation, the surface suffered smoke damage. For the treatment of this painting, a solution of mineral spirits and tri-methlypentane was applied to the surface, followed by an application of VM&P Naphtha emulsion, and then rinsed with VM&P Naphtha. The steps and series of solutions that facilitated the cleaning of this painting is an example of the tailored recipes required to clean most paintings.

Stronger solvents, such as xylene, were also employed in emulsions. An example of this was Tim Biskup's *I Love You Table*. An unvarnished, acrylic painted, 3-dimensional wood object, each of the six sides was cleaned with a 10:7 xylene emulsion: trimethlypentane solution, and then rinsed with distilled water. It was noted that the paint became sensitive with a second application of solvent. During the cleaning treatments, the conservators often found each area had to be cleaned completely in the first application. Once an area dried, the residual material was sometimes difficult to remove. It was also discovered that some solutions would work better if the conservators covered a larger area of surface with a larger volume of solvent. This helped loosen and push out the soot, while saturating the area. In the case of the *I Love You Table*, as much soot as possible was removed and the work was returned to the artist to retouch.

In summary, it was discovered that traditional solutions worked best on oil paintings and only a few of the acrylic paintings. This still left the conservators with many acrylics and a few oil paintings that could not be cleaned with established methods.

III. Testing Phase: New Approaches for Soot Removal: Rustin Levenson

The remaining paintings, which could not be cleaned with conventional conservation solvents, were scheduled to be discarded by the insurance company. This offered a unique opportunity for research. Working with Harold Golen and the artists, the conservators received permission to do further testing for soot removal with non-traditional solutions. Starting with the familiar, the solvent cabinet was exhausted, testing everything from resin soaps to complex emulsions in various sequences.

Solutions with stronger chelating agents were successful on some of the paintings. A mixture of 10% Versenol, an EDTA chelating agent, 10% VM&P Naphtha and 80% distilled water, rinsed with distilled water, successfully cleaned several works.

Tests with stronger detergent agents were next. Concentrated mixtures up to 50% of the anionic detergent Vulpex with distilled water and/or naphtha showed some success. For example, on an oil on canvas by Ron English, *Raising the Brow*, a 30% solution of Vulpex in distilled water, rinsed with distilled water, began to unlock the soot layer. On other works, good results were also realized with 3-10% solutions of Vulpex in VM&P Naphtha. However, difficulties in clearing Vulpex and the high concentrations of the solutions that were successful kept the conservators searching for other alternatives.

The next tests were done with commercial solutions. From the aisles of Whole Foods, Home Depot, and Bed Bath and Beyond, and the depths of the kitchen cabinets a range of cleaning products was assembled. Promising results were realized with two products JC-100 and Gonzo Stain Remover. The Gonzo Stain Remover, described as "a water based sur-

factant solution," satisfactorily removed soot from the acrylic painting on panel, *Mamie* by Mitch O'Connell. The JC-100 partially removed soot from an acrylic on panel by Ryan Heshka, *Avia*. Frustratingly, there was little information about the formulation of these solutions. The JC-100 was no longer available and the MSDS pages on Gonzo Stain Remover listed the ingredients as "proprietary."

The investigation of these products led to a conversation with Dick Anderson, a cleaning chemist at Sentinel Products who suggested that a key to effective removal of carbon deposits with the JC-100 might lie with ethylene glycol monobutyl ether, a carbon solvent. Samples were acquired of ethylene glycol monobutyl ether EB from Lyondell Chemical and experimentation began. Various mixtures were tested with this solvent, some with positive results. The best solutions combined ethylene glycol monobutyl ether EB with Vulpex in mixtures of 3-10%. An example of success was an acrylic and vinyl painting on panel by Shag, *The Best Party in Palm Springs* where a solution of 5% Vulpex in the ethylene glycol monobutyl ether EB rinsed several times with distilled water removed the soot on the face of the painting. The surface of *Tiki Cat,* an acrylic on canvas adhered to board by Thorsten Hassikan, was cleaned with ethylene glycol monobutyl ether EB, rinsed several times with distilled water. Soot was removed from the acrylic painting, *Electric Eye* by Ryan Heshka using ethylene glycol monobutyl ether EB followed by a VM&P Naphtha emulsion, then rinses of distilled water.

There were still some paintings where soot had not responded to testing. A search for other products that contained ethylene glycol monobutyl ether led to Formula 88 Cleaner and Degreaser produced by Petruj Chemical Corporation. Formula 88, available in Home Depot, is sold to "Get Rid of the Mess with the Best." Despite this hopeful motto, it was with some trepidation that the studio tested it on a painting, but Formula 88 on swabs immediately lifted the soot off some of the remaining artworks, leaving the paint surface intact.

The MSD sheets and container list the ingredients in water as ethylene glycol monobutyl ether and sodium metasilicate. Sodium metasilicate, a common component of household cleaners, forms alkaline solutions when dissolved in water. The pH of Formula 88 is listed as 8.7-9.5pH. This was confirmed by measurements in the studio.

After further testing, several of the otherwise untreatable paintings were cleaned with Formula 88, rinsed several times with distilled water and/or VM&P Naphtha. Successful results were realized with a number of the paintings; one example is an oil on panel, *The Happy Idiot*, by Gary Baseman. This was cleaned with a 50:50 mixture of Formula 88 and distilled water, rinsed with distilled water. Adding 5% of Vulpex to Formula 88 and rinsing with VM&P Naphtha removed the carbon deposits on the acrylic on canvas *Or Are You Happy To See Me* by Niagra. Working with this solvent under a microscope resulted in a cleaned and intact surface.

Naturally, the studio had concerns about using materials unvetted by the conservation community. In anticipation of this presentation several empirical tests were carried out. Commercially primed canvas was treated with the various products, and then rinsed with distilled water once, twice, and three times. Only the pure Versenol solution left any evident residue on the primed surface. The same materials were tested on clear Mylar. These tests showed residues with all the solutions, even after three rinses. Although this is partially attributable to the Mylar as a test substrate, it gives rise for concern. Noting the residues in this test affirmed our routine of carrying out the final aqueous rinses with a PVOH sponge or with solvents and blotting the rinses with paper towels.

Ultimately, there were still paintings that could not be treated. Several of these works were donated to the Getty Research Institute for further testing by Tom Learner. Others were returned to Harold Golen.

It was with some surprise that one of these works, *Elvis, Elvis Pink Lace* by Ron English appeared, shining pristinely in Harold's new gallery at a recent opening. The medium of the painting on canvas was described by the artist as acrylic/enamel with silkscreen. The painting had been treated with ethylene glycol monobutyl ether with 5 % Vulpex and had been considered much improved. But when Harold viewed it, he felt the colors were still muted. Nonetheless, he had taken *Elvis* back to his gallery. At the opening, he proudly revealed that he had cleaned it himself with a new Clorox Greenworks product. Although it is hard to know without seeing the cleaning swabs, the paint surface appeared to have tolerated the cleaning well offering another solvent possibility to test in the future.

In a recent conversation, Dick Anderson discussed another new cleaning solution, which is part of the Sentinel Products Restoration line. These products, formulated from naturally derived esters, offer another possibility for testing.

In summary, each work had a unique solution for unlocking the soot on the surface. If a conservator is confronted with soot damaged paintings, the following advice is offered. Vacuum the reverse and clean it with a vulcanized rubber sponge. Vacuum, without pressure, near the paint surface. Forego the vulcanized rubber sponge on the paint surface except in cases of very light soot or heavily varnished paintings. Try the traditional solutions of chelating agents such as ammonium citrate in distilled water and naphtha emulsions. Other solutions to test could include other petroleum distillates, alone or in emulsions, xylene emulsions, ethanol, or mixtures of Versenol, VM&P Naphtha, and distilled water. Detergent mixtures such as Vulpex in distilled water or VM&P Naphtha could also be tested. Finally, there is the possibility of carbon solvents/degreasers such as ethylene glycol monobutyl ether, diluted, alone, or combined with detergents such as Vulpex. Careful rinsing of all solutions is also recommended and blotting, or using a PVOH sponge for the final rinse, so that no residue is left on the surface.

This information is shared in the hope that other conservators and conservation scientists will undertake further testing and research into these materials.

ACKNOWLEDGEMENTS

Tom Learner, Senior Scientist and Head of Modern and Contemporary Art Research, Getty Conservation Institute

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Carol Young Verheyen, Conservator, Huntington Art Gallery

Dick Anderson, Chemist, Sentinel Cleaning Products

Harold Golen, Gallery Owner

Skot Olson, Artist

The LowBrow Artists

ENDNOTES

1. AIC *Reviews in Conservation*, Number 10 2009, "The effects of wet surface cleaning treatments on acrylic emulsion artist's paints-a review of recent scientific research," Bronwyn Ormsby and Tom Learner. pp. 29-30, 38.
2. AIC *Reviews in Conservation*, Number 10 2009, "The effects of wet surface cleaning treatments on acrylic emulsion artist's paints-a review of recent scientific research," Bronwyn Ormsby and Tom Learner; Tate Papers 2004 (Tate's Online Research Journal) "Conservation Concerns for Acrylic Emulsion Paints: A literature review," Elizabeth Jablonski, Tom Learner, James Hayes and Mark Golden; Tate Papers 2006 (Tate's Online Research Journal) "The Effects of Surface Cleaning on Acrylic Emulsion Paintings: A Preliminary Investigation," Bronwyn Ormsby, Tom Learner, Michael Schilling, Jim Druzik, Herant Khanjian, Dave Carson, Gary Foster and Mike Sloan; Modern Paints Uncovered: A Symposium organized by the Getty Conservation Institute, Tate and the National Gallery of Art, Tate Modern, London May 16-19, 2006, "From formulation to finished product: Causes and Potential Cures for Conservation Concerns in Acrylic Emulsion Paints," James Hayes, Mark Golden, and Gregory D. Smith

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An Empirical Evaluation of a Range of Cleaning Agents for Removing Dirt from Artists' Acrylic Emulsion Paints

ABSTRACT

This study reports on a visual and empirical evaluation of wet cleaning systems for the effective removal of artificial dirt from artists' acrylic emulsion (dispersion) paints. Several wet-cleaning systems currently used by conservators were assessed by researchers at Tate, London, alongside a number of new systems/products identified via The Dow Chemical Company's high-throughput (HTP) automated analysis facilities, as reported in the general session of the 2009 AIC conference in Los Angeles. These new systems include Dow specialty ethoxylate surfactants, ethylene oxide/butylene oxide (EOBO) block copolymers and novel water-in-oil micro-emulsions. This report is part of an ongoing collaboration between Dow, Tate and the Getty Conservation Institute into the development of improved cleaning systems for acrylic emulsion paints.

INTRODUCTION

Much of the recent research into the cleaning of acrylic emulsion paints has focused on measuring ways in which commonly-used wet and dry cleaning systems might alter the surface (or bulk properties) of artists' acrylic emulsion paints (Ormsby and Learner, 2009). Once known, steps can be taken by conservators to minimize those risks in practice. However, an equally important aspect of this research is to develop cleaning systems that are more effective at removing dirt from the surface of these paints. A major part of an on-going research collaboration between The Dow Chemical Company, Tate and the Getty Conservation Institute has been to utilize Dow's high-throughput (HTP) capabilities to develop frameworks for the selection of liquid cleaning agents for the removal of surface dirt from artists' acrylic paints; specifically, to identify cleaning formulations which contribute to high efficacy of cleaning with low damage potential (i.e. risk) to paints. The HTP systems used included a range of automated instruments designed to deal with several tasks including product formulation and material testing; these systems have been previously used by Dow to dramatically increase the speed of developing cleaning products, designing paint systems and assessing the optical, physical and chemical properties of a range of different materials.

The first results and insights from this collaboration were presented at the General Session of the American Institute for Conservation conference, Los Angeles, May 2009 (Keefe et al. 2009). In that presentation, an HTP-based methodology was described that had been developed for comparing the cleaning efficacy of many wet cleaning systems for removing a standard soil from test acrylic paint surfaces. This system was applied to screen a wide range of pure liquids and formulated cleaning mixtures in order to identify systems or features that looked especially active for this purpose. The initial range of substances and cleaning formulations that were screened included both materials commonly used in conservation (e.g. water plus minor ingredients such as TRITON™ X-100 [nonionic surfactant], triammonium citrate (TAC) or EDTA [chelates], ethanol [co-solvent] and combinations of such ingredients; and mineral spirits, VM&P naphtha, etc.) and materials new to conservation that had been suggested by cleaning specialists at Dow. This latter group of substances included: alkylpolyglucoside nonionic surfactants (e.g. TRITON CG110, which is readily biodegradable); new biodegradable/ low aquatic toxicity alcohol alkoxylate nonionic surfactants (eg. ECOSURF™ EH9); novel surfactants (e.g. Satin™ FX) based on ethylene oxide/butylene oxide diblock copolymers [EOBO] (Harris, et al. 2002); linear alkylbenzene sulphonate (LAS) anionic

surfactants; various oxygenated co-solvents (DOWANOL™, glycol ether-type) and INVERT™ 5000, a "water-in-oil" type of micro-emulsion. Initial screening of cleaning formulations for comparative efficacy considered both water-based and hydrocarbon solvent-based surfactant systems.

This paper aims to examine in more depth the cleaning performance of some of the more interesting and/or better-performing systems that emerged from the screenin tests. This involved the evaluation, via swab-rolling tests, of selected aqueous and non-polar cleaning systems that were highly rated in the Dow HTP tests alongside established and other novel cleaning systems. This empirical assessment aimed to compare the soiling removal efficacy of a relatively small group of systems using a methodology closer to conservation practice, and to evaluate other factors that might influence the final choice of cleaning system including: paint swelling, pigment loss or transfer during cleaning, handling properties of the cleaning solutions, clearance issues and detrimental changes to the paint surface. These factors cannot be assessed simultaneously using the HTP system but are clearly of concern to practicing conservators. The results of the empirical swab-rolling tests also help to inform subsequent HTP testing efforts, thus ensuring that ongoing experiments are optimized for the development of systems that rate highly in terms of soil removal efficacy, while being low risk in terms of damage potential.

EXPERIMENTAL

Paint samples

For this study, 2 colors of 4 brands of commercially available acrylic paints were cast onto a Fredrix 10 ounce double-acrylic dispersion primed cotton duck canvas (Fredrix) using a Sheen instruments adjustable film caster to a dry film thickness of ~110 μm (see Suppliers). In total a group of 23 soiled samples - 14 titanium white (PW6) and 9 azo yellow (PY3) - were chosen from a larger set. All paint media, extenders and pigments were characterized by using Pyrolysis Gas Chromatography – Mass Spectrometry (PyGCMS), μFTIR spectroscopy and Energy Dispersive X-ray analysis (EDX), as listed in Table 1. All samples were cast in 2003; some were thermally aged prior to soiling in a Fisons 185 HWC environmental oven (60° C; 55% RH) for 16 weeks; others were light aged at 15,000 lux for 16 weeks under Philips TLD 58W/840 daylight fluorescent tubes with the UV component filtered by acrylic sheet [Perspex p(MMA)]. Assuming reciprocity, this is equivalent to ~50 years exposure under normal museum conditions. All samples were soiled in 2006, after the initial period of natural/accelerated aging. Since soiling, all samples had a further 3 years natural aging in dark conditions prior to testing.

Artificial soil

An artificial soil mixture was prepared that was based on those proposed by Wolbers (1992) and Markopoulou (2003); the constituents (see Table 2) were blended together and sprayed onto the dried paint samples using a Badger Mini Spray Gun 250.4 (see Suppliers). The soil was applied in several layers to provide a medium-heavy coating with an area masked off as an unsoiled control.

Assessing surface characteristics of paint samples

The canvas samples were assessed before and after cleaning with methods aimed at documenting the nature of the film

Paint Brand	Pigment Type	Copolymer Type	Extender
Golden	Titanium white (PW6)	p(*n*BA/MMA)	-
W&N		p(*n*BA/MMA)	-
Talens		p(EA/MMA)	$CaCO_3$
Liquitex		p(*n*BA/MMA)	-
W&N	Azo yellow (PY3)	p(*n*BA/MMA)	-
Talens		p(EA/MMA)	$CaCO_3$
Liquitex		p(*n*BA/MMA)	-

Table 1: Description of test paints prepared for the swabbing study

Soil ingredient	Amount	% dry wt.	Supplier
Carbon black	2.0g	3.2	A.P. Fitzpatrick, UK
Iron oxide (ochre)	0.5g	0.7	
Silica	1.75g	2.8	
Kaolin	20.0g	32.4	
Gelatin powder	10.0g	16.2	VWR International, UK
Soluble starch	10.0g	16.2	
Cement (Type I)	17.5g	28.3	LaFarge Cement, UK
Olive oil (Berlotti)	10 ml	-	-
Mineral oil	20 ml	-	VWR International, UK
Petroleum spirit (80-100°C), 0% aromatic content [or VM&P Naphtha HT]	1L		

Table 2: Composition of complex artificial soil mixture

No	Cleaning system	pH	Conductivity (µS/cm)	Manufacturer/supplier
1	Deionized water (DI)	5	0	-
2	Tap water	7	650	-
3	Carbonated water (siphon)	5	1000	-
4	Acetic acid in DI water	4	72	VWR International, UK
5	1% v/v. ethanol in DI water	5	5	
6	1% w/v. triammonium citrate (TAC) in DI water	7	8100	
7	1% w/v. TAC + 1% v/v. TRITON® XL-80N in DI water	7	6700	Conservation Resources, UK
8	Petroleum Spirits (80-100°C bp.) ~ 0% aromatics	-	-	VWR International, UK
9	1% v/v. Surfynol 61 in petroleum spirits (80-100°C bp.) ~ 0% aromatics	-	-	Kremer Pigmente, Germany
10	Saliva	6-7	3100	-
11	INVERT™ 5000 (neat)	-	-	The Dow Chemical Company
12	INVERT™ 5000 (diluted 1:1 with mineral spirits (120-160°C bp.)	-	-	
13	2% v/v. SatinFX™ and 0.5% v/v. sodium lauryl sulphate (SLS) in petroleum spirits (80-100°C bp) ~ 0% aromatics	-	-	
14	1% v/v. SatinFX™ and 0.5% v/v. sodium lauryl sulphate (SLS) in petroleum spirits (80-100°C bp) ~ 0% aromatics	-	-	
15	1% v/v. ECOSURF™ EH9 and 1% w/v. TAC in deionized water	7	16800	
16	1% v/v. ECOSURF™ EH9 and 0.5% w/v. TAC in deionized water	6-7	500	

Table 3: Cleaning systems used for the swabbing study

surfaces. This assessment included measuring paint sample surface conductivity and the presence and relative amounts (see Table 5) of migrated surfactant, in order to explore whether these factors influence cleaning efficacy. Surface conductivity readings were taken to explore the relative ionic activity at the surface of each paint sample (unsoiled control areas), as this parameter that has been recently introduced as a tool to help tailor cleaning solutions to specific paint surfaces (Wolbers, 2000; Ormsby and Smithen, 2010). For this 100 µL of deionized water was pipetted and left on the paint film surface for 1min. The water was then drawn back up into the pipette and placed in a well-plate Horiba Conductivity Meter (B-173) (see Suppliers). The level of surface surfactant on each sample was assessed using Fourier Transform Infrared-Attenuated Total Reflectance (FTIR-ATR) spectroscopy. For this, a germanium ATR crystal was used with a Nicolet Avatar 360 spectrometer at 200 scans. At ~ 2000cm^{-1} the ATR system had a penetration depth of around 0.66 µm. Data was processed using Omnic 6.2 software and Table 5 contains data calculated as a ratio dividing the absorbance of the largest surfactant band at ~ 1110 cm^{-1} with that of the corresponding carbonyl band at ~1730 cm^{-1}. This provides a relative measure of surfactant abundance, with the highest figures indicating the greatest amounts of migrated surfactant.

Cleaning systems

Table 3 lists the systems chosen for this study, taken from a group of ten commonly used solutions (based on either deionized water or mineral/petroleum spirits), and supplemented by six systems that were highly rated by the HTP screening. Swab-roll cleaning tests were carried out with standardized Puritan® cotton-tipped applicators (see Suppliers).

RESULTS AND DISCUSSION

Table 4 contains the results from all swabbing study cleaning evaluations, which were defined as follows:

- Visual assessment of relative degree of cleaning after 8 x swab rolls.
- Number of swab rolls required to clean to a stopping point – determined as when: the sample was clean/pigment was removed/swelling was noted/damage was noted/100 swab rolls had been applied.
- Visual assessment of the final clean stage: compared with soiled and unsoiled control areas.
- Relative degree of 'damage' to the paint film: e.g. pigment removal, gloss change, swelling and/or abrasion of surface.
- Cleaning solution handling properties: consistency of swabbing action, control, wetting, clearance issues.

Visual Assessment

Each cleaning solution was applied to the 23 soiled test paint canvas samples and the results judged by eye and expressed in a scale ranging from 1 to 10; where 10 was the most effective system at removing soiling (Column A, Table 4). Interestingly, results were seen to approximate the soiling removal level achieved with the HTP system at ~8 swab rolls (consisting of 8 x 1 forward and back swab rolls).

As can be seen by the ratings and the example cleaned sample in Figure 1, eight swab rolls did not clean many of the samples to a significant degree, hence the maximum rating achieved for any of the solutions at this stage was 5/10. Nonetheless, the solutions rated highest in terms of cleaning efficacy were the neat and diluted INVERT™ 5000 water-in-oil microemulsion. The next most efficient included the surfactant and chelating agent combinations, followed by the various simple aqueous systems, with all of the mineral spirit-based solutions consistently rating poorly. This assessment provides an indication of the relative initial efficacy of each solution without accounting for any potentially complicating factors - such as pigment loss etc. The performance of the different cleaning solutions in this evaluation was in very good agreement with the results generated on the HTP equipment.

Number of swab rolls required to reach the final 'clean' point

Column B in Table 4 lists the number of swab rolls required to take the group of soiled samples to the final 'clean' state. This varied per sample, where swabbing was stopped at various

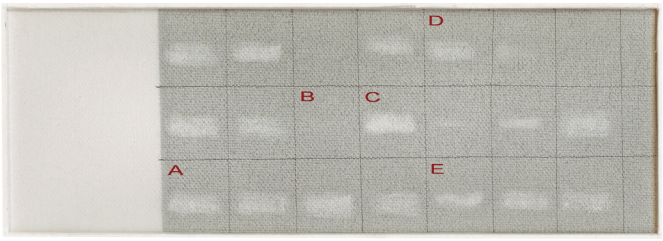

Figure 1: A soiled titanium white painted primed canvas sample cleaned to the 8x swab roll stage with the 16 swabbing-study cleaning systems. Marked tests are: water (A); Petroleum spirits (80-100°C bp.) (B); INVERT 5000 (C), 1% ECOSURF™ EH9 and 1% TAC in DI water (D); and 1% Satin™ FX in Petroleum spirits (80-100°C bp.) (E).

Evaluation criteria	A.		B.		C	D.		E.	
	Clean rating after 8 swab rolls (ave. 23 samples) 1-10; 10=clean	SD : 8x swab rolls rating	No. swab rolls till fully clean (ave. 23 samples) <100x	SD for no. swab rolls	Rating for speed of cleaning: 1 = slowest; 10 = fastest (no. swab rolls)	Clean rating final clean (ave. 23 samples) 1-10; 10=clean	SD for final clean rating	Relative 'damage' rating; 10 = best; 1 = worst (ave. 23 samples)	Cleaning system type
Material / solution (concentration)									
INVERT™ 5000 (neat)	5	2	15	12	10	8	1	1	ME
INVERT™ 5000 (diluted 1:1 with mineral spirits (MS) (120-160°C bp.))	5	2	23	14	9	8	1	3	ME
1% TAC + 1% TRITON® XL-80N in DI water	4	2	42	23	7	8	1	7	Aq + S + C
1% ECOSURF™ EH9+ 1% TAC in DI water	4	2	44	25	7	8	1	7	Aq + S + C
1% ECOSURF™ EH9 + 0.5% TAC in DI water	4	2	44	24	7	8	1	7	Aq. + S + C
1% TAC solution in DI water	3	2	57	27	6	7	1	8	Aq + C
Carbonated water (syphon)	3	2	58	29	6	7	1	8	Aq
Saliva	3	2	58	25	6	7	1	8	Aq
Deionised water (DI)	3	2	62	29	5	7	1	10	Aq
1% ethanol in DI water	3	2	66	25	5	6	1	10	Aq + solvent
Tap water	3	1	67	26	5	6	1	10	Aq
Acetic acid in DI water (pH 4.0)	3	2	69	27	5	6	1	10	Aq
2% SatinFX™ + 0.5% SLS in Pet. S (80-100 °C bp.)	1	1	82	26	3	5	2	10	Non-polar + S
1% SatinFX™ + 0.5% SLS in Pet. S (80-100°C bp.)	1	1	81	23	3	5	2	10	Non-polar + S
1% Surfynol 61 in Pet. S (80-100°C bp.)	1	1	87	21	3	3	3	5	Non-polar + S
Petroleum spirits (80-100°C bp.)	1	1	92	18	2	3	3	5	Non-polar

Table 4: Combined results for swab-roll tests on 23 different paint films on acrylic primed canvas. (Key: ME = microemulsion; S = surfactant; C = chelate)

points including: when the sample was clean; where 'damage' – such as pigment loss, abrasion or swelling - occurred; when 100 swab rolls had been reached. Not surprisingly, as shown in Figure 2, the required number of swab rolls varied with the cleaning system used: the least number of rolls were required when using the INVERT™ 5000 microemulsion and the largest number were achieved for all mineral spirits-based systems. The group of aqueous systems required moderate numbers of swab rolls, with marginally fewer for the surfactant-chelating agent combinations.

Although these tests were carried out by one person, the errors are notably large (see fig. 2). This is due to a number of factors including: the increased range of samples tested - i.e. 2 colors and 2 brands; differences in the heaviness of the applied soiling layer between samples; and the light and/or thermal ageing of some samples. It is also noted here that the number of swab rolls required was often far more than would be applied in typical conservation treatment situations; which is due to the tenacity of the applied soiling layer.

Solution efficacy at final clean point

When the final clean results were judged by eye (Column D, Table 4), it was clear that the mineral spirit based solutions were typically less successful at removing soiling compared to aqueous systems, apart from INVERT 5000, which was the most successful, alongside the aqueous surfactant and chelating agent combinations. The group of simple aqueous systems also cleaned moderately well. While still rating relatively poorly, the Satin™ FX/SLS mineral spirit combinations offered an improvement in cleaning efficacy over both the Surfynol 61 and pure mineral spirit solvent options. It was also noted during testing that cleaning efficacy appears to be at least in part dependent on the wetting power of each cleaning solution on each paint film. It was also observed, not surprisingly, that the paint film surface texture also affected the ease of cleaning. For example, samples with a limited number of air bubble holes as well as regular, flat surfaces tended to clean more easily; and films with more holes and rougher surface texture were often more difficult to clean.

Observations on relative damage: pigment transfer, handling, clearance and surface effects

During the complete clean stage, observations were also made on risks associated with each of the cleaning systems. This included assessing critical issues such as: pigment transfer during cleaning, surface abrasion, paint swelling, gloss alterations etc. A rating system was developed to assess the level of 'damage' caused by a particular solution (Column E, Table 4). The solutions with the lowest number posed the highest risk - where combined pigment loss, paint loss, gloss alteration and surface abrasion was noted. The highest ranking (10) was attributed to solutions where no visible change was noted either during or after cleaning. Differences were further refined according to the number of samples affected; hence if a particular solution caused damage to only one sample, the rating was lower than one that had repeatedly caused 'damage'.

These observations had a dramatic effect on the rating of some systems. For example, the INVERT 5000 microemulsion systems rated highest in terms of cleaning efficacy; however, the neat INVERT 5000 rated poorly with regard to risk due to frequent pigment transfer and surface abrasion noted during cleaning. With this product, pigment transfer was noted on 17 of 23 samples, which subsequently and reduced to 6 samples with the diluted system. The aqueous surfactant and chelating agent combinations also rated highly in terms of cleaning efficacy however they were sometimes affected by quantities of foaming at the paint surface, causing poor visibility and

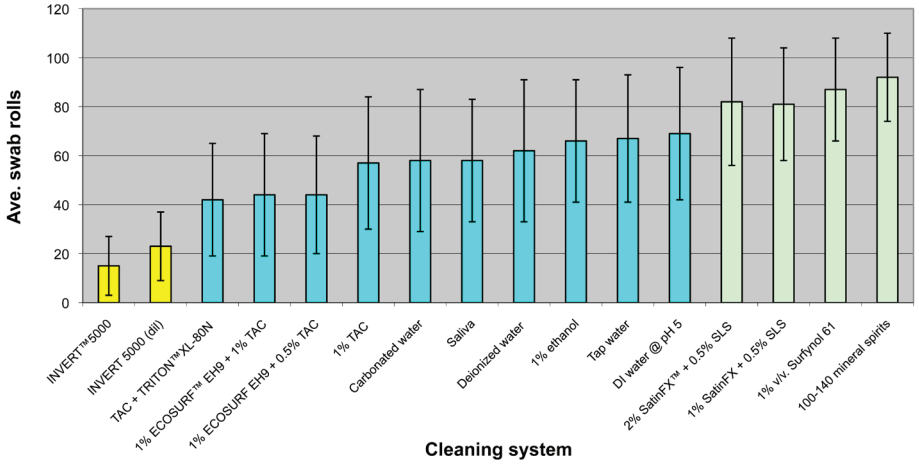

Figure 2: Number of swab rolls required for complete removal of soil (including stopping when clean/at damage or swelling point/after 100 swab rolls)

Pigment type	Paint Brand	Ageing regime	Surface conductivity - control unsoiled area. (1 x 1 min water extract) (µS/cm)	Surfactant level control unsoiled area (C=O/ 1110cm^{-1}) Ave. of 4 spots	Ave. swab rolls to final cleaning point across all solutions	Ave. of ave. swab rolls	SD. Ave. swab rolls
PW6	Talens	Natural	240	11.57	37	69	20
PW6	Golden		120	3.91	71		
PY3	W&N		151	2.20	52		
PY3	W&N		135	2.02	59		
PW6	Liquitex		39	0.51	82		
PW6	Liquitex		320	0.46	90		
PY3	Liquitex		250	0.94	90		
PW6	Golden	Light	97	0.74	61	71	13
PW6	Talens		102	0.72	72		
PW6	Liquitex		42	0.63	84		
PY3	Liquitex		250	1.03	85		
PW6	W&N		36	0.00	53		
PY3	Talens		93	0.00	70		
PY3	Liquitex	Thermal	227	12.16	50	42	10
PW6	Liquitex		195	10.19	27		
PY3	Liquitex		132	9.38	48		
PW6	Liquitex		143	3.88	25		
PW6	Talens		162	2.67	45		
PY3	Talens		147	2.62	42		
PW6	Talens		60	2.08	41		
PW6	Golden		20	1.06	53		
PY3	Talens		89	1.05	39		
PW6	W&N		19	0.00	52		

Table 5: Average swab rolls required for complete clean across all solutions compared to paint brand, pigment type, surface conductivity, and surfactant abundance

prompting concerns about adequate clearance. The simple aqueous systems - deionized water, tap water, water with added acetic acid and water with the addition of ethanol – did not caused any visible damage during or after treatment. Of the mineral spirits systems tested, the SatinFX™/SLS mixture rated highly in terms of its low damage potential, and therefore may be of some use in situations where aqueous systems and water-in-oil microemulsions are not suitable.

Repeated pigment transfer was noted with the INVERT™ 5000 systems across the range of samples. This did not appear to be brand dependent but was noted earlier with the PY3 samples. Those samples with higher initial gloss levels appeared to be more sensitive to surface abrasion and paint swelling, and the INVERT solutions were noted as occasionally causing paint surface swelling.

Influence of surface surfactant, paint brand, pigment type and aging on cleaning efficacy.
Several paint surface properties were also assessed in conjunction with the cleaning efficacy tests to ascertain whether the nature of the paint film surface plays a role. This included assessing levels of surface surfactant and surface conductivity; which have been discussed in detail elsewhere (Ormsby and Smithen, 2010; Ormsby et. al., 2009).

Table 5 compares the number of swab rolls required to clean each sample with pigment type, surface surfactant levels, surface conductivity values paint brand and ageing regime. The data indicates there was a slight reduction in average swab rolls required to fully clean the thermally aged samples. This may be due to the presence of substantial surfactant layers on many of these samples; or perhaps more feasibly, as the paint films had been thermally aged prior to soiling, they were probably a little harder, which may have prevented the applied soiling from becoming embedded.

Rearrangement of the data to reflect differences in pigment type (not shown) revealed little variation in the average number of swab rolls between the white and the yellow samples. Paints of the same brand – regardless of the pigment type - tended to require similar numbers of swab rolls to achieve a complete clean. For example, the Talens samples required an average of ~50 swab rolls; the Winsor and Newton (W&N) sample averages ranged from 53-56 rolls and the Liquitex samples ranged from 62-68 swab rolls. The data also suggested that there was no clear relationship between the surface conductivity of each paint film and either the surface surfactant levels present, paint brand, pigment type or the number of swab rolls required for complete cleaning. A marked increase in surface surfactant levels with thermal aging was noted for the Liquitex samples however this was not consistent across all samples.

Overview
Table 6 summarizes the results of this series of tests. For the aqueous systems, 1% ECOSURF™ EH9 + 1% TAC; 1% ECOSURF EH9 + 0.5% TAC; and 1% TAC + 1% TRITON® XL-80N were identified as the top-rated in terms of cleaning efficacy. These surfactant-chelating agent combinations showed a significant improvement in cleaning efficacy when compared to the simple aqueous systems, and the results generally concur with the HTP findings. That said, they also resulted in considerable foaming that occasionally obscured the paint surface during cleaning. The group of simple aque-

System	Swabbing study top rated systems	Comments from swab-roll study
Aqueous	ECOSURF™ EH9 / tri-ammonium citrate	Foams at surface; high cleaning efficacy; low risk to paint film.
	TRITON®XL-80N/ tri-ammonium citrate	Foams at surface; high cleaning efficacy; low risk to paint film.
	All other aqueous systems	Moderate cleaning efficacy; low risk to paint film.
Mineral spirits	Water-in-Oil Microemulsion (INVERT™5000)	Highest cleaning efficacy but can remove pigment. Requires reformulation to lower risk.
	LAS/ SatinFX™/VMP Naphtha	Generally poor cleaning efficacy; improvement on pure solvent; low risk to paint film.

Table 6: Top-ranked results from the swabbing study

ous systems also represented a low risk to each of the paint films, but up to 20 additional swab rolls were required to achieve the same degree of cleaning as the surfactant-chelating agent combinations.

Of the mineral spirits-based systems tested, the INVERT™ 5000 microemulsion achieved the greatest cleaning efficacy, representing an enormous improvement over the other systems tested, which all rated poorly. However, it also posed some risk to the paint films in this study, even when diluted with mineral spirits, and some further modification to its formulation may be needed before it can be fully recommended to the conservation profession (see Conclusion). The Satin™ FX and SLS mixtures offered a slight improvement over both the Surfynol 61 solution and pure mineral spirits which suggests that this approach may be worth pursuing to further increase the cleaning efficacy of mineral spirits-based systems.

CONCLUSIONS

This paper reports on tests into the relative efficacy of a range of different wet cleaning systems for the removal of dirt from the surfaces of artists' acrylic paint films, largely by practical tests carried out by conservators, and builds on previous work using Dow's HTP facilities to identify novel cleaning systems for this purpose. The results from the HTP and hand-swabbing assessments were in general agreement with respect to soiling removal efficacy.

When taking the associated risks into account; improved cleaning efficacy was consistently achieved using aqueous mixtures of tri-ammonium citrate and nonionic surfactants at low concentrations; with minimal associated risk to the paint film apart from some foaming noted at the paint surface. Many of the simple aqueous systems also produced moderate results with minimal risk to the paint films however longer mechanical action was often required. The least successful systems with respect to cleaning efficacy were the mineral spirits solutions. These had poor surface wetting and required extended mechanical action; and in many cases not removing much of the applied soiling. The addition of nonionic and anionic surfactant mixtures increased the cleaning efficacy of these systems however the most marked increase in soiling removal efficacy was noted when these solvents were formulated as part of an INVERT water-in-oil microemulsion.

Future work includes the assessment of these systems on case studies and the further refinement of the microemulsions, optimizing the surfactant-chelator content of aqueous systems and an investigation into the clearance of these materials from paint surfaces.
In particular, the good cleaning efficacy observed for the INVERT 5000 microemulsion has encouraged continued investigation of this class of formulation at Dow, with a view to preparing a microemulsion with properties more directly tailored to the particular application of cleaning acrylic paint, with lower inherent risk to the paint films. This work in progress will be achieved for example by lowering the overall concentration of surfactant and using faster evaporating co-solvents.

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ANA ALBA, SUSAN LAKE, MEL WACHOWIAK, AND JENNIFER GIACCAI

A Question of Technique: Condition Issues Associated with Layering Structure in Richard Diebenkorn's Ocean Park Series

ABSTRACT

An examination of Richard Diebenkorn's *Ocean Park No. 111*, 1978, revealed a pattern of lifting cracks that correlated to design and/or color areas. To determine whether or not Diebenkorn's materials, his working methods or a combination of the two are responsible for the cracking, three additional Ocean Park paintings from the same time period were also examined. One exhibited similar cracking while the other two were in near perfect condition. Materials analysis was completed for all four paintings and the two paintings showing cracking were found to contain an acrylic preparatory layer. The affects of alkyd and oil paint binders on the stability of the paint films was also explored.

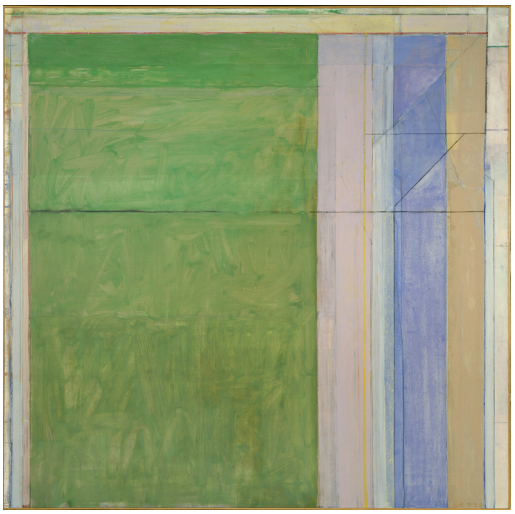

Figure 1. Richard Diebenkorn *Ocean Park No. 111*, 1978. Oil, alkyd, and charcoal on canvas, 236.5 cm x 236.9 cm, Hirshhorn Museum and Sculpture Garden.

INTRODUCTION

This paper presents the results of a two year study of the paint application methods, materials, and associated condition issues found on Richard Diebenkorn's paintings from the Ocean Park Series. The project began when a preliminary examination of *Ocean Park No. 111* (Hirshhorn Museum and Sculpture Garden, Washington, D.C.) revealed severe cracking patterns associated with specific areas of the painting (fig. 1). Subsequent examination and analysis of the painting revealed that the artist applied a clear synthetic resin directly to his canvas support before applying an acrylic ground and multiple oil-modified alkyd paint layers. Additional Ocean Park paintings from around the same time period were examined in order to determine whether or not Diebenkorn's materials and/or his application techniques are related to the extensive cracking seen in *Ocean Park No. 111* and the severe condition issues frequently associated with many of the paintings in the series.

Richard Diebenkorn (1922-1993) is recognized as one of the most important American artists in the abstract expressionist movement, as well as the leading artist of the Bay Area Figurative Movement. From 1947 to 1950 he taught at the California School of Fine Arts, San Francisco, where his fellow teachers included Elmer Bischoff and Clyfford Still. Under their influence he was drawn toward the Abstract Expressionist movement. [1] Richard Diebenkorn's Ocean Park series began late in 1967, while working in his studio in the Santa Monica Ocean Park district. The series includes about 150 paintings and was developed over the next 25 years. In the Ocean Park paintings, there is a shared emphasis on geometry and spatial relationships. The colors vary, but the paints he generally used

were airy, translucent, and brightly colored, seemingly influenced by the light and color of his surroundings.

EXAMINATION AND GROUND WORK

When *Ocean Park No.111* was requested for loan, a preliminary examination revealed an extensive system of lifting cracks that appeared to have become more severe than when the painting was last examined. Examination also revealed drips of clear polymeric resin along the tacking margins. This resinous material which the artist applied directly to the raw canvas overall and beneath the ground and paint layers is soft and malleable. Samples removed from the tacking margins are noticeably porous, as evidenced by air bubbles. Under magnification, the resin is readily visible at the bottom of crack openings and is evident in paint cross sections (fig. 2). As seen in this cross section, the resin is as thick as the combined paint and ground layers above.

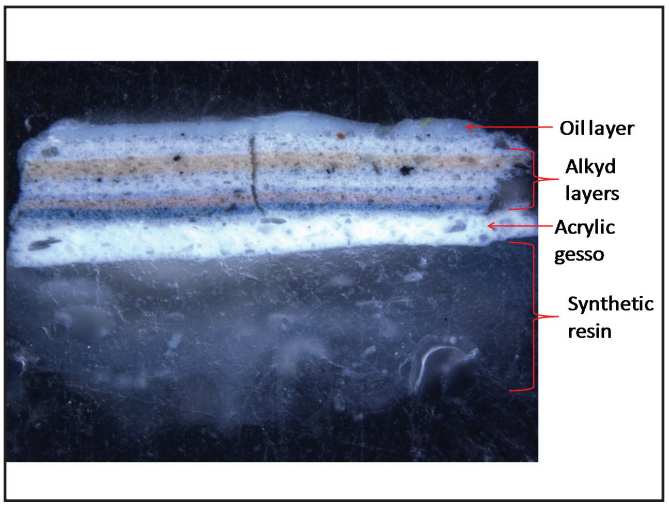

Figure 2. Cross section from *Ocean Park No. 111*. Darkfield 200x.

In an attempt to determine whether there is a correlation between the condition of *Ocean Park No. 111* and Diebenkorn's painting materials and methods of application, twelve additional Ocean Park paintings from other institutions were examined. Additionally, condition photos and treatment reports were reviewed for several other paintings of the series. Although samples were not taken from all the paintings examined, a general trend was noted. The paintings with a clear resin layer applied to the fabric support showed more severe cracking in the paint layers and were generally in poorer condition than those without it.

For the purpose of this study, the focus of the analysis was narrowed to four case studies: *Ocean Park No. 111*, 1978 (Hirshhorn Museum and Sculpture Garden), *Ocean Park No. 96*, 1977 (Solomon R. Guggenheim Museum), *Ocean Park No. 115*, 1979 (Museum of Modern Art), and *Ocean Park No. 125*, 1980 (Whitney Museum of Art). The four paintings chosen included two with severe cracking (*Ocean Park No. 111* and *Ocean Park No. 96*) and two that are in relatively good condition (*Ocean Park No. 115* and *Ocean Park No. 125*). These four paintings were also selected based on their closeness in date to remove concerns about making generalizations about condition issues of the whole series. Nonetheless, discussions and consultations with other conservators at additional institutions indicate that many of the Ocean Park paintings have varying degrees of cracking, some more distracting than others.

Case Study #1: Ocean Park No.111

Ocean Park No. 111 is executed on cream colored plain weave cotton duck canvas. The canvas is stapled and tensioned over an eight member wooden strainer. Wooden gussets are nailed into the strainer at each corner for additional support. The crossbars of the strainer, around the central square form, are smudged with paint, where the artist handled the strainer in order to turn the painting during execution. The artist applied his paints as diluted pastes, as evidenced by drying streaks and the matte, powdery surface appearance. In some areas, the paint is sufficiently thin that lower paint layers are readily visible. Also important to the design are charcoal lines drawn onto the paint surface and others that are half obscured by overlying layers of paint.

Cross sections from *Ocean Park No.111* indicate that the unpigmented resin layer described earlier was applied directly to the entire surface of the canvas, presumably as a size to protect the fabric support. Another possibility is that Diebenkorn wanted to create a smooth surface on which to work, as the resin completely masks the canvas texture. Fourier transform infrared (FTIR) analysis of a sample of the resin layer taken from a tacking margin identified it as an acrylic; specifically, a poly-ethyl acrylate-methyl methacrylate copolymer (pEA-MMA) such as Rhoplex. Rhoplex AC-33 is a likely candidate as the material was widely used by artists during the 1970s and 1980s. Figure 3 shows the spectra of a sample from *Ocean Park No. 111* compared to that of Neocryl BT-20, a bulk pEA-MMA resin. The shape of the C-H stretch region, around 2800-3100 cm^{-1}, is an indication of an acrylic resin, as is the location of the carbonyl peak at 1732 cm^{-1} and the shape of the fingerprint region. Pyrolysis-Gas-Chromatography–Mass

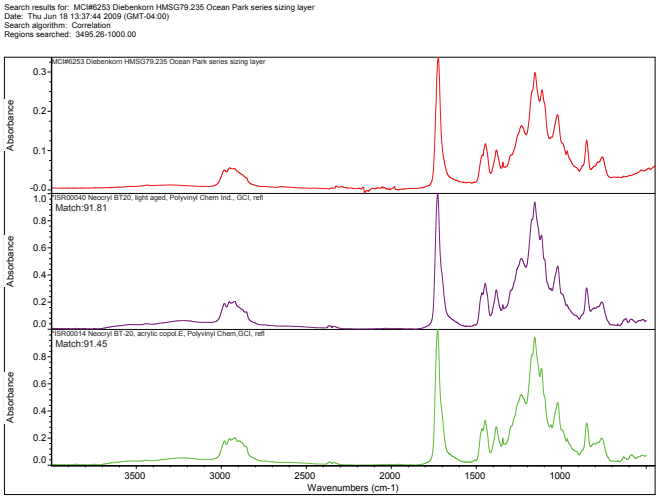

Figure 3. Comparison of the FTIR spectrum for the clear synthetic material in *Ocean Park No. 111* and two spectra for bulk ethyl acrylate methyl methacrylate acrylic emulsion (Neocryl BT-20 from DSM NeoResins).

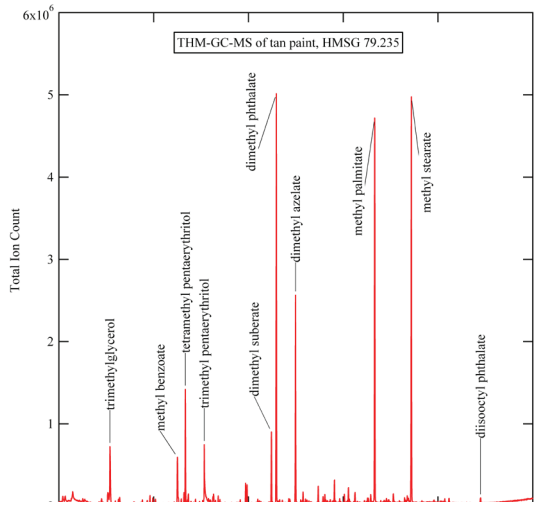

Figure 4. Pyrogram for a sample of tan paint taken from the surface of *Ocean Park No. 111* with the characteristic peaks noted.

Spectrometry (Py-GC-MS) verified the identification of the sample as a pEA-MMA resin.

Diebenkorn next applied a white ground directly to the synthetic resin layer. FTIR analysis and Py-GC-MS identified the ground medium as an acrylic resin (pEA-MMA). The homogenous dispersion of the pigments, the identification of the filler material (chalk and kaolin), and the fact that the ground does not extend onto the tacking edges suggest that this is a commercial priming that the artist applied himself.

FTIR and Py-GC-MS analysis identified the paints that Diebenkorn used as oil-modified alkyds. Peaks identifying the pentaerythritol backbone of an alkyd are clearly visible in the pyrogram from a sample of the tan paint taken from the surface of the painting (fig. 4). In several of the paint samples identified as alkyd paints, there also seems to be a peak at ~1160 cm^{-1} that suggests there is some free oil as part of the paint composition that may indicate an added artist's oil medium or paint. Additionally, the identification of pigments and the absence of filler materials characteristic of alkyds indicate that the artist occasionally alternated alkyd paint layers with artists' oil paints.

The surface of *Ocean Park No.111* is riddled with a complex network of cracking patterns (fig. 5). There are extensive linear cracks located at the corners of the painting. Additionally, isolated areas of branched crackle are associated with specific

Figure 5. Detail of *Ocean Park No. 111*, raking light, upper right quadrant.

color areas and appear to correlate with changes that the artist made to his composition. For example, near the center of the left side of the painting there is an isolated rectangular area of cracking within the larger green area (fig.6). This seems to be associated with a design area that the artist scraped and subsequently reworked. Also visible is a system of distracting rounded cracks with cupped edges that extend along the left side of the painting. These cracks appear to coincide with vertical charcoal lines on the paint surface as well as charcoal lines that are concealed beneath the upper paint layers (fig. 7). Under magnification, additional smaller cracks and fissures can be seen in close proximity to these larger rounded cracks.

Figure 6. Detail of *Ocean Park No. 111*, raking light, left edge, center.

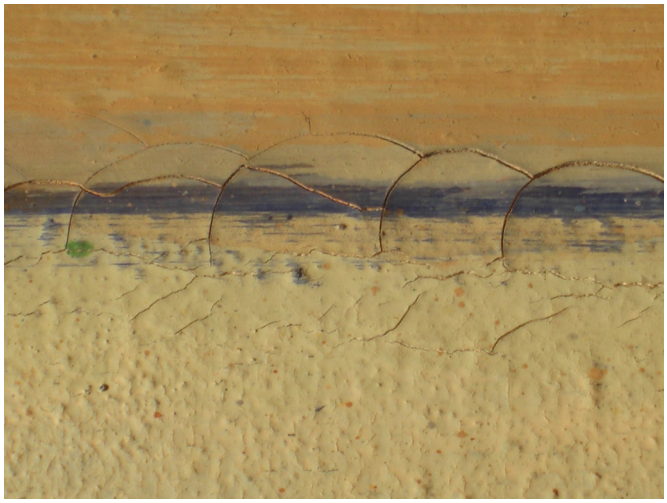

Figure 7. Cracking related to drawing on dry paint in *Ocean Park No. 111*, detail, along left edge.

Both cracking patterns appear to propagate from charcoal lines in the composition and were likely caused when the artist drew with charcoal into already dried paint layers. Diebenkorn was known to have worked on his paintings over long periods of time, sometimes repainting entire surfaces (Bernstein 2009).

Case Study #2: Ocean Park No. 96

Ocean Park No. 96, 1977, was painted a year before *Ocean Park No. 111* and exhibits many of the same condition issues. According to early examination reports, both paintings exhibited cracking less than two years following their completion. The cracking patterns in both *Ocean Park No. 96* and *Ocean Park No. 111*, show localized areas of dense cracking associated with reworked design areas and areas along drawn charcoal lines (fig.8).

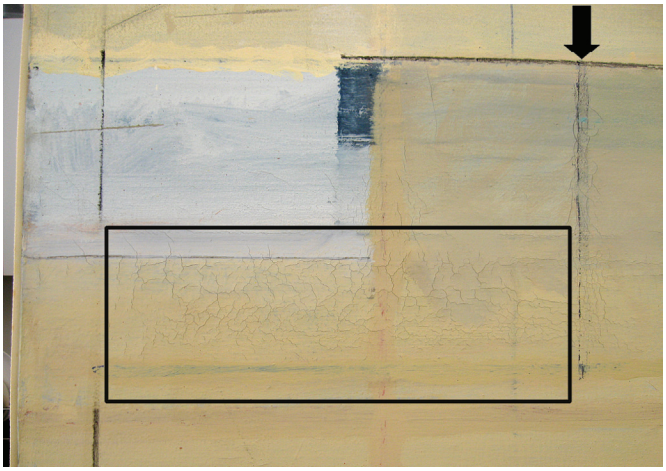

Figure 8. Detail of *Ocean Park No. 96* in an area exhibiting both widespread cracking and cracking following a drawn line as indicated by the square and arrow.

As is the case in *Ocean Park No.111*, a clear resin material is visible as drips on the tacking margin and at the base of the cracks. A section of the composition left unpainted along the bottom edge also reveals this layer. The band retains the color of the raw canvas, a feature which Diebenkorn is known to have appreciated because of its neutral tonality (Larson 1977). FTIR analysis of the paint in *Ocean Park No. 96* revealed that they are oil-based alkyds similar to those found in *Ocean Park No. 111*. Rather than an acrylic gesso ground, *Ocean Park No. 96* has a preliminary white paint layer over the clear resin size, presumably an alkyd paint, although a sample was not available for analysis. The artist applied this white layer selectively to areas of the canvas that were painted.

Two cross sections were taken from the blue square located in the upper left quadrant of the design, half of which exhibited cracking and half of which did not. One sample was taken from each half. In both cross sections, the unpigmented acrylic resin layer is clearly visible and is as thick as, or thicker than, the combined thickness of the overlying paints layers. Significantly, the cross section taken from the half that exhibits cracking reveals a surprising buildup of paint layers measuring almost 83 μm thick (fig. 9a). The cross section from the non-cracking portion contains only 2-3 layers of paint and measures less than 50 μm in thickness (fig. 9b). Moreover, several of the individual paint layers in Figure 9a measure less than 10

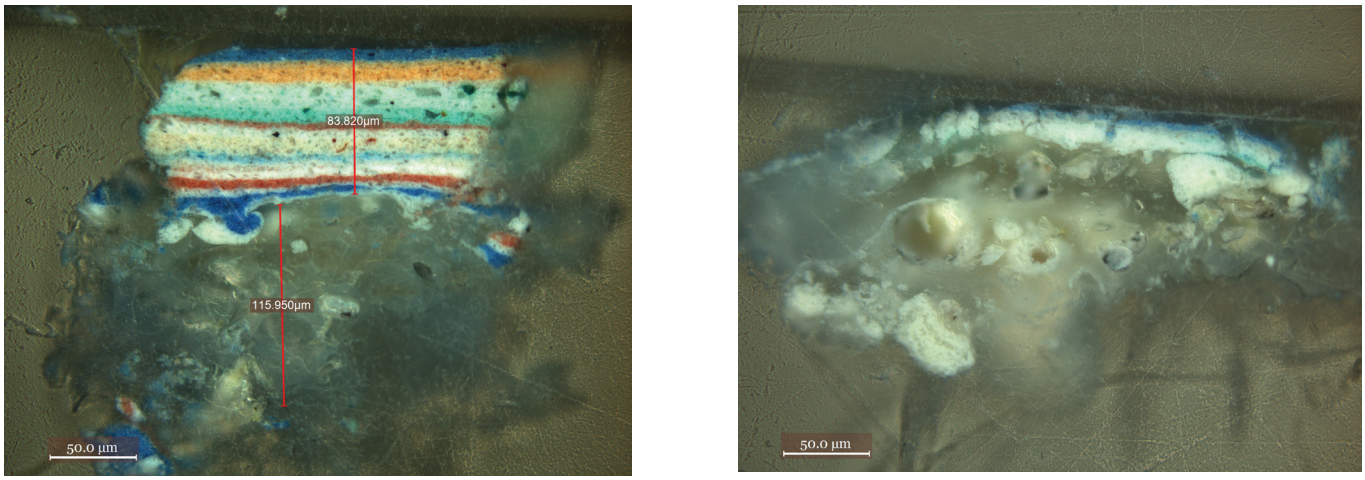

Figure 9. Comparison of two cross sections from *Ocean Park No. 96*, 200x, darkfield. The cross section on the left (a) was taken from an area that exhibited cracking while the section on the section on the right (b) was taken from an area that did not.

µm thick, which suggests that the artist diluted his paints to an almost wash-like consistency before applying them. As seen in *Ocean Park No. 111*, the filler content in both of these cross sections is consistent with a commercial paint, probably an oil-based alkyd. The difference between these two samples seems to indicate that artist layering and manipulation of his paint may play a large role in how much cracking occurs. Inconsistency of thickness in some of the thinner layers also suggests that the artist scraped down his paints once they were applied.

Case study #3: ocean park no. 115

Ocean Park No. 115, 1979, is in good condition and does not exhibit the widespread areas of cracking seen in the previous two case studies. The only cracking evident correlates with charcoal lines drawn into the surface along the top half of the painting. *Ocean Park No. 115* is executed on a commercially primed canvas, as the priming is evenly applied and extends to the ends of the tacking margins. It was again identified as an acrylic gesso ground. The paints were identified by FTIR as oil-based alkyds. Significantly, the painting does not have the synthetic resin preparatory layer identified in *Ocean Park No. 111* and *Ocean Park No. 96*. Otherwise, the painting materials in this work are similar to the previous case studies: oil-based alkyd and oil paints over acrylic grounds. Likewise, all three have similar exhibition histories.

Case Study #4: Ocean Park No. 125

Though painted only two years after *Ocean Park No. 111*, *Ocean Park No. 125* is in excellent condition. As with *Ocean Park No. 115*, cross sections revealed that there is no acrylic resin size present. The paint layers are exceptionally thin and alkyd use is very likely based on appearance and comparison of the paints to the cross sections of *Nos. 111, 115* and *96* where the medium was identified.

COMPARISON OF MATERIALS

The unpigmented acrylic resin size layers found in both *Ocean Park No. 111* and *Ocean Park No. 96* were compared using FTIR. Figure 10 shows their spectra compared to aged Rhoplex AC-33. As shown, the three materials share the same characteristic peaks. Furthermore, samples of the resin size material taken from two additional Ocean Park paintings were identified as poly(ethyl acrylate-methyl methacrylate).[2]

The grounds of *Ocean Park Nos. 111*, *115*, and *125* were all identified as acrylic gesso. Figure 11 shows their comparative spectra. Interestingly, the grounds of *Ocean Park No. 115* and *Ocean Park No. 125* were commercially primed while that of *Ocean Park No. 111* is an acrylic that the artist applied by hand based on the fact that the ground does not extend over the tacking margins. As mentioned previously, the preliminary white paint layer from *Ocean Park No. 96* is probably an oil-based alkyd based on pigment and filler composition.

FTIR analysis indicates that Diebenkorn's paints in all four works are predominantly oil-based alkyds, although isolated layers of drying oils were also identified. Figure 12 is a

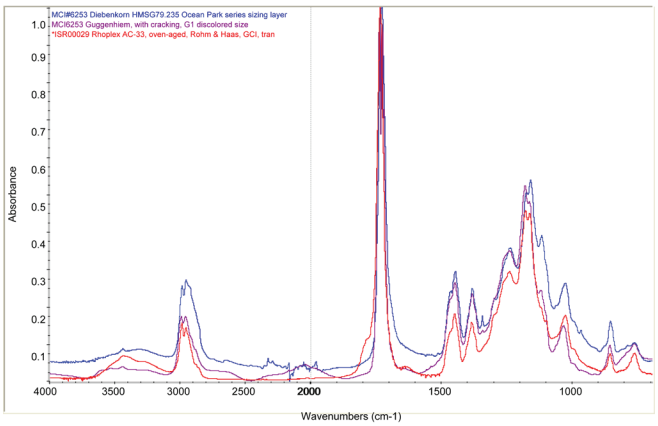

Figure 10. Comparison of FTIR spectra for the synthetic preparatory material from *Ocean Park No. 111* and *Ocean Park No. 96* to aged Rhoplex AC-33.

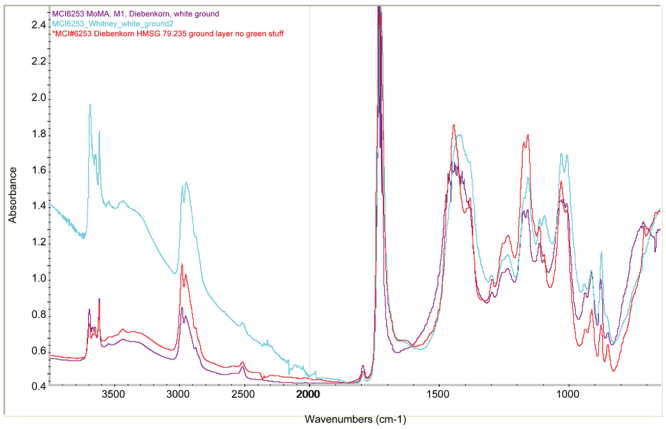

Figure 11. FTIR spectra for ground samples from *Ocean Park Nos. 111, 115,* and *125*. The comparison illustrates the similarities of the acrylic ground layer in the three paintings.

comparison of the FTIR spectra of paint samples from *Ocean Park Nos. 111*, *115*, and *96*. All three show a broad peak from 1260-1280 cm^{-1}, typical of alkyd paint binder (Ploeger, Scalarone and Chiantore 2008). The alkyd peak at between 1260 through 1280 cm^{-1} in the spectrum of a paint sample from *Ocean Park No. 96* is partially obscured by the large calcite peak. Very small peaks or shoulders were visible in a number of the paint samples from the three paintings at 1600 and 1582 cm^{-1}, indicating the presence of phthalates, one of the components of an alkyd paint. The location of the carbonyl peak at 1732 cm^{-1} instead of 1740 cm^{-1} for oil based paint found in all of the spectra is also indicative of an alkyd binder. Py-GC-MS analysis of four samples from *Ocean Park No. 111* confirmed the presence of oil-based alkyd paint.

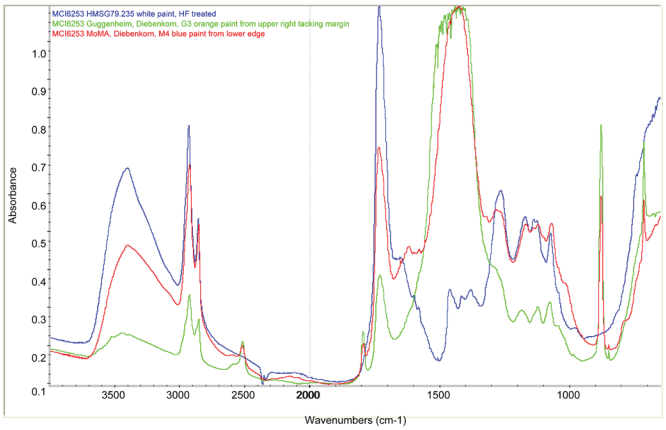

Figure 12. FTIR spectra of alkyd paint samples from *Ocean Park Nos. 111, 115,* and *96*.

PROBLEMS ASSOCIATED WITH ALKYD USE

Diebenkorn's use of oil-based alkyds and his methods of applying them may have contributed to the condition issues associated with many of the Ocean Park paintings. Oil-modified alkyds form stiffer and stronger paint films than do traditional drying oils due to the polyester backbone of the polymer. The molecular weight of an alkyd is much higher than that of traditional drying oils so fewer cross links are required for stable film formation, causing the binding medium to harden to the touch between 18 and 24 hours after application (Ploeger 2009). The artist may have found this quality appealing and selected these paints, in part, because they dry faster than artists' oils. Diebenkorn's use of fast-drying and relatively brittle paints combined with his practice of scraping down and drawing through them with charcoal at later stages in the painting process likely contributed to the cracking reported just two years after *Ocean Park No. 111* and *Ocean Park No. 96* were executed. Alkyd paints have also been found to become increasingly stiff with age (Ploeger 2009). Additionally, Ploeger found that the continuation of the oxidation processes in alkyd paint after film formation is complete might also lead to the deterioration of the film. With age, excessive cross linking may occur, causing the alkyd paint films to become still more stiff and brittle.

Diebenkorn's practice of heavily diluting his alkyd paints with solvents may also have had an effect on the overall stability of

paint layers. Commercial alkyds are formulated for application to architectural structures and are meant to be applied directly from the can. Changing the formulation has the potential to adversely impact the integrity the paint. Evaporation of solvents from the alkyd paint creates a porous, under bound paint film that further contributes to the overall brittleness of the paint layer. With excessive dilution, a two phase structure forms instead of a cohesive layer, with the pigments favoring one phase over the other (Croll 2009). Additionally, much of the binder may have leached out of the uppermost layers, causing the powdery, matte surface characteristic of these paintings. Solvent loss during drying also has the potential to cause internal drying stresses (Whitmore et al. 1999). This results in paint layers under tension that are more prone to failure from additional stresses during handling, environmental responses, or further aging.

The cross section illustrated in Figure 2 may be indicative of what is happening structurally to the Ocean Park paintings that are in poorer condition. An internal vertical fissure is visible through the center of the sample. Significantly, the alkyd paint layers have cracked preferentially to the oil paint layer on the surface and the acrylic gesso layer beneath. Many of the cracks now visible on the surface of these paintings may have started in the alkyd paints and with time migrated to the softer artist's oil and ground layers. Moreover, it is likely that the inherent flexibility of the acrylic size layer would have magnified any stresses placed on the paint layers, causing smaller fissures and flaws in the brittle alkyds to propagate to the surface and into the ground. As previously noted, the paint layers in most of the cross sections from *Ocean Park No. 111* and *Ocean Park No. 96* measure about 100 microns on average, while the clear synthetic resin of both paintings is twice as thick. In these examples, brittle and excessively lean alkyd paints were applied to a heavy layer of flexible resin size that provides inadequate support. Moreover, Rhoplex has been found to maintain rubbery flow over many years (Michalski 1991). This potentially means a longer period of vulnerability these paintings might experience. With any cause of stress whether it be mechanical or environmental, and little resistance from the support, cracks form freely and propagate. A particularly interesting study by Young et al. (2006) found that alkyd paint layered over an acrylic gesso increased the overall stiffness of samples and caused premature failure of the acrylic during stress tests. These paintings illustrate this in a real, natural setting.

POSSIBLE PIGMENT EFFECT

Zinc was identified in *Ocean Park No. 111* within isolated layers of the white and green oil paints. It has been observed that the presence of zinc in paint layers has the potential to increase brittleness and cause structural failure (Mecklenburg, Tumosa, and Erhard 2005). In their study, paint layers over zinc grounds were found to crack preferentially compared to paint layers over lead grounds. A more recent study by Mecklenburg also suggests that zinc ions in an isolated paint layer can migrate to surrounding paint layers, increasing brittleness and changing mechanical properties (Mecklenburg, Tumosa, and Vicenzi 2010). As zinc was identified in isolated layers of drying oil across *Ocean Park No. 111*, it is possible that zinc may be affecting the stability of surrounding paint layers. As mentioned, the alkyd paints become progressively more rigid over time and the addition of zinc magnifies this effect.

CONCLUSION

A comparison of the materials and paint structures in two Ocean Park paintings by Richard Diebenkorn in good condition with two more extensively cracked paintings shows that those with alkyd paints applied over the synthetic resin show greater evidence of cracking than those that did not have the resin layer. While there may be other factors that have contributed to the condition issues evident in these paintings, this study indicates that the artist's practice of applying brittle paints over a rubbery, flexible support is a recipe for cracking. The relatively elastic nature of the synthetic size is poorly suited as a support for the extremely brittle alkyd paint and layering methods employed by Diebenkorn. Localized areas of dense cracking associated with specific design elements likely occurred when the artist scraped down and drew into already dried painting layers. While heavy paint build-up and scraping away of paints are techniques seen in Ocean Park paintings with no condition issues, the presence of the unpigmented resin size in combination with an inherently brittle paint magnifies the adverse effects.

Future work may include formulating a conservative treatment proposal and establishing preventative measures to protect against further cracking. At this time it is recommended that handling and traveling is limited. The effect of zinc ion migration on surrounding paint layers is currently being studied.

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ENDNOTES

1. http://www.diebenkorn.org/bio/bio.html. From the RD Biography. © 2010 The Estate of Richard Diebenkorn.
2. These were *Ocean Park No. 66.*, 1973, (Albright Knox Art Gallery in Buffalo, New York), and *Ocean Park No. 83,* 1975, (Corcoran Gallery of Art in Washington, D.C.)

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Do Weave Matches Imply Canvas Roll Matches?

ABSTRACT

Computational algorithms for measuring thread counts from scanned x-rays produce warp and weft thread count "maps" across entire paintings. Within the database of over 300 van Gogh paintings, we found a clique of 44 warp-weave-matched paintings. By reconstructing the smallest canvas section that could have produced this match, they must span the entire width of a commercial canvas roll (2+ meters) and more than 13 meters of length, much longer than a single roll (10 meters). Several grounds were found, further suggesting these matched paintings came from separate rolls. Investigation showed that commercial priming firms cut rolls from longer bolts.

INTRODUCTION

The recent introduction of computer-assisted and computer-automated thread count algorithms has not only greatly eased the tedium of measuring the vertical- and horizontal-thread densities from x-rays, but also provided more information about how thread densities vary across a painting (Johnson et al. 2009). The algorithms not only measure thread densities across an x-ray, but also thread angles: the departures of the horizontal and vertical threads from coordinate axes. These angle measurements provide immediate information about the presence and degree of cusping.

Thread densities are depicted as *weave maps* that use colors to illustrate how the thread densities vary across a painting (fig. 1). These maps reveal that thread density variations can typify the painting's canvas support. For example, a canvas's vertical thread counts persist across the height of the painting, but vary horizontally in a seemingly random fashion. The horizontal threads show a similar variation, but with persistent horizontal counts that vary vertically. In other words, thread packing varies across the painting's support. These variations in canvas thread densities are not specific to each painting, but characterize the larger canvas from which the painting's support was cut. Consequently, thread density variations serve as a fingerprint for the canvas, allowing painting weave maps to

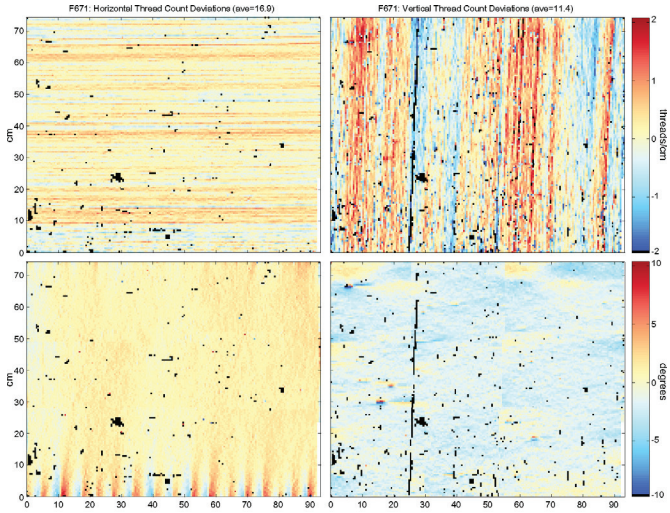

Figure 1. Example of weave maps (top row) and angle maps (bottom row) for the van Gogh painting *Blossoming Almond Tree* catalogued (de la Faille 1970) as F671. The colorbars on the right show how to convert colors into measured thread counts (as differences from painting average) and angles. For F671, the average horizontal thread count is 16.9 threads/cm and the vertical average is 11.4 threads/cm. Black indicates where no measurement was made because the algorithm could not extract a count due to poor legibility of the canvas weave in the x-ray. The warp direction corresponds to the horizontal threads and the horizontal thread angle map shows strong cusping along the bottom of the painting.

be compared in a search for matching weave patterns. We have also found that thread angle maps (fig. 1) help in determining painting position and, surprisingly, reveal aspects of the canvas weaving process. These interpretations result from understanding the commercial priming process: how canvas is delivered, how canvas rolls are cut from a longer length of canvas—known as a *bolt* of canvas—and then mounted on a priming frame, and how the primed canvas is stored and delivered to retail outlets.

This paper describes how weave matches are determined and illustrates how matching canvas support information can be used in art history. Angle maps coupled with knowledge of commercial priming operations supplement the weave matches, confirming painting support placement (for example, does cusping along a painting's edge confirm placing the support along an edge of a commercially primed strip of canvas).

We focus on the paintings of Vincent van Gogh for several reasons. First of all, a large fraction of his oeuvre is concentrated in a few museums. But more important are the detailed insights into his painting practices provided by the copious and well-preserved correspondence with his brother Theo, a Paris art dealer, and several artist friends (Jansen et al. 2009). Not only do the letters describe (in varying amounts of detail) what paintings were executed when, but also when he asked his brother for a new canvas roll and when shipments were received. Furthermore, the letters reveal that, particularly in his later periods, he was very specific about the kind of canvas he wanted. [1] On the one hand, we discovered that his preferred grade of canvas could be easily counted from x-rays, allowing accurate count estimates. On the other, this specificity could complicate the ability to localize weave-matched paintings to a specific roll. Could matching paintings come not from the same roll, but instead from different rolls cut from the same bolt?

Interpreting Weave and Angle Maps

Thread count (density) measurements are made with the algorithm described elsewhere (Johnson et al. 2009). The weave maps shown in Figure 1 represent the thread count measured every 0.5 cm for the surrounding 1 cm square as a color, which allows a ready visual representation of thread count variations across a painting. The horizontal- and vertical-thread weave maps look very different. Here, the horizontal-thread densities (counts) vary less (have a more consistent color), have a more persistent count along the thread direction, and vary more rapidly vertically than the corresponding features in the vertical-thread weave map. From this and many other examples, these features typify how weave maps allow quick determination of warp/weft direction: the horizontal threads in F671 correspond to the warp direction. [2] Because warp and weft threads are handled differently in the weaving process, they have different thread count characteristics. Van de Wetering (1997) noted that, for hand-woven seventeenth-century canvases, warp threads tend to vary less than weft threads. We have found this criterion to be reliable in 80-90% of van Gogh's paintings we have examined. By exploiting the features just described, we believe that weave maps can provide additional criteria that will improve warp/weft judgment.

Angle maps provide different information. If the canvas weave were perfect, with the horizontal and vertical threads crossing each other at right angles, the measured thread angles should be zero, which corresponds to a light golden color. The horizontal-thread angle map shows such consistency except near the bottom of the painting, where the color variation suggests the horizontal threads are waving up and down slightly. Such variations indicate cusping, in this case strong cusping. Because cusping occurs only along one side of the painting (none along the top and the vertical-thread angle map shows no cusping), the canvas support must have been primed (sizing or ground applied) not on the painting's strainer, but on a larger priming frame. If there had been cusping on four sides, then the interpretation would be that the primer was laid on unprimed canvas after it had been tacked to the strainer.

Weave Matching Procedure

The first step in the weave matching procedure is to determine whether the thread-count histograms agree sufficiently. We find the best agreement between the two pairs of measured thread counts (does the horizontal and vertical thread count from one painting agree most with horizontal and vertical from another painting or with vertical and horizontal?) and use a detection-theoretic technique to determine the degree of agreement (Johnson et al. 2010). Only if the histograms agree sufficiently—what we call a *count match*—do we consider determining if the two x-rays have a weave match. [3]

Once a count match has been found, we calculate deviation maps for a painting's x-rays and determine warp/weft directions. We then collapse the deviation maps along their count-persistent directions (horizontal direction for horizontal threads, vertical for vertical threads) to obtain what we term a *profile* that summarizes thread count variations. We then correlate the pairs of profiles to determine if they sufficiently agree

to declare a match. In more detail, we take the vertical and horizontal profiles from two x-rays. We first correlate vertical-with-vertical, horizontal-with-horizontal, and retain the pairing that yields the largest correlation (Johnson et al. 2010). Just relying on this comparison does not take into account the various possibilities for how a canvas section cut from a larger sheet could have been oriented: it could be rotated arbitrarily and, if not pre-primed, flipped over. Letting v_i denote the vertical profile for painting i, h_i its horizontal profile, and rev(•) the operation of reversing a profile, the largest of the following eight pairs is selected to represent a possible weave match: $v_1 \leftrightarrow v_2, h_1 \leftrightarrow h_2$, $v_1 \leftrightarrow h_2, h_1 \leftrightarrow v_2$, $v_1 \leftrightarrow \text{rev}(v_2), h_1 \leftrightarrow \text{rev}(h_2)$, $v_1 \leftrightarrow \text{rev}(h_2), h_1 \leftrightarrow \text{rev}(v_2)$. The degree of correlation of the maximal pair must exceed a threshold to declare a calculated weave match. Because warp and weft threads have different characteristics, the threshold for weft matches is lower than for warp matches.

Once the x-rays for two paintings are calculated to have a weave match, we have found we must observe the match by constructing deviation maps for the entire paintings and comparing them in the suggested alignment. Warp thread matches suggested by single-x-ray calculations usually survive full-painting evaluation, but not weft matches. The wide-stripe characteristic of weft threads can produce a calculated match just because two wide stripes happen to match. Such potential matches may not persist across a larger segment of canvas, which can easily span more than one x-ray. In such cases, the matches are discarded. Figure 2 shows a typical warp-thread match. In several cases, warp-thread weave matches allowed us to align several paintings that do not all match each other. As Figure 2 shows, F659 and F617 do not have a warp-thread weave match. But, because F386 matches each, we indirectly have a weave match between the first two. In this case, the third painting straddles the other two and brings the paintings together. We term the paintings that share a weave match in this way a *match clique*.

Interpreting Weave Matches

A reason to determine weave matches is to locate the relative positions of two paintings on a canvas sheet. Once a warp- or weft-thread weave match is found, the two paintings are aligned in one direction but the distance between them in the opposite direction cannot be determined. For example, if the warp-thread deviation patterns match, as in Figure 2, their lateral alignment is known, but they could be close together or far apart in the warp direction. The opposite holds true for weft matches, but these are far more constraining because canvases are narrower in the weft direction.

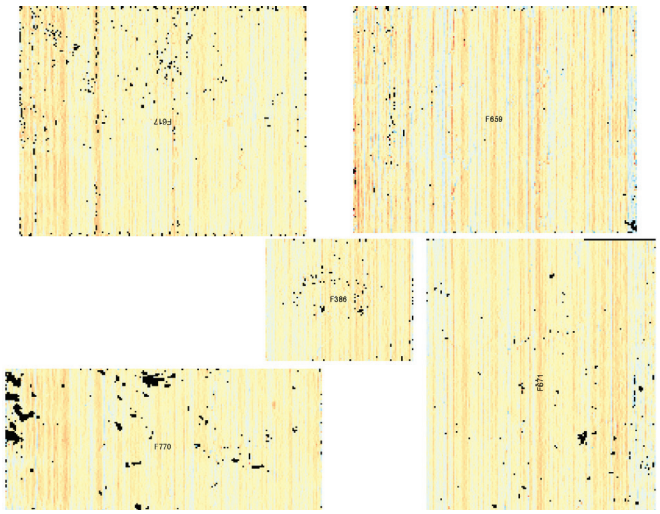

Figure 2. Aligned warp-thread weave maps for five of Vincent van Gogh's paintings F386 (*Still Life with Potatoes*), F617 (*Enclosed Wheat Field with Reaper and Sun*), F659 (*The Garden of Saint-Paul Hospital*), F671 and F770 (*Landscape with the Chateau of Auvers at Sunset*). The convention here has warp threads oriented vertically. To depict weave matches, paintings may need to be rotated to conform to this convention. The catalog labels on the weave maps indicates the "up" direction for the painting. These paintings were placed side-by-side to minimize vertical size of the graphic, *not* because they matched in weft. In fact, none of these paintings matched each other in the weft direction.

The location of warp-thread matches in the weft direction on the canvas sheet can be further detailed by considering the angle maps. Angle maps reveal the presence of cusping in a painting. Strong, so-called primary cusping occurs when the canvas sheet is stretched, sized and primed; the sizing and primer (ground) seal the thread deviations that occur at the fixture points on the priming frame. If primary cusping occurs on all four sides of a painting, the canvas was first cut to size and stretched on the working-size frame before it was prepared for the artist's use. In this case, preparatory size and ground layers only cover to the front edges of the picture area, but do not extend onto the tacking margins that were folded over the sides of the stretching frame. If primary cusping occurs on one side, two opposite sides, or not at all, the painting's support was primed on a larger priming frame and the support cut from the larger primed canvas. In this case the preparatory size and ground layers coat the tacking margins of the picture support too. If a painting's angle map reveals primary cusping on one or two opposite sides, that painting's support was cut from the edge(s) of the sheet and a painting that weave matches in that direction should also show cusping.

The absence of primary cusping implies the support did not originate from the sides of the sheet.

Van Gogh repeatedly requested ten, occasionally five, meters of canvas, corresponding to a whole or a half-length length (warp direction) of a commercially primed roll that usually measured about 2.10 m wide (weft). [4] The largest weave match clique we have found among van Gogh paintings in our database contains 44 paintings, while spreading across a little over 2 meters in weft, must encompass more than 13 meters of canvas in the warp direction, much larger than what van Gogh ordered. Figure 2 shows five aligned paintings from this clique. Furthermore, ground analysis of a subset of paintings in this clique reveals at least two different ground compositions, which coincides to the paintings' chronology (paintings having the same ground have similar dates). Clearly, weave matches don't necessarily imply roll matches. Exploring the practices of commercial priming firms reveals that canvas rolls were cut from a much longer sheet we term a *bolt*. [5] Common practice in manufacturing artist-grade canvas was to produce 100 m or 200 m long bolts, which were shipped to a commercial priming company as an accordion-style stack, probably because a stack can be more efficiently shipped than a large roll. The company would cut each bolt into rolls, making each a little more than 10m long, and prime each separately.

What follows is a description of one company's sizing and priming procedure that fits with our findings on van Gogh's works, though variations on this method are known to have existed during his period .[6] A priming frame is depicted in Figure 3. The short ends of the cloth were folded and nailed to upright bars. One bar was affixed to the end of the priming frame and then the other bar attached to the other end of the frame, stretching the canvas taut in the process. The top of the canvas was then pushed onto a set of spikes protruding from the frame. A set of hooks inserted through the canvas's bottom edge and then laced with a length of rope to the frame that stretches the canvas vertically. The nail/hook system stretches the canvas in the weft direction, which has the effect of creating cusping in the warp threads (fig. 3). The intervals between the fixed spikes at the top were typically shorter and more consistent than that between the hooks inserted each time by hand along the bottom. Consequently, cusping should differ along these edges. [6] Because the canvas ends are nailed to the *sides* of the end bars and the primer does not extend to the tack locations, one should not expect cusping in the weft direction. [7] After the primer has been applied and has dried, the canvas is removed from the frame and rolled onto a rod for shipping to the client. If the firm had a good customer that repeatedly asked for rolls of the same grade of primed canvas, it would hold them in reserve, shipping them upon request.

CONCLUSIONS

The weave pattern introduced by slight manufacturing variations can be used to search for warp- and weft-direction weave matches. In our experience, warp-direction weave matches are very sharp and well defined; weft-direction matches are generally much more vague and ill defined (Hendriks et al. 2010).

For commercially primed canvas from van Gogh's era, when one finds a warp-direction weave match among a set of paintings, the best that can be claimed is a *bolt* match, not necessarily a roll match .[8] Since ten to twenty rolls comprise a bolt, bolt matches by themselves say little about the timing of warp-matched paintings. Other considerations must be brought to bear to assign paintings to the same roll, which would suggest a close temporal relationship.

Paintings having a weft-thread match must come from the same roll. Unfortunately, it is difficult to find such matches. Longer lengths of canvas must overlap than required for warp-direction weave matches.

The build-up and composition of the sizing and ground layers for paintings from the same roll must be the same for commercially primed canvas. Priming firms used a variety of grounds, but only one type was used on a roll. Of course, different rolls could have the same ground, but if warp-matched pre-primed paintings have different grounds, they must have come from different rolls. These differences further point to different rolls within the same match clique.

Van Gogh's correspondences describing paintings he executed at about the same time can help localize paintings to a roll.

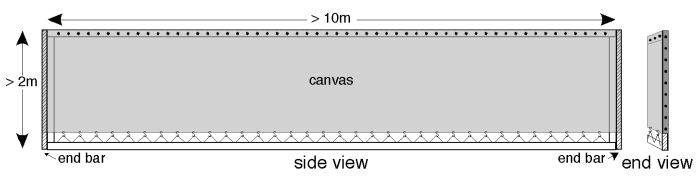

Figure 3. Schematic representation of a commercial priming frame. The black dots represent spikes. Note that the bottom edge is stretched with a hook-and-lace mechanism.

However, it is not always possible to identify the pictures mentioned with certainty, as in the case of some of his repetitions or serial versions of the same theme. For example, there are five *La Berceuse* paintings, six *Postman Roulin* paintings, and seven *Sunflower* paintings, all painted during his time in Arles. [9]

We are working to determine other criteria so that paintings can be located on a canvas roll rather than a bolt, which would provide further insight into the artist's process.

ENDNOTES

1. Van Gogh preferred 5 or 10m rolls of "ordinaire"-grade canvas obtained from the Paris colorman Tasset et L'Hôte.
2. By convention, the threads along the long direction of a canvas roll are the warp threads and the short-direction threads running across a roll the weft threads.
3. We must make sure that the x-ray-wide thread counts agree sufficiently because two deviation maps could agree even though the average thread count subtracted from the weave maps to produce them do not agree. In fact, we have found that such false agreements do occur.
4. For example, see letters 593, 629, 631, 680, 687, 689, 691, 699, 758, 777, 800, 808, 823 and 863, 874 from February 2, 1888 to May 21, 1890 (Jansen et al. 2009). Occasionally, other lengths were ordered (one time 20m but not from Tasset) and van Gogh made use of local canvas suppliers.
5. The authors are indebted to Philippe Huyvaert, President of nv Claessens sa, for devoting his time for a tour of his operations and answering our questions about his manufacturing practices. The company is exceptional for its knowledge and skills concerning traditional hand methods of preparing artist canvas, which it still practices there today.
6. These findings agree with what we see in the angle maps of van Gogh's paintings on Tasset et L'Hôte canvas, suggesting that the canvas was indeed stretched in a manner similar to this hook-and-lace system on an upright priming frame and them primed. An alternative commercial practice was to simply nail the four canvas edges at consistent intervals to the sides of a priming frame that had been laid flat on trestles for applying sizing and ground layers. This procedure is used today by the French Company Lefranc Bourgeios (Bomford 1990, 48).
7. We have found strong weft-thread cusping for two paintings that aligned in weft. Cusping strength, as measured by the size of the thread angle deviation, was much larger than the warp thread cusping introduced by the priming frame. Philippe Huyvaert informed us that cusping occurs in the canvas weaving process due to the initial slackness in the tension of the wound bobbin. Its presence indicates the beginning of a bolt.
8. We do not know if looms produced bolts having similar manufacturing variations in the warp direction.
9. The *Sunflower* paintings differ sufficiently in composition that determining which one is being referred to in a letter can be at least partially, if not uniquely, deduced.

ACKNOWLEDGEMENTS

The authors are indebted to Philippe Huyvaert, President of nv Claessens sa, for allowing us to visit his commercial priming facility and extensive discussions. We thank Luuk van der Loeff, conservator for the Kröller-Müller Museum, for allowing us to use F386 (KM 108.951) and F617 (KM 101.173) in our examples. The van Gogh Museum provided F659, F671 and F770 for this study.

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Visible and Infrared Imaging Spectroscopy of Paintings: Pigment Mapping and Improved Infrared Reflectography

ABSTRACT

Imaging spectroscopy, the collection of images in narrow spectral bands, has been developed for remote sensing of the Earth utilizing reflectance or luminescence. In this talk, the authors presented findings on the use of imaging spectroscopy to identify and map artist pigments as well as to improve the visualization of preparatory sketches. Two novel hyperspectral cameras, one operating from the visible to near-infrared (VNIR) and the other in the shortwave infrared (SWIR), have been used to collect diffuse reflectance spectral image cubes on a variety of paintings. The resulting image cubes (VNIR 420 to 970 nm, 240 bands, and SWIR 950 to 1700 nm, 85 bands) were calibrated to reflectance and the resulting spectra compared with results from a fiber spectrometer (350 to 2500 nm). In addition, a calibrated luminescence multispectral camera (600 to 950 nm, 8 bands) was used to obtain luminescence spectral image cubes after exciting the painting materials in the blue. False color reflectograms, obtained from the SWIR hyperspectral images, of extensively reworked paintings such as Picasso's *The Tragedy* (1903) are found to give improved visualization of these changes. Spectral image processing on the VNIR and SWIR image cubes are found to be useful in identifying the primary pigments. Kubelka-Munk theory was used on some of the data to determine the composition of the mixtures. For example, the primary pigments and their distribution in Picasso's *Harlequin Musicians* (1924) and *Peonies* (1901) were determined and compared with X-ray fluorescence data. The results show that inclusion of the NIR and SWIR reflectance along with the luminescence provides for a more robust ability to assignment of pigments than using visible spectroscopy alone.

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ANNA VILA AND MARGARET MACDONALD

Historical and Analytical Literature Review on Driers Used in Late 19th and Early 20th Century Paint Formulations

ABSTRACT

Historically, certain pigments were noted to have a drying effect on drying oils and were frequently added as an ingredient in artist paints. Artists' recipes in the mid-eighteenth century called for compounds containing lead, zinc, copper, and manganese to be mixed in to aid in drying time. By the nineteenth century, colormen sold products known as driers containing premixed oil and driers in bladders and, later, metallic tubes. [1]

These early recipes led the way to manufactured artists' tube paint and house paint in the late-nineteenth and early-twentieth centuries, of interest in the present paper. To identify and address the evolution of paint formulations manufactured in this period, this presentation will carry out an exploration of the incorporated driers. Therefore, the aim is to identify and catalog compounds, such as metallic soaps (metallic fatty acid salts), which were employed commercially as driers in late-nineteenth and early-twentieth century oil paint. Paint manuals, notebooks from paint factories, and ancient and contemporary paint catalogues have been collected and will be presented. In addition, a technical study has been undertaken to analyze driers in paint samples from this period. Identification of driers could aid in the differentiation of artists' tube paint from house paint and individual manufacturers and play an important role in understanding the materials for the conservation field.

This work arose out of on-going research on paint driers and will be restricted to oil paint and painting manuals from the end of the nineteenth and the first half of the twentieth century with consideration of characterization methods and conservation strategies.

ENDNOTES

1. Carlyle, L., *The Artist's Assistant: Oil Painting Instruction Manuals and Handbooks in Britain, 1800-1900, With Reference to Selected Eighteenth-Century Sources.* London: Archetype Publications Ltd., 2001.

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Studio Tips: Bench Cookies

Bench Cookies are non-slip discs made for wood working. They are advertised for uses such as sanding and router work. The textured soft rubber on each side of a hard plastic disc creates two non-slip surfaces designed to hold a piece of wood in place, hands-free, while being worked on.

We found them quite by accident in a Rockler wood workers supply store and immediately thought they could also be very useful for varnishing paintings when it is desirable to varnish flat, as with a small panel.

For varnishing a solid flat painting four cookies are placed under the painting, one at each corner. The panel stays in place held only by the friction of the rubber pads. Substantial pressure and vigorous brushing cause no slipping.

A larger painting or a panel with a weak join might require more cookies for extra support. A warped panel or stretcher may need a lift in one corner.

You can find them on the Rockler web site along with Rockler stores and product outlets.
ROCKLER Woodworking and Hardware. Advertised at $11.99 for set of 4.
Find a ROCKLER outlet near you via their website. http://www.rockler.com

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LAURENT SOZZANI

Studio Tips: Wall Mounted Easel

Space Saving Wall Mounted Easel
This is a MABEF easel mounted directly to the wall. Wall mounting eliminates the floor space normally necessary for the base.

The easel base has been removed and the easel is bolted in place onto the wall. It isn't as versatile as a rolling easel but there are others for that. The easel pictured is Mabef model M/02, a double design, made to hold large paintings. Its location is set-up for larger paintings, paintings up to 7 X 7 feet in a rather small room. It is also wide enough to hold two independent paintings side by side. The bolts holding it to the wall go through the wall into a closet.

http://www.mabef.it for a distributor near you.

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