1999
AIC PAINTINGS SPECIALTY GROUP POSTPRINTS

St. Louis, Missouri June 8 - 13, 1999

The American Institute for Conservation of Historic and Artisti Works

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Papers Presented At The Twenty-Seventh Annual Meeting
Of The American Institute for Conservation of Historic and Artistic Works
St. Louis, Missouri
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Compiled By Frederick A. Wallace

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INVESTIGATION OF FATTY ACID MIGRATION IN ALIZARIN CRIMSON OIL PAINT IN TWO WORKS BY FRANK STELLA

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Michael Cunningham[4]
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Introduction

In 1996, during a routine examination in preparation for treatment, a white crystalline growth was discovered on the surface of portions of two paintings created by Frank Stella in 1985-1986. These works are currently in the collection of The Art Institute of Chicago. An investigation of the crystalline growth included a review of existing literature and discussions with others in the field who had encountered this phenomenon in their own conservation work. Experiments were designed to test the theories described in the literature and our own theories developed during our research. This paper describes Stella's paintings, the materials used and the crystalline growths observed including possible causes and origins of these crystals. Finally, a description is given of the experiments, results and conclusions.

The two works studied belong to Stella's "Pillars and Cones" series, which spanned from 1982 into the mid-to-late 1980's. *Gobba, zoppa e collotorto* was painted in 1985 and acquired by the Art Institute in 1986 (Fig. 1). *Cricche, crocche e manico d'uncino* was painted in 1986 and acquired by the Art Institute in 1992 (Fig. 2). The works are composite pieces where two large rectangular back panels support smaller panels, which are cut into various geometric forms and secured to the back panels, forming a three-dimensional structure. The back panels measure about eleven feet in length by four feet wide and are approximately one inch deep. The smaller panels range in size from four-to-five feet high by two-to-three feet wide and are on average one inch thick.

Through discussions with Frank Stella's studio, via his private conservator, we determined what materials were likely used on these works and how they may have been treated or altered to enhance their working properties. Each support is made up of an aluminum honeycomb core with various skins attached of aluminum, magnesium or fiberglass. These skins were adhered using a two-part epoxy made by the *Hexcel Corporation*. The top skins of each panel were coated with clear polyurethane. Some of the edges of each panel were sealed with *Bondo*® polyester resin mixed with talcum. The paints used on the surfaces included a two-part polyurethane marine paint called *AWLGRIP*®, oil paints made by *BLOCKX* and a third paint mixed by Stella consisting of dry pigments in *Acryloid* B-72® resin (1).

Photographs of the panels exhibiting crystals were sent to Stella's studio assistants and his conservator for examination. They identified the paint that exhibited crystals as likely the *BLOCKX* oil paint. They further informed us that *BLOCKX* oil paint, though of high quality and preferred for their bright, strong tints, tend to stay tacky for a long time. For this reason, the studio often added cobalt driers to these paints, sometimes in large amounts, to speed up the drying process. The addition of the drier results in wrinkling which is evident on the dark red paint used in two panels (1).

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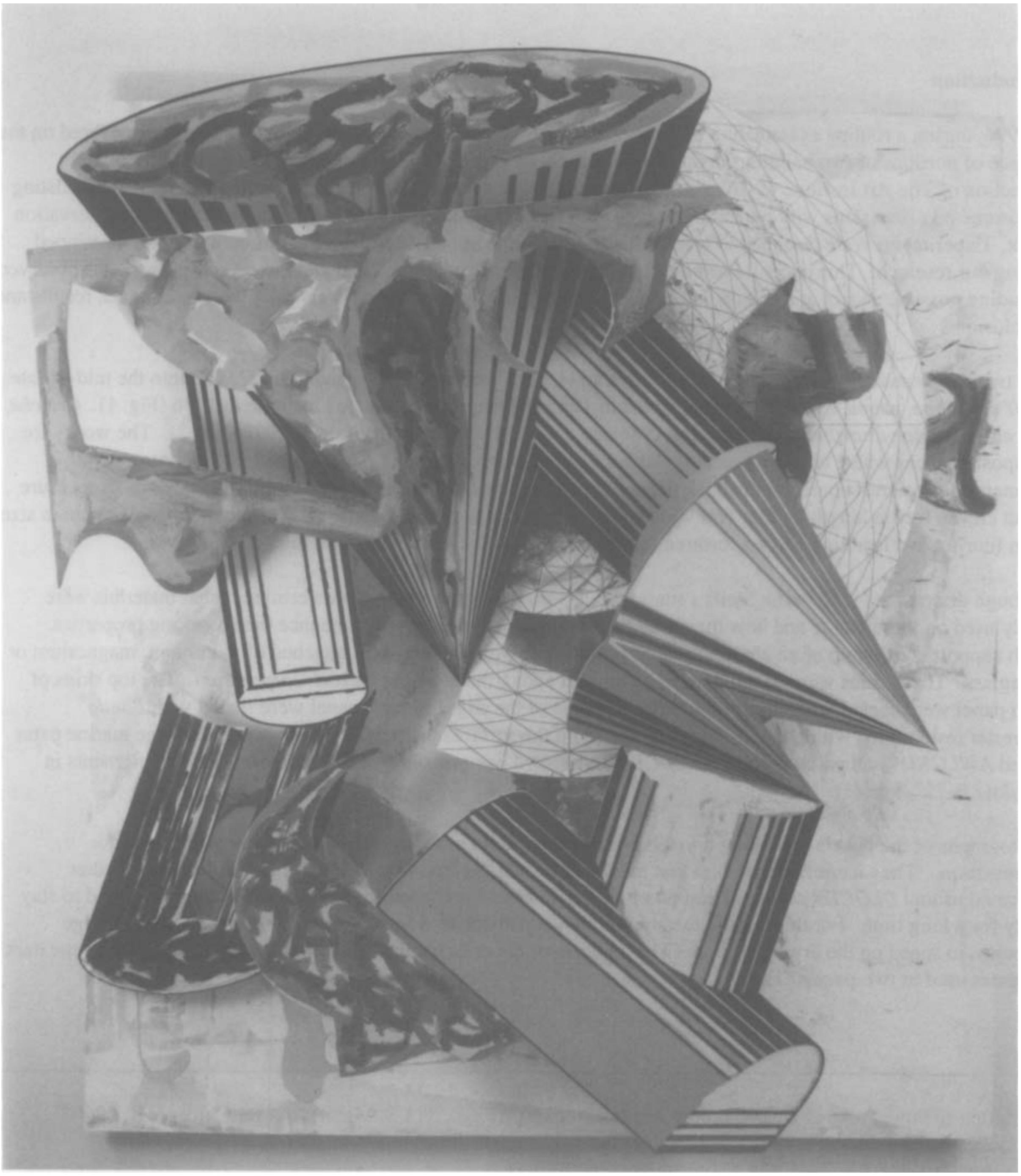

Figure 1. Frank Stella, *Gobba, zoppa e collotorto*, 1985. Mr. & Mrs. Frank G. Logan Fund; Ada Turnbull Hertle Endowment.

Figure 2. Frank Stella, *Cricche, crocche e manico d'uncino*, 1986. Gift of Cooperfund, Inc.

The crystalline growths were discovered on four panels: 4, 5 and 6 from *Cricche* and 7 from *Gobba*. They were present as a white disfiguring film on the dark red and dark blue paints. No other paints were effected by the crystals unless they were painted over the red or blue. The crystals were most prevalent in more thinly painted passages, and were barely visible in areas of high impasto. In Panel 6 from *Cricche* there were no crystals evident in areas painted over masking tape remnants (Fig. 3). The support for this panel is a sheet of magnesium adhered to an aluminum honeycomb core. Stella may have used the tape to mask the etching lines made in the magnesium support and then incompletely removed the tape leaving remnants, which were painted over with the red paint. In Panel 5 from *Cricche*, crystals were less apparent when the dark blue paint lay directly over the fiberglass support or over areas very thinly painted with a pink polyurethane paint.

The crystalline growths appear under the microscope as fine branched networks and occasionally as small needle-like crystals (Fig. 4). Some are exfoliated or dendritic formations of thin plates. They do not appear to rupture the paint as they grow, but seem to rest on the surface of the paint layers. Sampling with a scalpel blade and soft brush revealed them to be very soft and easily detached from the surface of the paint. They were readily deformable and could be rolled onto themselves like a wax with the end of a scalpel blade.

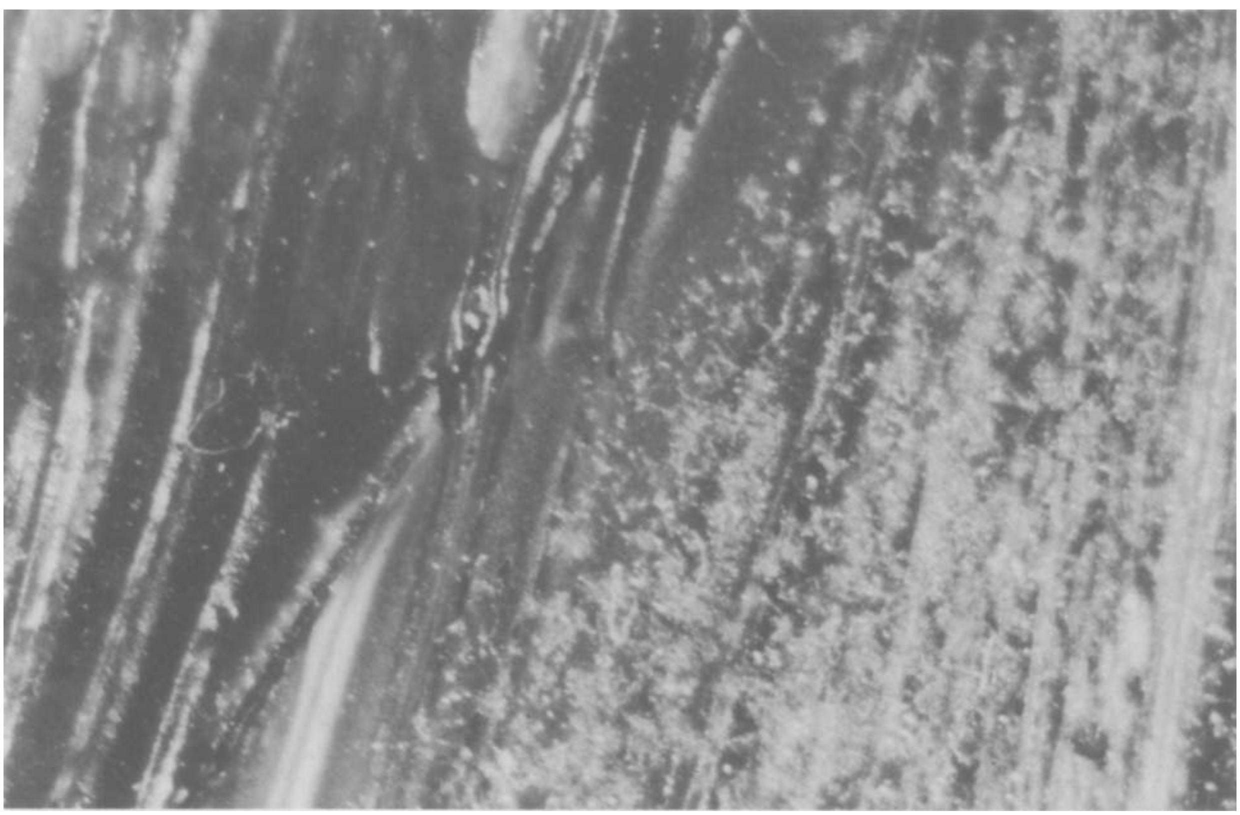

Figure 3. Photomicrograph of masking tape remnants under red paint of *Cricche* Panel 6. The left portion of the image shows an area where there are no crystals due to the underlying tape.

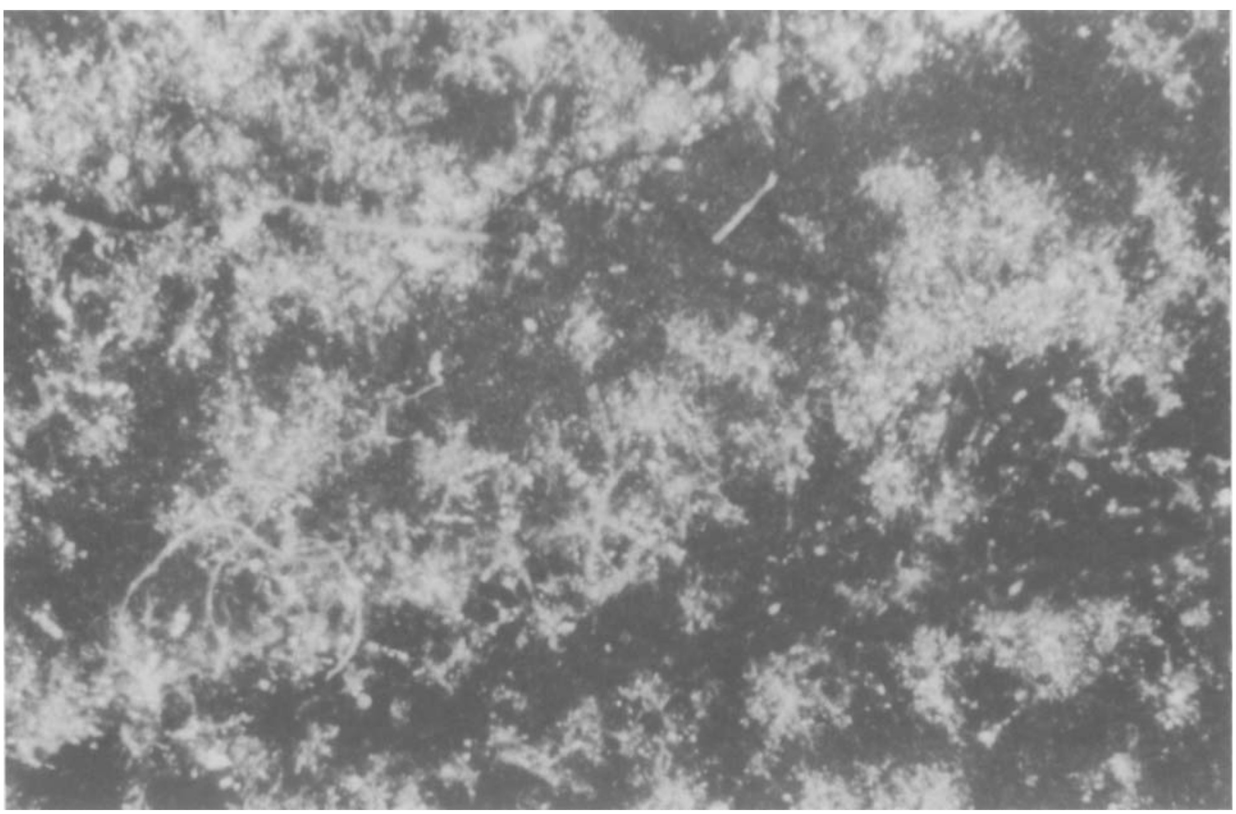

Figure 4. Photomicrograph of crystalline growths observed on the red paint of *Cricche* Panel 6.

In addition to the white crystalline growths, a series of worm-like patterns were noted over the surface of the magnesium support of *Cricche* Panel 6 and on the metal supports of several other panels from both works (Fig. 5). Through discussions with Marie Laibinis-Craft, these patterns were identified as filiform corrosion (2). Laibinis-Craft had investigated this problem on Frank Stella's work *Long Beach*. According to her research the filiform corrosion appears as a worm-like form. The head of the worm is acidic and acts as an anodic site with a pH of 2-4. The area directly behind the head is alkaline with a pH of 7 or 8 and acts as a cathodic site. The presence of the filiform corrosion indicates that these panels were likely exposed to relative humidity levels of 65% or higher (3, 4).

Figure 5. Photomicrograph of filiform corrosion on magnesium support of *Cricche* Panel 6.

Analytical Results

Table 1 summarizes the analytical results to date for the crystals and red and blue paints from the four panels. Samples were analyzed by a variety of techniques including; Fourier transform infrared spectroscopy (FTIR), Curie point pyrolysis-gas chromatography/mass spectrometry using on-line (trans) methylation with tetramethylammonium hydroxide (Cu-Py-TMAH-GC/MS), direct temperature resolved mass spectrometry (DTMS), and scanning electron microscopy with energy dispersive x-ray spectroscopy (SEM/EDX). Preliminary results indicate that the two paints exhibiting crystals are cobalt blue and alizarin crimson, both in a drying oil medium. The palmitic to stearic acid ratios were consistent with poppyseed and walnut oils. The crystals were identified by FTIR as a fatty acid, possibly palmitic and stearic acids. Analysis of the crystals using DTMS indicated free fatty acids with a high number of C16 (palmitic) fatty acids, relative to C18 (stearic). In addition, some diacylglycerols of the saturated fatty acids were present. These can no longer be incorporated into the polymeric network and therefore can be found at the surface along with the free fatty acids. The distribution of the different diacylglycerols also shows the richness in C16 fatty acids of the paints and crystals suggesting that the binding medium is likely poppyseed oil.

Table 1. Analytical results for red and blue paint from *Cricche* Panels 4, 5 and 6 and *Gobba* Panel 7.

COLOR	SAMPLE	FTIR	Cu-Py-TMAH-GC/MS and DTMS	SEM/EDX
*Red Paints**	***Pigment***	Alizarin Crimson	---	Al, S
	Medium	Drying Oil	Poppyseed Oil[1]	---
	Crystals	Fatty Acids	Palmitic & Stearic Acids[2]	---
*Blue Paints***	***Pigment***	Cobalt Blue	---	Al, Co (Si, S, Ca)[3] Al, Co (Si, S, Fe)[4]
	Medium	Drying Oil	Poppyseed Oil[1]	---
	Crystals	Fatty Acids	Palmitic & Stearic Acids[2]	---

* Red Paints - *Cricche* Panel 6 and *Gobba* Panel 7
** Blue Paints - *Cricche* Panels 4 and 5
1 Probably poppyseed oil based on ratio of fatty acids
2 Crystals analyzed with DTMS
3 Blue pigment *Cricche* Panel 4
4 Blue pigment, *Cricche* Panel 5

Further information regarding the formulation of the alizarin crimson paint used by Frank Stella in the 1980's was obtained from the paint manufacturer, *BLOCKX* Paints. The pigments used at the time were from a company called Blythe & Blythe Burrell. The alizarin crimson pigment was ground in poppyseed oil at 0.5% acidity. No fillers or driers were said to have been added. These paints were sold to Frank Stella in five liter buckets (5).

Review of Literature

Discussions with colleagues and a review of current literature revealed that fatty acid crystallization on the surfaces of modern unvarnished oil paintings is a common problem. The mechanisms that cause the free fatty acids to exude out of the paint film and form crystals on its surface are still under investigation. However, it is known where they originate and what factors may contribute to their presence on some paintings.

Essentially, the free fatty acids are thought to originate from the oil medium. A paint film is made up of polymerized three-dimensional materials, unpolymerized or partially polymerized triglycerides, and saturated fatty acids which exist either on the triglyceride or as free fatty acids in the system. If the remaining triglycerides of an oil film are exposed to moisture, particularly in the presence of an acidic or alkaline environment, hydrolysis can occur. This is essentially breaking up the triglyceride into a glycerol and a mixture of fatty acids. These fatty acids include palmitic, stearic, linoleic, linolenic and oleic acid (6, 7, 8). Smaller free fatty acids and dicarboxylic acids, such as azelaic acid, may be formed during oxidation and polymerization of the triglyceride molecules.

It is the palmitic and stearic acids that are being found on the surface of modern oil paintings as white crystals. Several theories have arisen to explain the mechanisms that mobilize the free fatty acids and cause them to exude at the surface. Scott Williams of the Canadian Conservation Institute has examined and analyzed several works with "disfiguring accretions" on their surfaces in an attempt to understand the possible mechanisms that lead to their formation. One mechanism he suggests is "syneresis," which is described as the physical exudation of components, (in this case free fatty acids), from the oil film as it shrinks or undergoes other chemical/thermal changes. Free fatty acids are produced within the film through oxidation or hydrolysis. The shrinkage of the paint film may result as the film cures or as a result of the loss of absorbed water. This shrinkage is then in effect squeezing the mobile free fatty acids out of the film. Williams has also suggested that the migration of these components through the film may be initiated or catalyzed by other elements in the vehicle, such as extenders or driers (9, 10).

Johann Koller and Andreas Burmester of the Doerner Institute in Munich suggest a possible mechanism for the migration and subsequent exudation of these fatty acids in their article titled, "Blanching of Unvarnished Modern Paintings: a Case Study on a Painting by Serge Poliakoff" (11). They theorize that the fatty acids such as palmitic and stearic acids exist as a mixture within the paint film with other lower molecular weight free fatty acids, such as oleic and azelaic acid. This mixture diffuses through the paint film to the surface where certain fatty acids are lost through oxidation and volatilization leaving the palmitic and stearic acids as crystalline deposits.

Another possible factor on which Koller, Burmester and Williams all agree, is that the incidence for crystal formation is significantly greater with those pigments that are high oil absorbers. This means they require large amounts of oil to make a quality paint (10, 11, 12). Alizarin crimson and cobalt blue are considered high oil absorbing pigments. In addition, alizarin crimson and cobalt blue are slow drying paints (13, 14). The large amounts of oil present and the slow drying times may allow for access to non-polymerized triglycerides which can be hydrolyzed and give free fatty acids. If low oil absorbing pigments such as lead white or other absorbent materials such as canvas or ground are not present to absorb free fatty acids, there is more likely to be an exudation at the surface.

The literature further suggests that porous or cracked paint films may present passageways, which ease migration of fatty acids to the surface. Since this phenomenon is less common in varnished works, it is theorized that the varnish layer may obstruct movement of the free fatty acids. (11, 15).

To summarize, the literature has identified several factors that initiate or contribute to fatty acid crystal formation:

- Presence of moisture
- Acid/Alkaline environment
- Physical/Thermal changes in the film
- Pigment type (high oil content)

- Lack of absorbent materials to consume free fatty acids
- Addition of extenders or driers
- Unvarnished surfaces

Hypotheses

Using *Cricche* Panel 6 as an example it can be seen that several of the factors suggested by the literature, as possible mechanisms can be associated with this panel. The presence of filiform corrosion on the surface of the support indicates that this panel was likely exposed to levels of humidity above 65%. In addition, both an alkaline and acidic environment are said to be present at a filiform corrosion site (3, 4). Alizarin crimson, a high oil absorbing pigment, was the only colorant identified in the effected red paint. There are no other pigments or grounds associated with this paint that might have acted as a site for absorption of the free fatty acids, with the possible exception of the masking tape remnants. Cobalt driers may have been added to these paints which could have contributed to the migration and exudation of the free fatty acids. Finally, we know these works have never been varnished.

Based on this information and the theories discussed in the literature, experiments were designed in an attempt to reproduce the crystalline growths. It is believed that these investigations will lead to a greater understanding of the mechanisms involved and to a viable treatment. It is felt that several of the factors, either alone or in combination, are producing an excess of free fatty acids in the system which then migrate through the oil film, are exuded at the surface and eventually form crystals.

It was decided early on that due to time constraints growing actual fatty acid crystals was outside the scope of these first experiments. Instead an attempt was made to produce the exudation that would, under the right conditions, eventually become crystals similar to those found on Stella's panels. Based on H. P. Kaufman's description in his article entitled, "Luster Spots on Paint Films I: Blooming", the exudant would appear as a "white haze" and/or "tiny droplets" or "luster spots" on the surface of the paint film (15). In addition, it was assumed that gas chromatographic analysis would verify an increase in the free palmitic and stearic acids present within the paint.

Methods and Materials

The first set of experiments was designed to test the alizarin crimson oil film alone when exposed to varying levels of humidity and temperature and with the addition of cobalt driers. The factorial experimental design seen in Table 2 included paint-outs of *BLOCKX Alizarin Crimson* oil paint onto 4x6 inch glass slides. Two of the factors were studied at two levels (humidity of 20% or 85%; drier or no drier) while temperature was studied at three levels (4°C, 20°C, and 38°C). Half of the samples were mixed with an excess of cobalt driers. Samples were prepared in replicates of three and placed into six different environments. Environments included various combinations of high, medium and low temperature and humidity. The samples were exposed for a period of 100 days. The surfaces were examined every 25 days using a stereomicroscope and any changes were noted. Exposure to light was limited to these periodic examinations. At the end of the 100 days the sample's surfaces were examined once more and were then analyzed using gas chromatography.

Based on the above-mentioned theories, samples that were placed in high temperature, high humidity and mixed with cobalt driers were expected to display an exudant at the surface of the paint film and show the greatest increase of palmitic and stearic acids. Those without cobalt driers and in lower temperature and humidity environments were expected to display little or no exudant or increases in the two fatty acids. Visual examination did reveal the presence of a yellow exudant on the surfaces of some of the paint-outs and a slight sweat of material on several others. The exudant was most prevalent on those samples exposed to higher levels of heat and humidity. No exudant was evident on samples kept in the lower temperature and humidity environments.

Gas chromatographic (GC) analysis was conducted on replicate samples from each paint-out. Weighed samples of the exposed paint were transferred to screw-capped glass vials. Methylene chloride was added and the vials were allowed to stand for 24 hours, extracting the fatty acids from the paint. The vials were centrifuged and the supernatant was transferred with a pipette to a clean glass vial and evaporated under a gentle stream of nitrogen, concentrating the extracted fatty acids. The fatty acids were converted to their methyl esters using a derivatization solution containing trimethylsilyldiazomethane (TMS), methanol and ether. The samples were allowed to react for 30 minutes with occasional shaking to facilitate the reaction. This derivatization procedure improves GC separation of the fatty acids (16). Methyl ester standards of oleic, azelaic, palmitic, stearic, linoleic and linolenic acids were analyzed. Identification of fatty acids within each sample was based on the retention times of these standards. The fatty acid methyl esters were quantified using hexachlorobenzene as an internal standard (17, 18).

Table 2. Experimental design.

SAMPLES	HUMIDITY	TEMPERATURE	ADDITIVE
#1-3	85%	38°C	None
#4-6	85%	38°C	Cobalt Drier
#7-9	85%	20°C	None
#10-12	85%	20°C	Cobalt Drier
#13-15	85%	4°C	None
#16-18	85%	4°C	Cobalt Drier
#19-21	20%	38°C	None
#22-24	20%	38°C	Cobalt Drier
#25-27	20%	20°C	None
#28-30	20%	20°C	Cobalt Drier
#31-33	20%	4°C	None
#34-36	20%	4°C	Cobalt Drier

Statistical Analyses and Results

Statistical analyses of the gas chromatographic results were performed to determine the significance of temperature, humidity and the presence of the cobalt drier. This experiment was designed so that statistical calculations could be made which would provide the maximum amount of information for a given number of experiments and in order to show the effect of a particular factor independent of variations in the other factors. Furthermore this technique shows the effect of each factor with the most precision that can be achieved within the given operating region.

The experiments were based on a two level factorial design. Three factors were studied: temperature, humidity and the addition of cobalt driers. Several replicates were obtained which gave greater precision. A pooled estimate of all of the data was used to approximate the variance. For each of the acids, there were at least 70 degrees of freedom used in the calculation of variance.

Tables 3 and 4 represent the main effect values for each fatty acid for a given factor. Table 3 represents samples that were kept in 4°C and 20°C environments, Table 4 those kept in 20°C and 38°C. A negative number indicates a negative effect or a lesser amount of free fatty acids present in the sample and a positive number indicates an increase in the amount of free fatty acids.

Using this method it was possible to determine that in samples stored at temperatures of 4°C to 20°C, temperature had little or no effect on the amount of free fatty acids present. Humidity had the greatest positive effect on the azelaic and palmitic acids; it had a negative effect on the unsaturated fatty acids and no effect on the stearic acid. Cobalt driers had a significant negative effect on the unsaturated fatty acids. The presence of the cobalt driers increases the rate of oxidation leading to lower amounts of intact unsaturated fatty acids. The cobalt driers did not significantly impact the production of any of the other fatty acids in this temperature range.

In the temperature range from 20°C to 38°C, however, dramatic increases in the amount of free fatty acids present were seen. Also, all factors appear to be playing a part in the production of free fatty acids within each sample, with temperature having the most significant effect followed by humidity and then a small effect of the drier. The drier appeared to have no effect on the presence of palmitic acid and again had a negative effect on the unsaturated fatty acids.

Table 3. Design 1, main effect values for each fatty acid for samples at 4°C and 20°C.

TEMP. (HI-LO)	AZELAIC	PALMITIC	UNSAT.	STEARIC
EFFECT	-0.04	-0.36	-0.59	-0.16
SIGNIFICANT?	NO	YES/MARGINAL	NO	YES/MARGINAL

HUMIDITY (HI-LO)	AZELAIC	PALMITIC	UNSAT.	STEARIC
EFFECT	0.16	0.55	-1.74	0.1
SIGNIFICANT?	YES	YES	YES	NO

DRIER (W-W/0)	AZELAIC	PALMITIC	UNSAT.	STEARIC
EFFECT	0.03	-0.12	-3.44	0.11
SIGNIFICANT?	NO	NO	YES	NO

Table 4. Design 2, main effect values for each fatty acid for samples at 20°C and 38°C.

TEMP. (HI-LO)	AZELAIC	PALMITIC	UNSAT.	STEARIC
EFFECT	0.35	2.19	5.52	0.71
SIGNIFICANT?	YES	YES	YES	YES

HUMIDITY (HI-LO)	AZELAIC	PALMITIC	UNSAT.	STEARIC
EFFECT	0.56	2.91	4.02	0.78
SIGNIFICANT?	YES	YES	YES	YES

DRIER (W-W/0)	AZELAIC	PALMITIC	UNSAT.	STEARIC
EFFECT	0.33	0.26	-9.89	0.2
SIGNIFICANT?	YES	NO	YES	YES/MARGINAL

Conclusion

To summarize, all three factors: high temperature, high humidity and cobalt driers effect the increase of all free fatty acids within the paint film. High temperature has the greatest impact and cobalt drier the least. The magnitude of the effects of humidity and cobalt driers depends on the temperature; both appear to have a greater effect at higher temperatures. Also, it is likely that at higher temperatures the free fatty acids have a lower viscosity and therefore move more easily through the paint film.

Further tests would include samples of *BLOCKX* cobalt blue and paints that did not exhibit crystals. In addition, it would be useful to test paints by different manufacturers and of different mediums including linseed oil and egg tempera. We feel that experiments of this kind will give us a better understanding of the mechanisms involved in the breakdown of paint films and can help us make decisions about the treatment of these works and the environments in which they should be housed.

Acknowledgements

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REMBRANDT: A STUDY IN COMPLEXITY

Scott A. Heffley, Conservator of Paintings, The Nelson-Atkins Museum of Art

Introduction

In preparation for the 1997 Australian exhibition "Rembrandt: A Genius and His Impact" the long overdue restoration of Rembrandt's *Portrait of a Young Man* in the collection of The Nelson-Atkins Museum of Art was addressed. This portrait is an unusual late piece in that it depicts a bright and warm young man, unlike the usual dark, contemplative portraits that the artist was doing at this time (three years before his death). The painting was purchased at the very beginning of the formation of the Nelson's collection in 1931.

The portrait was last restored in 1951 by James Roth, resident conservator at the Nelson. In addition to removing a thick, badly discolored natural resin varnish coating, Roth removed extensive overpainting from the background and the fully overpainted gap between the two collars. (Figure 1: Before 1951 treatment.) He inpainted the fills and abrasions using pigments ground in a mixture of four parts orange shellac, two parts Venice turpentine, and one part beeswax. Roth stated that this mixture was selected to "assure easy removal without danger to the original paint." Roth's inpainting proved easily removable forty-six years later with just toluene. Perhaps because the colors inpainted were warm browns and blacks, no appreciable color shift was detected.

Professor E. v. d. Wetering of the Stichting Foundation Rembrandt Research Project visited Kansas City twice in the early 1990s to examine *Portrait of a Young Man* and evaluate its authenticity. It was accepted as by Rembrandt without reservation.

Conservation Questions

The current treatment chose to address important questions that had been bypassed in previous treatments. A 3 1/2" wide strip of canvas had been added to the top of the picture. Was this by Rembrandt? (He is known to have added strips and canvas sections to expand compositions while he worked.) Was it by some later restorer? What should the appearance with this strip be today? Another important question involved a tacking margin that is now a part of the picture plane across the bottom. It has many old tack holes and a fold line with only slight paint loss. This roughly 3/4"wide strip is a continuation of the portrait image and has been folded out to be part of the picture plane with all of the necessary filling and inpainting. Should this strip be tacking margin or a part of the original picture plane? If the 3 1/2" canvas strip at the top and 3/4" tacking edge strip at the bottom are alterations after Rembrandt's time, then why and when were they done?

The Evidence

Top Canvas Strip Addition (Figure 3: After cleaning, before compensation)

- This extension is made from a strip of old painted canvas that is butted against the lower portrait canvas with a gap of 1/16" - 1/8" and is held in place by attachment to the lining fabric. The junction line slopes down to the right with the strip width on the left at 3 1/2" and on the right at 3 3/4".

- The strip addition and the portrait canvas are both plain weave fabrics but of differing thread count (strip canvas: 29 x 39; portrait canvas: 37 x 33). The strip canvas fabric is made from finer threads.

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The Nelson-Atkins Museum of Art
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- The ground of the canvas strip addition is a mid-toned red earth color, unlike the portrait canvas ground, which is a medium dark brown color. The x-ray radiograph shows that the canvas strip addition ground contains much more lead than the portrait canvas ground. The strip addition has developed a different mechanical crack pattern: parallel short mechanical cracks with more cupping. An area of many small paint/ground losses 3" x 2" located along the bottom of the strip does not continue into the portrait canvas, indicating a difference in damage history experienced between the two canvases. Also, the ground of the strip addition does not show the many large red, yellow, white, and black pigment particles that are visible under magnification throughout the portrait canvas ground.

- Rather pronounced canvas cusping is evident along the top of the portrait canvas, but no cusping occurs anywhere within the strip addition.

- Brushstrokes of the surface paint on the canvas strip addition are generally arched in a horizontal direction, whereas the brush strokes of the portrait background paint at the top of the canvas follow the direction of light, angling from the upper left to lower right.

- Removal of the 1951 retouch shows that the angle direction of light from upper left to lower right is an important composition element of this piece. The light originates from outside the picture plane, and Rembrandt has reinforced this diagonal direction by painting two fine, white, diagonal lines flowing with the light near the top of the remaining original portrait canvas above the proper right edge of the hat. These white lines had been overpainted in the 1951 restoration.

- Small fragments of very old retouch were found under the 1951 retouch on the bottom of the canvas strip addition and on the top and right side of the portrait canvas. Microscopic examination showed that this retouch had developed some of the crack pattern of the original paint beneath and was difficult to remove. This would suggest that the strip addition was rather old, dating perhaps to well before its acquisition in 1931 by the Nelson.

All of this evidence suggests that the top canvas strip was added after Rembrandt's time. Additional key supporting evidence comes from the discovery of fine, nearly continuous cracks outlining what was once the inner edge of the original stretcher members. These crack lines are found 2 3/8" in from the right and left sides and 2 3/8" up from the fold line of the bottom tacking margin. Along the top, the crack line is parallel to the bottom crack line and not parallel to the sloped junction line between the portrait canvas and the strip addition. Also, the distance between the top crack line and the strip addition junction line is only 1 7/16" left and 1 3/16" right. Using the 2 3/8" assumed original stretcher member width found on the other three sides, it seems that 15/16" of the painting on the left and 1 3/16" on the right have been cut away and lost from the top of the picture plane.

Bottom Tacking Margin (Figure 3: After cleaning, before compensation)

- Since the 2 3/8" width of the original stretcher member measures up from the top of the tacking margin at the fold line and not from the bottom of the tacking margin, it strongly suggests that this was the original tacking margin for the painting, even though the portrait image continues across it.

- Careful measurement and examination of the many tack holes along the bottom show that there are two distinct sets. The upper set shows worn canvas, enlarged holes, and considerable paint loss typical of used and probably reused tack holes through an old brittle paint film. The lower set, however, shows very little loss of paint beyond the actual canvas tack puncture. Also, very interestingly, each hole is surrounded by a circular indentation. Under magnification, this indentation deforms the paint but doesn't cut or break it. This evidence suggests that the tacks (probably upholstery-type tacks) were used while the paint was still soft and pliable, probably shortly after it was painted. These tacks would have to have been installed after the paint was dry to the touch but before it had become very hard and brittle (perhaps a few months or up to a year or so after the paint application). The tack spacing between the later, more tattered set of holes is 3" – 3 1/2", and the tack spacing for the earlier holes with circular tack-head indentation is 1 3/4" – 2 1/4".

- Tiny losses occur in some places along the line, while in other areas there are no losses – only cracking. This suggests that this fold was initially made while the ground/paint layers were still pliable, probably shortly after the painting was made. If the ground/paint layers had aged and were more brittle when the painting was folded, more loss and cracking would have occurred. In particular, many parallel cracks would have formed with some paint loss between these crack lines.

All of this evidence suggests that the bottom tacking is not to be a part of the original picture plane, even though the image paint continues across it. An explanation for this can be found in the different ways that Dutch artists at that time stretched and prepared canvases. Professor E. v. d. Wetering of the Stichting Foundation Rembrandt Research Project discusses these methods in the publication, "A Corpus of Rembrandt Paintings" Vol. II, pp. 31-37. Sometimes Dutch artists would lash paintings into a strainer frame similar to a trampoline, or they might tack the canvas to the face of a strainer, or even some combination of the two. After the painting was completed, the canvas would usually have to be restretched in the more traditional manner with tacking edges around a stretcher or strainer so that the painting could be installed into a frame.

Painting History Recreated

Collectively, the physical evidence and the resulting assumptions tell a story of how the painting was made and what has happened to it since. These assumptions suggest that Rembrandt lashed his blank canvas into a "dutch-style" strainer and painted the portrait. Between several months and less than a year after completion of the painting, he removed it from the "dutch-style" strainer and attached it to a traditional stretcher with members measuring 2 3/8" wide. At this time the upholstery-style tacks were used and the painted image continued across the tacking margins. The painting remained on this original stretcher long enough for cracks to form outlining the inner edge of the stretcher member, perhaps over 80 years.

Several things happened to the painting between, say, c 1740 and c 1900. During various restoration treatments, the tacking margins were removed from the right side, left side, and top; and the picture plane was cut at an angle across the top, resulting in the loss of roughly 1" of the painting. The later set of tack holes in the bottom tacking margin show use and probably re-use, so perhaps the lined painting remained near its original size for some time in this middle period (c 1740 to c 1900). In the latter part of this period, the painting was expanded in size, in conjunction with a different lining. The bottom tacking edge was folded out into the picture plane and a roughly 3 1/2" wide canvas strip cut from an old painting was attached at the top. It is likely that the painting's vertical dimension was expanded by this roughly 4 1/4" so that the piece could fit into a standard French frame size (#25 portrait size, 81 cm. x 65 cm). (Figure 2: Before current treatment) This enlargement occurred well before the painting entered the Nelson's collection in 1931, based on the 1951 conservator's discussion of the varnish and lining fabric's condition. (The painting actually arrived at the Nelson in 1931 in a gilt, 18th-century-style French frame that was probably made in the 19th century.)

The Treatment

Since the physical evidence strongly suggests an original size and formatting, it was decided to direct the treatment towards that goal. In an effort to minimize intervention, the lining was not disturbed and the additions at the top and bottom were covered by a new frame. A reproduction 17th-century Dutch frame with specifically large rabbets was made for this purpose. The new sight size allowed approximately 1" of the top canvas strip addition to show with the picture plane as compensation for the calculated lost original canvas. This area was filled and inpainted to continue Rembrandt's background. At the bottom, the sight edge coincided with the original tacking margin fold line. The general treatment involved varnish and old retouch removal followed by inpainting and build up of a new, natural resin varnish coating. (Figure 4: After treatment and reframing)

Acknowledgments

Special thanks go to my colleagues at The Nelson-Atkins Museum of Art: Roger Ward, curator of European art; Forrest Bailey, former chief conservator; and Hal Prestwood and Christa Goodman, conservation assistants.

Figure 1
Rembrandt, *Portrait of a Young Man* 31-75; before 1951 treatment. Notice retouched collar.

Figure 2
Before current treatment

Figure 3
After cleaning, before compensation

Figure 4
After treatment and reframing

From The Ground Up: The Ground in 19th-Century American Pictures

Joyce Zucker, Painting Conservator

ABSTRACT—A painting is built from the ground up. The materials and color of the ground have a significant impact on the stability, tonality, and quality of the finished work of art. For 19th-century American artists of the Hudson River School, who became students of light and translucent media, the color and properties of the ground were critically important. To achieve certain visual effects, highly absorbent, highly water-soluble grounds were commonly used. During this time artists' colormen were experimenting with various recipes to produce economical grounded canvas that could be stored and rolled. Experimentation precipitated problems with faulty ground layers. The paintings of Frederic Edwin Church (1826–1900) are used to document changes in the use of ground color and to describe ground staining. With ground staining and its associate bloom prevalent in American paintings of the 19th century, the importance of recognizing these conditions is noted. Preliminary analysis and possible mechanisms for ground staining are discussed as well as problems with water-soluble grounds and shrinkers.

TITRE—La couche préparatoire dans les tableaux américains du XIXe siècle. RÉSUMÉ— Un tableau se fait en commençant par la couche préparatoire. La couleur de la couche et les matériaux dont elle se compose ont un très grand impact sur la stabilité, la tonalité et la qualité de l'œuvre finale. Au XIXe siècle, pour les artistes américains de l'école de l'Hudson River qui étudiaient la lumière et les liants translucides, la couleur et les propriétés de la couche préparatoire étaient particulièrement importantes. Pour obtenir certains effets visuels, des couches préparatoires extrêmement absorbantes et solubles à l'eau étaient souvent utilisées. Durant cette période, les marchands de couleur pour les artistes inventèrent différentes recettes pour produire des toiles préparées bon marché qui pouvaient être roulées sur elle-mêmes et mises de côté. Ces expériences ont parfois eu comme résultat des couches préparatoires défectueuses. L'auteur utilise les tableaux de Frederic Edwin Church (1826-1900) pour illustrer l'évolution des couleurs des couches préparatoires et pour décrire les taches présentes dans ces couches. Il est important de reconnaître ces conditions, car ces taches et le bleuissement qui y est souvent associé sont des phénomènes fréquemment rencontrés dans les tableaux américains du XIXe siècle. Les analyses préliminaires et les mécanismes qui semblent expliquer la présence de ces taches sont discutés. Les problèmes causés par les couches préparatoires solubles dans l'eau et par les toiles prônes au rétrécissement sont aussi abordés.

TITULO—Desde los cimientos: la capa de preparación en las pinturas americanas del siglo XIX. RESUMEN—Una pintura se construye desde sus cimientos. Los materiales y el color de la capa de preparación tienen un impacto significativo sobre la estabilidad, tonalidad y calidad de la obra de arte terminada. Para los artistas americanos del siglo XIX de la escuela del río Hudson, quienes se convirtieron es estudiosos de la luz y del medio translúcido, el color y las propiedades de la capa de preparación eran de importancia trascendental. Para lograr ciertos efectos visuales, eran usadas frecuentemente capas de preparación altamente absorbentes y muy solubles en agua. Durante esta época los pretaradores de color de los artistas experimentaron con varias recetas para producir lienzos con capas de preparación económicas que pudieran ser enrollados y almacenados. El experimento ocasiono problemas por capas de preparación defectuosas. Las pinturas de Frederic Edwin Church (1826 - 1900) son usadas para documentar cambios en el uso de capas de preparación de color y para describir la tinturación de la capa de preparación. Siendo que fue predominante en las pinturas americanas del siglo XIX el uso de capas de preparación con color y el opacamiento (bloom) asociado a esta técnica, se resalta la importancia de reconocer estas condiciones. Este trabajo contiene análisis preliminares, ademas de la descripción de posibles mecanismos para la coloración de las capas de preparación y de los problemas producidos por capas de preparación solubles en agua y los lienzos que se encogen ante la presencia de agua, produciendo problemas de cambios dimensionales.

New York State Bureau of Historic Sites
Peebles Island, Waterford, New York

1. Introduction

Between the teachings of the academies in Europe and the development of impressionism, American artists of the Hudson River School painted the beautiful, the picturesque, and the sublime. These artists were students of light (Huntington 1966), painting the "evanescent colors of dawn and sunset, the dramatic clear light of midday and the warm haze of Indian summer afternoons" (Stebbins 1983, 79), observing effects of atmosphere and the articulation of light.

A painting that captures light is built from the ground up. The materials of the ground and the color of the ground both have a significant impact on the stability and tonality of the finished work of art. The dynamics of the ground influence the absorbency, permanence, and, ultimately, the quality of painting, light, and luminosity.

This paper provides an overview of the use of grounds in 19th-century painting and uses the work of Frederic Edwin Church (1826–1900) to demonstrate the extent of change and the nature of some problems encountered with grounds in 19th-century American paintings. The materials of the ground have been identified by the use of the polarizing microscope or analytical transmission electron microscope and/or by analysis with Fourier transform infrared spectroscopy.

The 19th-century marked a turning point for artists. No longer did they have to prepare their own canvases and grind their own paints, for as the century progressed, art supplies were more readily available from artists' colormen. Many artists' colormen had businesses in lower Manhattan near the Tenth Street Studio Building where Church, Albert Bierstadt (1830–1902), Sanford Gifford (1823–80), and many other artists shared both common space and a camaraderie in following a common pursuit. These artists were in and out of each other's studios, often viewing works in progress and learning techniques from one another. They purchased art supplies from the same group of vendors (Blaugrund 1987). At this time, a growing number of new, synthetic, relatively untried products were appearing on the market. Unfortunately, many products were adulterated, especially materials coming from England (Kemp 1990), causing the stability of artists' materials to be a matter of great concern. Manuals and handbooks of the period (Merimée 1830; Bouvier 1844; Ridner 1850; Field 1869) provided advice on durability and tips on how to achieve translucency and brilliant color to maximize the potential for carrying light (Ridner 1850).

In an effort to capture light and ensure permanence, the artists used translucent materials. Colormen used resins and vehicle modifiers (Carlyle 1990) to improve the working properties of the materials. In addition, they experimented with nearly every aspect of painting technique. Modifying recipes to achieve certain effects began with the ground layer. The colormen needed to provide a supple grounding for canvas that could be stored and rolled for long periods without apparent damage. The artists wanted a uniform, often smooth surface that would absorb excess oil. Because the profit motive was on the minds of artists' colormen, their inclusion of extenders, foreign materials, and impermanent materials was not unusual. In an attempt to achieve low cost and good working properties, mistakes were made, often at the expense of quality.

1.1 The Importance of the Ground

Max Doerner, an authority on painting materials, explains that the ground "has an extraordinary influence on the durability of the picture and the action of the colors." He notes that a ground "makes the canvas more impenetrable and less porous and at the same time heightens the brilliance of the colors by means of a luminous ground" (Doerner 1984, 8–9). He goes on to say:

> Even with the thickest oil colors, the ground strikes through, giving either luminosity and clarity, as a clean white ground will, or dirty, greasy color effect, which upon drying, becomes still more displeasing, and in the course of years allows the underlying coats of paint to strike through (Doerner 1984, 9).

The great variety of grounds (i.e., oil, chalk, half-chalk) and their recipes have been discussed elsewhere (Hendy and Lucas 1968, 266–76) and are not addressed in this article.

The ground not only provides a texture of the artist's choice and a level of absorbency and color but also serves as the structural layer between the fabric support and the paint. "The use of absorbent, semi-absorbent or non-absorbent grounds and the question of how to achieve the desired state of controlled absorption" (Hendy and Lucas 1968, 271) have much to do with the technical problems encountered in 19th-century American painting. In addition:

> There are technical and economic difficulties in mass producing oil priming. Even the best white oil used for grounds takes time to dry and mature. Powerful siccatives have to be used, and these cause oil paints not only to darken but in time to become brittle and break up. The brittleness is counteracted by adding saponified fats and waxes (Hendy and Lucas 1968, 272).

Balancing the right proportion of additives is extremely difficult. Therefore, it is not at all surprising that a variety of problems arose with commercially prepared canvas. In a letter to Asher B. Durand (1796–1886) dated May 24, 1836, Thomas Cole (1801–48) expressed his concern with proper primings:

> The canvases arrived, and safe, but I am afraid they will not be very durable ones for it appears to me that the oil has penetrated through the cloth and you know that some sort of size is generally used to prevent that as linseed oil rots canvas in a very short time. . . . Will you when you see Dechaux, ask him if it is oil that is seen on the back of the canvas for I am almost afraid to work upon it (quoted in Katlan 1987, 19).

Period treatises provide additional insight into the difficulties encountered by artists' colormen. Merimée explained that "originally canvases were prepared like panels with distemper grounds." He continued: "Size made of glove parings is laid on with a palette knife or trowel. When the size is dry, it is rubbed with a pumice stone. Then with a knife lead-white is laid on and pumiced. A second or third is also applied" (Merimée 1839, 218). Merimée noted that cloth prepared in this way required two or three months to dry in summer and five or six in winter. He also advised (220):

> The time for priming may be shortened very much by making the first and second couches with distemper and as soon as they are quite dry and pumiced, let the last couch be merely oil (stand oil); this will penetrate the distemper and render it quite pliant. But by this mode, as soon as the oil is absorbed, they may be rolled up like wax cloths, with perfect safety.

It was imperative that colormen find a proper grounding that would take less than six months to dry. Although Merimée's suggested method offered an alternative shortcut procedure that added versatility, his system might have led to the kind of oil-stained canvas described by Thomas Cole. Experimentation continued, and the recipes and products produced varied in quality and type. While not a member of the Hudson River School, at the time the 1839 translation of Merimée appears, the American artist John Vanderlyn (1775–1852) used what can be called an experimental canvas for his grid sketch of *The Landing of Columbus, 1839*. The canvas stencil shows that this fabric was prepared by Valle and Bourniche. These Parisian artists' colormen had applied for a patent application in 1839 for primed linen canvas that would not react to changes in relative humidity. According to the patent, located with the help of the French Government Patent Office, the "active" ingredient was natural rubber (Valle and Bourniche 1839). They suggested that paintings that were to be hung on damp church walls be executed on this canvas for the achievement of long-term preservation. This example reveals the kind of experimentation being carried out by canvas preparers in an effort to develop a flexible, stable, primed canvas to meet increasing demand.

During such a period of change and experimentation, problems originating from the ground layer should come as no surprise. It is also likely that a variety of recipes for canvas preparation were being used and tested by the New York City artists' colormen and others. A basic recipe follows: "The canvas is first treated with size or a solution of glue. . . . The priming consists of two coats, the first containing whitening and size, the second lead white and linseed oil" (Church 1915,34–35).

This recipe represents the most commonly encountered commercially prepared ground structure in 19th-century American paintings. Although ingredients used in the various layers change, invariably most recipes called for added drier in the upper layers to speed the drying time (Hubbard 1795; Hubbard 1939; Arteni and Posada 1984).

It is interesting to note that a mid-century manual—a translation and compilation of European sources by the American artist, Laughton Osborn (1809–78)—asserted that canvas was universally used for pictures in oil. Evidently it was kept pre-primed in rolls of various widths at the colormen's shops. With short notice the canvas could be cut and stretched to any ordered size. Standard sizes were available off the shelf. The manual's writer urges that this ready-made canvas be aired for many months and suggests that even a year is not too long to wait. He recommends pumicing the surface and washing it off with water and alcohol before use (Osborn 1845).

1.2 Ground Color

Osborn was also specific about the color of the ground: "As to the tint given to this preparation, it is better that it should be light. Of the three kinds that are found in the shops, light grey, pink and the faintest flesh color, this last is the best" (Osborn 1845, 271). For landscapes, the specific recommendation for ground color is a warm and somewhat golden orange tint. If, however, the priming is grayish white, then a wash of a warm orange color is to be applied—brighter for the lights, darker for the darks. The gayest and brightest tone is selected for skies and distances (Osborn 1845).

The fact that the warm colors will show through the upper layers of paint, enriching and harmonizing the colors on the surface is clearly understood. Bouvier (1844), in his influential treatise, recommended what he considered the best method for priming oil canvases. This method includes the use of a good, clear, rectified nut oil with lead-white of Holland, yellow ochre, and a little red ochre. He believed this method was "resplendent in light, not cold. It gives a harmonious warmth" (Bouvier 1844, 533). He did not ignore the use of pure red ochre grounds by the Old Masters but cautioned that pictures painted on this type of ground become suffused with brown in a relatively short time.

In both *Scene on Catskill Creek* (1845) and *The Charter Oak* (1847, Olana State Historic Site), Frederic Church used a technique similar to that of many contemporaneous artists. He worked on a white absorbent ground washed over with a warm imprimatura. Ground and pigment samples were mounted in Aroclor 5442 1.660 for optical analysis. Optical properties of the pigments were observed by polarized light microscopy (Zucker 1987). The layer directly against the fabric appeared to be primarily chalk (calcium carbonate) with a thinner layer of lead-white on top. In 1845, directly influenced by his teacher Thomas Cole, Church used the methods recommended by the influential treatises. Indeed, Cole's methods of preparing studies, sketches, and oil sketches prior to completing the finished painting are typical of European academic training (Boime 1986). In *Scene on Catskill Creek*, the imprimatura color changes from a light buff to a deep terracotta as we move from sky to foreground with four noticeable tonal changes. Using the Munsell Color System (Munsell 1976) to identify visual color and the Universal Color Language (Kelly and Judd 1976) to identify color names, the Munsell numbers and color nomenclature for the colors of the ground beginning with the color underneath the sky and moving down toward the foreground are: 5YR 7/8 (moderate orange); 10YR 8/8 (moderate orange yellow); 5YR 5/6 (brownish orange); 2.5YR 5/6 (grayish reddish orange). This imprimatura is applied over the chalk and lead-white layers.

Huntington (1966, 63) observed that by the 1850s Church had abandoned Cole's "salmon buff" ground in favor of a thinly spread cream white ground. It has been suggested that Church's knowledge of Turner's use of white grounds may have motivated this change in technique. Church had John Ruskin's *Modern Painters*, which introduces the reader to Turner's methodology, on the bookshelves at Olana, his home. By the time Church painted *The Andes of Equador* (1855), he was using a two-layer ground, but the upper layer of lead-white contains a small quantity of bone black and raw umber to counteract the natural yellowing tendencies of lead-white in linseed oil. Church added zinc white at the sun to ensure a brighter white at this most radiant spot on the canvas. These pigments were identified from an unfinished canvas found in the archive at Olana State Historic Site (Zucker 1988). The basic outline drawing had been laid in with chalk over the ground. This unfinished canvas appears to be the precursor for *The Andes of Equador*. The large-scale painting of *The Icebergs* (1861, Dallas Museum of Art) shows a two-layer white ground with a translucent blue-gray imprimatura and various translucent layers above (Thomas 1980). In Church's *The Afterglow* (1867), the double-layer calcium carbonate and lead-white ground is found on both sides of the canvas (Zucker and Newton 1994). Church may have seen the double-sided ground as a measure to ensure permanence.

Unpublished conservation examination and treatment records were reviewed from the New York State Bureau of Historic Sites, Perry Huston and Associates, and the Cleveland Museum of Art to determine the components of the structure and grounds in Church's oeuvre. The thick, translucent, blue-gray imprimatura found on *The Afterglow* was used to carry and radiate light .

In Church's move to lighter colored grounds, he attempted to capture the brightness and luminosity of the white ground. The interposed translucent layers served to reflect and refract the light. Many other Hudson River School painters varied the color and type of ground. Ross Merrill, Jim Wright, Dare Hartwell, and Helen Mar Parkin reported in conversations with the author that Albert Bierstadt (1830–1902) used commercially primed linen canvas with primarily lead-white grounds (Hartwell and Parkin 1999). Later in his career, however, Bierstadt used a thin graphite ground on *The Last of the Buffalo* (1888, Buffalo Bill Historical Center) and (Hartwell and Parkin 1999). It is difficult to determine whether Bierstadt was interested in the preservative properties of graphite (it was said to impart waterproofing qualities) or in the ability of its silvery gray tone to produce the optical effect of the old masters (Doerner 1984, 30). In either case, graphite grounds had poor qualities as a substrate and produced poor adhesion with the layers above.

J. F. Kensett (1818–72), another painter of the Hudson River School, also used commercially primed linen canvas. His primings vary from yellow to red to orange. A large amount of glass was identified in a sample of underpaint from Kensett's *A Summer Day at Conesus Lake* (Dwyer 1985). Glass can also be used to enhance drying properties.

A period description of the working methods of Sanford Gifford (1823–80) reveals him working in a manner similar to Frederic Church in his unfinished work *The Hudson Valley from Olana* (1870–73). Gifford began with a white canvas and then stained it with a mixture of burnt sienna oil paint thinned with turpentine. He then took a white chalk crayon and sketched in the design. Painting began with the horizon of the sky (Sheldon 1877). "With Mr. Gifford, landscape painting is air painting; and his endeavor is to imitate the color of air, to use the opposition of light and dark and color that he sees before him" (Sheldon 1877, 284). Church, Kensett, Gifford, and Martin Johnson Heade (1819–1904) were interested in light reflected and refracted through the atmosphere. Their paints tended to be more translucent in application. They used an underlying white ground to carry light. Bierstadt, on the other hand, used opaque colors more appropriate for clear, sharp outlines.

2. Some Problems Encountered in 19TH-Century Grounds

In February 1885, Frederic Church responded to a notice from the Corcoran Gallery of Art, Washington, D.C., that his great *Niagara* (1857) had vertical streaks through the sky and the water. He replied that the "obnoxious" streaks were due to the canvas maker Winsor and Newton. He attributed the streaks to the use of sugar of lead—that is, lead acetate drier—in the canvas preparation to hasten the drying process. Church explained that the only pictures to develop this problem were those painted on Winsor and Newton Roman canvas. He recounts that it often took years for the streaks to work themselves through to the surface and that many years before he had carefully repainted the sky of *Niagara* to cover streaks. Church (1885) recommended that a restorer from New York, Mr. Oliver, undertake the repairs. It is likely that Church purchased the fabric in question from William Schaus on lower Broadway. According to an invoice in the archive at Olana State Historic Site, Church purchased Winsor and Newton Roman canvas from Schaus in 1860, the year he painted *Twilight in the Wilderness*, another picture with severe ground staining. In 1857, Schaus is listed in the New York City directory as "importer of the best English canvas, . . . purchasers can always rely to find here the very best articles from the most celebrated London and Paris manufacturers" (quoted in Katlan 1987, 220).

2.1 Ground Staining

Ground staining is a phenomenon peculiar to many paintings by artists of the Hudson River School. This is not to say, however, that it is limited to these artists. Ground staining is evident in the work of Church, Bierstadt, Heade, Kensett, Gifford, Cole, and others. As Church noted in his 1885 letter to the curator of the Corcoran Gallery, he was painting on canvases that were unstained at the time. As time progressed the dark staining would appear, usually following vertical lines but sometimes spreading out beyond a thread to cover a more generalized area, as in *Twilight in the Wilderness*. In Church's *Vale of St. Thomas, Jamaica* (1867) ground staining is visible, primarily through the cloudburst. The stained areas appear darker, more saturated, and patchy. The real image is obscured.

One conservator looking at stains in Kensett's work described "slight discoloration occurring in patterns resembling wide brush strokes but seems to be coming from a layer under the paint." She suggested that Kensett's experimentation with colored or toned primings might have accounted for some of the problems in his late work. Another factor might have been the modification of his usual paint mixture to "achieve greater freedom and fluidity of brushwork" (Dwyer 1985, 177–78). She finds that the most disfiguring and least explicable alteration occurs in *Salt Meadow in October* (1873; Metropolitan Museum of Art).

> In the blue foreground and sky, large stained patches . . . have appeared with time. When cross sections were compared, the darkening was identified as a chemical alteration of lead-white: the upper particles of this pigment, which is normally opaque, had been transformed into transparent crystals, which have not to date been specifically identified. The well-known alteration of basic carbonate of lead into the black lead sulfide has been ruled out. . . . This type of change frequently has been called ground staining (Dwyer 1985, 177–78).

Church identified the cause of the ground staining to be the inclusion of lead acetate in the ground layer. He explained that an artists' colorman of his acquaintance who made grounds with lead acetate had this staining problem develop. Church owned more than a dozen texts on chemistry, including Field's *Chromatography*. Field (1869, 52) warned: "The inexperienced ought here to be guarded against the highly improper practice of some artists, who strew their pictures, while wet, with acetate of lead; which though it may promote present drying, will ultimately effloresce on the surface of the work and throw off the color in sandy spots."

What Field called efflorescence leads us to the problem of bloom. In general, this phenomenon—the appearance of a white or bluish white opaque or semi-opaque film on the surface of an oil painting—is prevalent throughout Church's work. It is most visible in the hundreds of architectural sketches in the archive at Olana State Historic Site . On these sketches, bloom appears as a bluish white hazy film that seems to be waxy in nature. Similar bloom has been identified on other pictures as lead stearate (Williams 1988). On Church's architectural sketches and on other oil-on-paper works, there is extensive bloom, yet there is no ground staining. This phenomenon suggests the possibility that the size and/or fabric support together with the materials of the ground may contain the combination of factors producing ground staining. The architectural sketches were executed quickly. No doubt Church wished them to dry quickly and so would add extra drier. It is quite possible that the drier enhanced the formation of bloom and staining. Based on bills in the Olana archive we know that Church ordered large quantities of a drier called *sicatif de Courtrai* from Goupil & Co. While Church owned Field's *Chromatography*, he did not write about problems with lead acetate drier until 1885, long after most of his major paintings and oil sketches had been completed.

2.2 Analysis

Another fortuitous find in the Olana archive sheds additional light on this subject. An unused, rolled piece of primed linen was identified during a site survey), measuring 78.5 cm from selvage to selvage, 74 cm long with a plain tabby weave having 18 warp and weft threads per cm.

Polarizing microscopy showed that the linen was coated with a layer of calcium carbonate with a very thin layer of lead-white on top. It appeared that either an oily coating had been applied overall or that there was excess oil in the top layer of lead-white. The selvage on one side appeared to be saturated with oil. Oil had penetrated to the reverse irregularly. Stains on the front did not correspond to areas where oil has penetrated to the reverse.

Fourier transform infrared spectroscopy analysis of a sample from this canvas was undertaken. Unfortunately the analysis was inconclusive in identifying the materials in the size layer of the canvas. Significant amounts of long chain C_{18} alkyl compound, categorized as most likely a C_{18} carboxylic acid salt were identified . The analyst suggested that the C_{18} alkyl compound was the reaction product of the C_{18} alkyl moiety in dried linseed oil with an inorganic metal (Miaw 1989). A possible source for the metal is a lead drier such as lead acetate or the lead-white pigment. Lead was confirmed as the primary metallic component in the bloom material using an analytical electron microscope interfaced with a energy dispersive x-ray detector (Webber et al. 1990).

2.3 Possible Mechanism

The white material or bloom proved to be a carboxylic acid salt, most likely lead stearate. Christopher Tahk, director of the Art Conservation Department, Buffalo State College, New York, in a private conversation, offered several suggestions as to a possible mechanism for the formation of bloom and ground staining. Lead from the lead-white paint film and/or the lead acetate drier could react with any carboxylic acids in the linseed oil paint to form the lead salt, lead stearate. The lead drier in the presence of humidity cycling would enhance the formation of bloom. The oil staining is also likely a product of the production of lead stearate. The lead-white paint film may be partially converted to lead stearate, which has a lower refractive index. On a prominent thread, where the paint film is thin, the paint becomes nearly transparent. Thus the uppermost threads of the dark, oil-saturated fabric may become visible or partially visible.

Why is the ground staining selective, and why is it found primarily along vertical threads? One possible explanation is related to the preparation of linen for weaving. Warp threads were prepared with adhesives, usually starch or gum; softeners, such as tallow, palm oil, soap, paraffin or resin; or deliquescents, such as magnesium chloride, antiseptics, and weighting agents. The warp threads were treated selectively to lessen abrasion of the fibers and to increase the strength of the fibers during the weaving process (Woodhouse and Milne 1914). Chemical interactions between soaps and metal ions may in part account for the selectivity of ground staining. More research is necessary to examine this problem.

3. Water-Soluble Grounds

Church's 1847 painting *Christian on the Borders of the Valley of the Shadow of Death* has suffered much due to the water-soluble nature of its ground. The picture was subjected to a double Elmer's Glue lining in 1965. Its removal and subsequent wax relining did not solve the structural problems, for the ground literally dissolves when water is applied to its surface. The application of a water-based lining adhesive compromised the structure even further. The minimal amount of water that seeped through the back of the fabric was enough to cause additional breakup of the ground. There was a lack of adhesion between paint and ground and between ground and canvas. The paint sat like corn flake crumbs over large areas of the surface. During the removal of the Elmer's Glue lining in the 1980s, a Theodore Kelley canvas stencil was found on the reverse and noted in the conservator's report. In the year Church painted *Christian*, Theodore Kelley was located on Wooster Street in lower Manhattan (Katlan 1987). His primings are notorious for their water-soluble nature. The painting was recently re-treated using local consolidation.

Artists who used absorbent grounds like the calcium carbonate–animal glue combination found in Theodore Kelley canvases may well have been seeking a bright, fresco-like appearance. Unfortunately, the chalk ground is highly susceptible to the action of water. When Church's oil sketch for *The Icebergs* was subjected to harsh treatment, including the use of water-based adhesive in the 1960s, the result was severe cleavage between ground and canvas and between paint and ground. The restorer felt compelled to extensively overpaint the accompanying loss. While the two previous examples come from the works of Church, many other artists were interested in achieving the light, bright appearance possible with absorbent grounds. Many of them also purchased supplies from Theodore Kelley, including Durand and Gifford (Katlan 1987).

In the past, paintings with water-soluble grounds were often infused with wax before cleaning was undertaken. There is a need to look for alternative methods for treating these precarious structures. Before treating 19th-century American paintings, it is critical to know the structure well. Not only the resinous components in the layered structure, but also the ground can become solublized. Chalk grounds or partial chalk grounds are also implicated when we see severe shrinkage and loss in a painting. The tendency of this painting was to shrink in areas exposed to water. A high percentage of calcium carbonate and animal glue is often found in the ground layers of pictures that have a tendency to shrink. Hedley had conducted research on "shrinkers," according to

Carlyle (1990). Carlyle noted that Hedley's preliminary findings suggested that power-loomed fabrics were implicated. A need for better understanding of the history and properties of the fabric painting support is clear.

4. Summary

The materials and the color of the ground have a significant impact on the stability, tonality, and quality of the finished work of art. For the 19th-century American artists who became students of light and translucent media, the color of the ground became even more critical.

Experimentation in the 19th century by artists' colormen precipitated problems with faulty ground layers. Changing recipes led to the use of primed canvases that developed unsightly stains, which eventually disfigured the paint film. To achieve certain visual effects, highly absorbent, highly water-soluble grounds were commonly used. Because these grounds are hidden by the layers above, the potential for disaster is latent.

In treating 19th-century American pictures, there is a need to think about the varnish, the glazes, the upper paint films, the resinous interlayers, and, certainly not least of all, the ground. Methods of approach must include testing for hidden components.

Care must be taken to determine whether one is looking at broken scumbles or the vestiges of bloom that have migrated through the structure to be deposited on the surface, making the artist's original intent difficult to decipher. Hazy, atmospheric effects are part of the vocabulary of many of these pictures.

Many of the painters of the Hudson River School purchased materials from a group of vendors near the Tenth Street Studio Building. At the same time that colormen were experimenting with ground recipes, the artists were modifying European techniques to produce the American idea of landscape and American light. Grounds were changed in color and type based on aesthetic needs and permanence. Ground staining and water-soluble grounds were not unique to any particular artist of the period. They did, however, mark paintings and produce problems and challenges. Understanding the milieu and the materials and structure will help art historians, conservators, curators, and conservation scientists to meet the challenges of treating these pictures.

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THE PHYSICAL HISTORY AND CONSERVATION TREATMENT OF THOMAS HART BENTON'S INDIANA MURALS

Margaret Contompasis, Painting Conservator*
Martin Radecki, Chief Conservator and Director of Collection Support**

Part 1: MURAL HISTORY, CONSTRUCTION AND CONDITION
by Margaret Contompasis

The State of Indiana gave Thomas Hart Benton's monumental mural cycle *the Social and Industrial History of Indiana* to Indiana University in 1939. The murals were installed in the Indiana University Auditorium during construction in 1939. It was late in 1996 when, in light of an imminent renovation of the IU Auditorium it became vital to understand the construction and condition of Thomas Hart Benton's Indiana murals. While the project to upgrade, repair, and replace IU Auditorium environmental and safety systems, scheduled to begin in December 1997, would eventually provide a more stable environment for the Hall of Murals and throughout the building, it quickly became clear that the renovation of the almost sixty-year-old building would have a major impact on the condition of Thomas Hart Benton's prized Indiana murals. The university was committed to the long-term survival of the murals, and, in recognition of the potential for damage during the extensive building renovation, a steering committee was assembled and charged with assessing the condition of the murals and reviewing all aspects of the construction project that could have an impact on them.[1] Funding to preserve and conserve the murals themselves was provided by IU, the IU Foundation, and private donors, combined with major conservation grants awarded by the Getty Foundation and the National Endowment for the Arts.

Of concern to the committee was the inevitable shutdown of major building systems including heating and electricity, which could have left the murals in an uncontrolled climate for several months. Other areas of concern included the planned reinforcement of the balcony support structure, and the installation of an elevator and handicap access ramps in the areas directly below and adjacent to the murals. The installation of the elevator and access ramps would require cutting through the walls beneath and behind the murals and removing the cement flooring in adjacent areas.

The committee members came together to ensure the immediate safety and treatment of the murals during the renovation and to address the long-term environmental issues affecting them, including security, lighting, and climate control. The university agreed that no heavy demolition or construction would occur until the conservation plan was in place and the murals had been stabilized.

The committee, drawing on the expertise of the IU Art Museum's conservators Margaret Contompasis and Danaë Thimme, worked to gain a collective understanding of the materials used in the construction of the murals, their fragility, and the impact the renovation could have. The first issue at hand was a comprehensive evaluation of the murals' present condition. The committee contracted Martin Radecki, head of conservation at the Indianapolis Museum of Art, to complete a detailed condition survey and conservation treatment proposal for the murals.

Radecki and his team of conservators[2] documented condition problems associated with both inherent vice[3] and previous treatment campaigns that had left the murals both structurally and aesthetically compromised. Concurrent with the condition survey, the author began to research the history and construction of the Indiana murals and to study condition problems associated with Benton's work of the period. The museum and university archives were

* Indiana University Art Museum, East 7th Street, Bloomington, Indiana 47405
** Indianapolis Museum of Art, 1200 West 38th Street, Indianapolis, Indiana 46208

searched for old photographs and other documentation about the murals' manufacture and treatment history. The author and Kathy Foster, IUAM curator of nineteenth- and twentieth-century art, undertook research on the aesthetic issues associated with Benton's murals of the 1930s.

The results of the condition survey, chemical analysis, and field research were presented to the steering committee, which further discussed technical and aesthetic issues associated with the conservation of the murals. The committee continued to meet throughout the project, setting criteria for qualifications of the professionals contracted to conserve the murals, ensuring a safe working environment, outlining the scope of work for the overall conservation campaign and approving the conservation treatment as it progressed.

The Hall of Murals

The IU Auditorium is a 58,226-square-feet, reinforced concrete and steel building with a limestone skin. The murals are currently displayed in the Hall of Murals, a long rectangular entry vestibule measuring 28 1/2 by 92 feet with a stepped ceiling that is 32 1/2-feet high around the perimeter and 35 1/2-feet high in the center cove. Twelve feet in height and approximately 144 feet total in length, the eight mural panels, each depicting two scenes, are mounted within ceramic block niches in the walls, approximately 15 feet above the floor in two long, east-and-west-facing rows, and in pairs on the north and south walls above the stairs. They are held in place by a system of shims and moldings and are tied into the ceramic niches with metal rods.

Mural Construction

The murals are painted in "egg tempera" on a thick gesso ground applied over canvas, which is attached with either a lead-based adhesive or "marine glue" to support panels. The support panels measure approximately 12 by 18 feet and consist of a 2-by-6-inch framework, covered with 1-by-6-inch sheathing, overlaid with 1/2-inch plywood. The backs of all of the panels were painted with white lead-based paint (in order to reduce the detrimental effects of fluctuating relative humidity).[4] The medium-weight linen-and-bast-fiber canvas covers the individual 12-by-18-feet panels and continues around the panel edges.

The ground covering the canvas is highly textured and has pieces of dried gesso embedded throughout the layer. There are physical contradictions within the ground layer. The prevalence of craters or dimples found throughout the mural surface and the porous nature of the gesso indicate it was spray-applied[5] in a relatively thin slurry and that air bubbles introduced into the slurry either during mixing or during the application had time to rise to the top of the fluid layer and break, forming the craters. However, the heavily textured surface appears to have been applied with broad stiff brushes or brooms in order to mimic impasto or brushmarks usually visible in an oil paint film. Pieces of dried gesso ranging in size from 1/8 to 1/2 inch in diameter are found embedded in the ground throughout the mural surface, suggesting the ground was textured with broad brushes or brooms when partially dry, after being spray applied.

The pigmented layer was applied over the gesso. There are several variations in the medium used in the traditional technique of egg tempera painting, and three formulas for egg tempera paint have been documented as the medium for this project. These will be discussed later.

Benton was very specific about the final surface coating of the murals: they received a coating of a solution made up of 2/3-parts water to 1/3-part egg yolk, followed by a layer of mastic varnish. A final coating of Matvar, a proprietary varnish and wax solution manufactured by F. Weber Company of Philadelphia, was applied and later polished. The purpose of the wax was to reduce the glare of the varnish.

Condition

The condition survey was both puzzling and alarming in revealing the poor state of the murals. While the wooden panel support structure appeared to have held up well over the years, with relatively little cracking of the gesso ground or delamination between the canvas and the plywood support, significant instability existed in the bond between the dry, brittle, paint layer and the ground or gesso layers, manifested in the form of flaking paint over approximately thirty percent of the murals. The thinly applied paint layer had pulled away from the ground in many areas, furling back in tight curls ranging in size from approximately 1/8 to 1/2 inch in diameter. The large areas of active flaking and loss appeared to be associated with thick, unevenly applied surface coatings. In some cases the gesso ground had pulled away with the flaking paint, evidence of some breakdown of the gesso ground layer.

Cleaning tests indicated that the paint was sensitive to solvents that usually left egg tempera medium unaffected. The instability in the ground and the uncharacteristic flaking and solubility in the paint layer uncovered during the initial examination, combined with conflicting documentation of Benton's technique, warranted further chemical analysis of the painting structure in order to clarify the material construction of the murals.

Additional condition problems found throughout the mural cycle included chemical and mechanical abrasion of the paint during past cleaning, cracks, scratches, and protruding nail heads visible on the painted surface. The accumulation of over forty years of grime (now embedded in the uppermost wax coating) and the discolored varnish layers had disfigured the murals and affected the color balance and sense of space.

A review of the history of the murals suggests the condition problems could be associated with Benton's ongoing struggle to master his materials, the haste in which this ambitious project had to be completed, storage conditions after the fair and before coming to IU, and the previous restoration campaigns, as orchestrated by Benton.

Benton's Egg Tempera

Benton was riding on the success of his recent commissions, which had garnered him recognition as America's premiere muralist, when he was awarded the contract for the Indiana murals. He had actively promoted his revival of egg tempera painting,[6] stating his certainty that his murals "will remain essentially unchanged in appearance for centuries to come, and that even his finish surface will remain intact for a hundred years, standing as a vivid record of American life in his time."[7]

Benton's experimentation with various painting mediums began early. Planning a career in "journalistic art," he had enrolled at the Chicago Art Institute in 1907 "in order to improve my drawing for such a career."[8] There, he began painting in watercolor. Fascinated by the process, he gave up his "journalistic ambitions." By 1908 Benton was working in oils, a medium he found less satisfying than watercolor. With his drafting background, Benton was disappointed in his inability to maintain any sense of the drawing in the "slippery, buttery medium" of oil paint.

In August 1908 Benton enrolled for the autumn term at the Academie Julian in Paris, where he continued to draw and paint. He became interested in "distemper " in the summer of 1914, when, back in New York, a friend, Rex Ingram, arranged a job for Benton as a set designer by. [9] He was attracted to the quick-drying medium that allowed "precise brush drawing," and by 1917 he had begun the "habitual" practice of underpainting in distemper and overpainting in oil. "The distemper, drying rapidly, permitted me to make up my mind about what I was going to do in a third of the time it took with oil and without the risk of muddied color. Later egg-tempera would take the place of distemper, but the principles of such combinations of mediums, the use of which was commenced here, are the same."[10]

Benton began experimenting with egg temper techniques some eight years before receiving the Indiana commission. "During the winter of 1925 and 1926...having come across Cennini's famous treatise on Renaissance techniques, I started working with the tricky problems of egg-tempera painting."[11] Benton admits his ongoing struggle to master the technique: "I made the mistake of using too heavy a glue solution, with the consequence that most of the paintings cracked so badly they were not worth preserving."[12]

Benton briefly discussed the materials used in the New School and Whitney murals (both completed prior to the Indiana murals) in his book *An American in Art*. About the New School murals, Benton states, "Work began with underpaintings of distemper and was finished with overpaintings of egg-tempera. On some of the dark areas transparent glazes of oil paint were thinly applied." Of the Whitney mural, Benton recalls "I painted this second mural wholly in egg-tempera from drawings and pilot sketches in black and white paint."[13]

A letter dated December 27, 1932, to Benton from F. W. Weber of the Weber Company, a fine art materials manufacturer in Philadelphia, makes it apparent that, in spite of his bravado, Benton was still quietly struggling with the medium.[14] Condition problems in his earlier murals for the New School and the Whitney could have prompted him to seek advice from Weber about the glue sizing he had thought might be at the root of the cracking paint in the earlier murals. [15] It is clear from the scope of Weber's response that Benton had many questions on the use and function of the materials of traditional tempera painting. Weber advised Benton extensively on the formulation, preparation, and application of gelatin as a substitute for the glue size. He further suggests the use of gelatin in the ground layer, stating "Whiting and Gelatin chemically react to form a very durable compound." Weber continues with a short dissertation on the function and application of ground layers in tempera painting.[16]

The Indiana Murals

As stated above, three sources for information on Benton's paint preparation for the Indiana murals were found. All include eggs as a major component of the medium. Project accountant Ross Teckmeyer's report on the Indiana murals of 1949 states, "These murals are in watercolor, and to give them some semblance of permanence it was necessary to secure several different types of materials and supplies.... [including] Mr. Benton's request that he have not less than two dozen fresh eggs each day...since he used the whites of the eggs in preparing his paint. I have often wondered what became of the yolks of the eggs since they were not used by the painter."[17] Wallace Richards, the project coordinator, states Benton used one-part egg yolk and one-part water as the medium for the paint.[18] Finally, a young student-reporter from the *Indiana Daily Student* documents Benton demonstrating his egg tempera technique for the students of the fine arts department during his December 1941 visit. The reporter states "Art students actively participated in the demonstration by helping Benton mix the base that he used for his tempora [sic] pigment.... [a] s the students shook the glass jar containing equal parts egg yolk, oil and water...."[19]

No statement by Benton himself describing his working medium for the Indiana murals has been found. The most likely of the three scenarios is, as Wallace Richards documents, that Benton had made his paint using a "half yolk of egg and half water in his medium. The brush is dipped into this medium, and then directly into Weber dry color, and his paint mixed directly on a glass palette."[20]

Traditionally the dry pigments to be used in egg tempera painting would be wetted with water and mulled on a smooth surface in order break up clumps and to saturate and disperse the pigment crystals, producing a consistent paste which would then be mixed with the egg and water medium. This painstaking process is necessary in order to produce a strong, homogenous paint film. Whatever the medium, Benton's nonchalant attitude in mixing his paint would have affected the long-term stability of the paint, producing an uneven, perhaps underbound paint with questionable structural integrity. He may have rationalized that his additional step of coating the entire finished paint film with, essentially, a slightly dilute layer of medium was a remedy for his shortcut in mixing the paint. Over time it has proven to have the opposite effect. The aging coatings of egg yolk and water, mastic varnish, and wax had oxidized and contracted, pulling the paint film and compromised ground from the surface of the painting.

Material Analysis

Analysis of the samples taken from the murals did little to clarify the issues of the paint medium. The murals have been examined and analyzed on three different occasions with three different conclusions.[21] The first sampling took place in the mid-eighties when conservators from the Indianapolis Museum of Art, treating the mural panels in Woodburn Hall and the IU Theater, identified the ground as calcium sulfate or plaster and the paint medium as "egg tempera." The murals were analyzed again in 1996 by the Canadian Conservation Institute using Fournier Transform Infrared Reflectography. They identified the ground as calcium carbonate with no binder, and the paint as a protein base, possible albumen. Albumen is a major component of egg white, supporting the seemingly improbable Teckmeyer account. The CCI report further identifies a synthetic resin and protein as the surface coating on the murals. The paintings were sampled again by conservators during the recent conservation campaign and analyzed by the Williamstown Regional Conservation Laboratory, which identified the ground as calcium carbonate with a protein binder. Once again the paint medium was identified as protein. The original surface coatings were identified as natural resin, probably mastic, with a protein component, over which was a methacrylate-based synthetic resin varnish.

It seems unlikely that Benton would have painted the image using egg white and water as his medium, as Teckmeyer claimed. Cennini, Benton's source for technical information on tempera painting, does discuss the use of egg white as a paint medium for illuminated manuscripts and as a varnish coating on painting made with the more accepted egg yolk medium. An egg white medium would have produced a relatively weak paint film. Indeed, the uncharacteristic flaking and solubility of the paint layer coupled with the analysis identifying protein as the medium does lend some credibility to the Teckmeyer report. Further analysis is being completed in order to clarify the composition of the paint medium.

Mural Manufacture

With the contract for the murals awarded to Benton in late December 1932 and the fair opening in late May of '33, there was no time to waste. By January 1933 three carpenters and several students had signed on to assist Benton in the project. Clearly these hired helpers would have had little if any training in the tradition of tempera painting. Benton, himself, still struggled with the technique. Correct formulation and application of the materials on the scale of traditional easel painting would have been difficult enough for the assistants to master in the time frame of the project; on this scale, these preparatory tasks must have been daunting.

Ross Teckmeyer's report chronicles the "many problems" encountered at the onset of the project, beginning with building the massive panels that would serve as the support for the paintings. "First, there was the difficulty...of obtaining canvas large enough to cover the panels without any seams."[22] After a national search, a manufacturer was found who could supply enough canvas to complete the project. Once the canvas had arrived, a second problem arose. Benton had intended to use a white-lead/oil-based adhesive to attach the canvas to the wooden panels. After two attempts to do so, "it was soon discovered that because of the large area, the canvas did not dry fast enough to allow painting of the murals." A satisfactory substitute was found to be "boat-glue." In Indianapolis there was only a half-gallon of boat-glue to be found. Securing the canvas had to wait until the manufacturer could deliver the required amount of glue to the city. The white lead already on hand in the studio was put to good use, being applied to the back of the panels as paint. Teckmeyer comments, "The only happy incident relative to the construction of these frames [support panels] was since we had purchased a quantity of white lead, we had this material on hand and used it for painting the wood backs of the panels."[23]

Reporters, politicians, and other visitors to the studio were stunned by the speed and skill with which Benton was attacking the process of painting the murals. Wallace Richards reported to the commission: "In Indianapolis the frames designed by Mr. Hibben for Mr. Benton's murals are constructed. Scaffolds are built. The racks to hold the completed panels and the supports on which the one ton panels rest while being painted, have all been completed. Canvasses have been stretched and gesso applied. The backs of the frames have been painted."[24] Wallace Richards writes of Benton productivity and speed: "Mr. Benton's labor can be fully appreciated only after the 2,685 square feet of his mural have been divided by the seventy days in which they must be painted. Then only is it found that the artist on each of these seventy days had and has to produce 38 square feet of finished mural. Nor will he allow any one but himself to put one brush stroke on the huge panels. Those who have volunteered to aid him have scaled up his 12 by 18 inch designs to the final 12 by 18 foot panels, they have pushed his painting scaffold for hundreds of yards, they have broken dozens of eggs in replenishing his medium, but the creative ideas and every stroke of the final designs and murals is the work of Thomas Benton." [25]

Once again Richards and Teckmeyer are at odds in their account of the project. Contrary to Richards, Teckmeyer credits Benton with all of the preparatory work discussed in Brewers article including the scaling up of the image onto the mural panels. Teckmeyer continues "After it was outlined on the final 20' [sic] by 12' panels he allowed his associates to use his colored sketches and fill in the outline."[26]

Little evidence exists to substantiate either claim. A newspaper artist's rendering of the worksite supports Richards' account of the assistants working ahead of Benton scaling up the drawings while Benton paints. A photograph of the worksite lends some credibility to the Teckmeyer account as areas of background appear to be blocked out in paint as Benton focuses on the details of the painted image.

Transporting the Murals

Once the murals were completed, the Capital Transfer Company of Indianapolis was contracted to move the panels to Chicago. Included in the task was the removal of courses of bricks between an upper and lower window in Germania Hall to create an opening 2 by 20 feet from which the individual panels (weighing up to 800 pounds each) could be lowered by crane onto the truck below. Loaded on a specially constructed trailer equipped with "pneumatic tires" that was 44 feet in length and had a 19-feet-long underslung bed to receive the 18-feet-long panels, the murals traveled to Chicago, where they were unloaded at the Indiana Building.[27] Photographs of the process indicate the murals were braced with two by fours. It is unclear whether the mural were crated in any way or just draped with tarpaulins. Teckmeyer remembers "The murals could not be laid flat for two reasons: first, there would be the danger of scarring the paintings by vibration, since each panel was painted edge to edge. The second reason was that being 12' in width they would extend over the truck and be in danger of being hit by passing vehicles as they were being transported." Teckmeyer goes on to discuss the "white glove treatment" the murals received during shipping. "The Capital Transfer Company selected their most reliable employees to do this work, and the commission agreed to furnish white gloves to each person who was to handle the panels. Before moving any of the panels these transfer company employees were given a lecture as to how much care should be taken in handling each piece and they became as much interested in the success of the transportation as those of the commission who were very much interested that they be transported without damage. The entire program of transportation was handled very successfully and according to schedule."[28]

Benton found himself unable to watch the entire process, leaving before the Indiana murals were lowered to the waiting trucks. He had had previous experience with just this kind of move during his New School project. Considerable damage had occurred when the relatively light-weight, 2-by-4-inch framing and wall board support on which the New School murals were mounted buckled when being moved by crane into the third-floor board room for installation. The substantial support system for the Indiana murals was probably in a direct response to that earlier experience.[29]

When the Indiana Pavilion closed, the murals were once again collected by the Capital Transit Company, returned to Indianapolis, and stored in crates at the Capital Transit warehouse for one year. When the budgeted funds for the project ran out, a new storage area had to be found. The murals were shipped to the Manufacturer Building at the State Fairgrounds in Indianapolis, where they remained, crated, in essentially a barn, until October 1939.[30] They were quietly on their way to even less commodious storage, the Poultry Building at the fairgrounds, when ownership of the murals was transferred to IU.[31] The murals were moved to Bloomington and stored, uncrated, for a few months in the engine room of the university power plant located some four blocks from the new Auditorium.[32]

The uncontrolled climate in storage over a period of six years surely affected the condition of the murals. Paintings of any size and complexity of structure change dimensions (expand and contract) in response to changes in temperature and relative humidity. Benton's murals suffered the worst kind of extremes during six years of seasonal changes, not only experiencing the dimensional changes associated with diurnal temperature cycles and humidity, but also the extremes of Indiana's climate, from the hot, muggy summers, when they surely would have expanded from the heat and absorbed moisture from the air, to the freezing winters, when the absorbed water would freeze and expand while the overall structure would contract. Under these conditions, it was inevitable that the structural integrity of the murals' hygroscopic materials would be compromised. The extreme storage conditions could, in part, be responsible for the breakdown in the areas of the structurally compromised ground layer.

Installation of the Murals at Indiana University

When it was time to install the murals in the IU Auditorium's Hall of Murals, the individual panels were hand-carried by twenty men the four blocks to the Auditorium. Betty Savesky recounted the installation of the murals in her March 22, 1941, article in the *Indiana Daily Student:* "The entire lobby had to be scaffolded to put them up, then they had to be cleaned and varnished before they could be placed. Benton made two trips to the campus to supervise special adjustments on them. It took 20 men to handle each panel and a gross of white gloves was used in the task." [33]

Benton's Murals of the Thirties

Visits to Jefferson City, Missouri, to view Benton's 1939 murals in the Senate Lounge of the Missouri State House; to New Britain, Connecticut, to view the Whitney murals of 1932, now at the New Britain Museum of American Art; and to New York City to view the New School murals of 1930 (now at the Equitable Assurance Company) helped elucidate the aesthetics and inherent condition problems of Benton's work. The visual impact different conservation techniques had on that group of paintings also was assessed.

Technically, the Indiana murals are an anomaly within the group. The New School and Whitney murals have more highly textured ground layers. The Whitney murals, the second in this series, are the most highly textured of the group, with Benton literally building up the ground in areas of highlights, creating a three-dimensional picture plane. In the Indiana murals, the ground layer remains comparatively thick and textured, and there is no hint of the canvas below the paint and gesso layers. However, we see Benton beginning to move away from the highly textured grounds that deny the use of canvas at all. This trend culminates in the Jefferson City murals, the last of the group, where we find a thin, finely textured ground with the weave of the canvas visible through the paint film.

The New School, Whitney, and Jefferson City murals all have highly developed compositions realized through multi-layer paint films, incorporating glazes and painted with more extensive and vibrant palettes than the Indiana murals. The use of color and glazes produces a transparent and luminous paint surface. Benton's Indiana work is more extemporaneous and is painted in a very thin, almost intermittent layer. In many areas the underdrawing is visible and forms an integral part of the image. Still other areas remain unpainted. It is tempting to speculate that the project's abbreviated timeline necessitated Benton's minimalist approach in creating and executing the Indiana murals. More likely, the exhibition parameters of the Indiana project determined the outcome: the murals were to be viewed from ten feet below. The other mural projects of the thirties were conceived for more intimate spaces, where the painting surface and the added detail were visually accessible to the viewer and consequently important to the success of the composition. Such a detailed paint layer would have been lost on the viewer of the Indiana murals. Benton needed bold, high contrast, gestural strokes executed in strong uncomplicated color for the image to be successfully viewed from the floor below.

All of Benton's murals of the thirties have undergone extensive conservation treatment (some by Benton himself) and they offered examples of several different combinations of modern and traditional adhesive/consolidants and varnishes to compare with what we considered, while not an original varnish layer, at least one using Benton's original varnish system. It is probable that these treatment campaigns affected the murals' original appearance, and we can only speculate about their original surfaces, aided by Benton's own handwritten instructions about his intent in the final appearance of the murals.

The murals on the Indiana campus alone have been treated with at least three different types of consolidants and two different synthetic varnishes. Testing of the Auditorium murals revealed that a synthetic, methacrylate-based varnish had been used as a final varnish over the egg, mastic, and wax scheme Benton had requested. The use of this material is not documented, and it is unclear when it was applied to the surface of the murals.

While Benton eventually moved away from traditional old master natural varnishes, opting for synthetic paints and varnishes later in his career, at the time he painted the Indiana murals he was still deeply entrenched in the old master aesthetic and might have objected to a varnish with different reflective qualities. Regardless of Benton's personal choice to move to synthetic varnishes later in his career, the goal of conservation campaign was to preserve Benton's original intent of 1933.

Previous Restorations

Benton came to Bloomington in September 1940 and again a month later. He worked with Eggers and Higgins, the Auditorium architects, in resizing the murals, several of which had to be trimmed in order to fit the space. The canvas on the trimmed panels was secured to the support panels with nails through face of the painting. Some edges needed to be repainted in order for the image to blend, once again, into the adjacent panels. Benton also directed, but did not actually participate in, an unplanned cleaning and restoration that took place at the time of installation.

It appears that Benton had recommended revarnishing the murals during his October visit. Benton received a letter dated November 20, 1940,[34] from the architects informing him that the coat of varnish done at his request "has not gone satisfactorily." They stated, "It has made the canvas wrinkle badly and the varnish has not dried but still remains in a tacky condition. The worst feature, however, is that the varnish has given the canvases such a high gloss that it is most difficult to view them satisfactorily because of the spectral reflection...."

Benton was skeptical that the application of varnish could have caused the canvas to wrinkle and was puzzled by the failure of the varnish to dry. In his November 22 response,[35] Benton writes, "The mere application of the varnish should have no power to wrinkle the canvas. I am at a loss to explain that. The only thought that comes to me is that during their years of storage the panels absorbed a good deal of moisture and that too rapid application of heat to their surface occasioned a too rapid drying out." On the varnish, Benton speculated about his decision to leave the original wax coating on the murals before applying a new layer of varnish, conceding no option but to remove the newly applied tacky varnish with alcohol.

Benton adds, "This trouble is a pain in the neck for me. The panels were in perfect condition except for a few surface scratches when I saw them in Sept. and later in October. I suppose I should have let them alone even though they needed cleaning. P.S. Be sure and get in touch with Mr. Engels [sic] on this. He can be a great help in watching the workers--seeing that care is taken."

Not quite ready to let the matter sit, Benton wrote Egger and Higgins on the following day, in defense of his request to revarnish and (likely of his skill as an artist): "I happened to remember that several years ago I had a painting which had been waxed and over which I later put a coat of new varnish. I remembered this as drying perfectly. In order to make the test I came out into the studio and put a coat of mastic varnish over a waxed painting which I have here. This morning it is dry and hard. Some conditions which I do not understand are involved in the Indiana murals.... There may be something in the preparation of the Weber wax (it is called Mat-Var) which will not take a new varnish coat. It might be good to get in touch with Mr. Weber on that."

"Mastic varnish, the one used on the murals, is soft and responds immediately to alcohol.... When my easel paintings get dirty, as they frequently do travelling around exhibitions, I clean them with alcohol as indicated here. I have never yet damaged a painting. The egg film protects the paint. It is easy to put on a new coat of varnish and wax. After you have cleaned the varnish off the Indiana murals be sure to test the application of new varnish on a small spot. If it does not dry in 24 hours, there is no use in putting it on."[36]

The mystery of the wrinkling canvas remains. The murals bare no physical evidence at present that the canvas support had wrinkled at any time. Surface texture can sometimes be mistaken for a distortion of a painting's support structure. Thus the inconsistent and sometimes highly textured ground could have played a role in the interpretation of a "wrinkled canvas." The early panels, *The Mound Builders* through *The Pioneers,* have marked, complex, branched linear cracks radiating vertically through the gesso layers to the canvas support. These cracks are visible in the earliest photographs of the murals and appear to have formed before the panels were painted. The cracked areas in *The Pioneers* panel were sanded and scored to better blend with the surrounding texture before the painting began. Benton, also, in his letters to the architects, offers no instruction in the treatment for such a condition. With his penchant for preservation, this suggests to the writer that the "wrinkling canvas " was a non-issue once the murals were resurfaced.

In 1956, Benton returned to the IU campus to consult with workmen from the university's Department of Building and Grounds, who were preparing to clean the murals. After two days of "experimentation" Benton arrived at the appropriate cleaning method to be used.

This time Benton cautioned not to be too aggressive when using a 1:1 solution of "oleum and acetone" and left handwritten instructions for the restoration process. This could suggest that the damage from chemical abrasion seen in the 1997 examination was a result of the 1940 cleaning, when Benton states that the egg yolk coating would isolate and protect the paint film from the rigors of the cleaning process if done carefully. Donald H. Horton, then manager of the Auditorium, recalls that after removing the old varnish "the panels were allowed to dry before being painted again with a solution of egg yolk and water and covered with another coat of varnish. The entire job took two weeks and used up six dozen eggs. But the results were well worth the trouble. The murals have regained their original brilliance, and certain delicate shadings were easily visible for the first time in several years, Mr. Benton remarked, upon inspecting the murals; he asserted they will probably last as long as this building lasts"[37].

Current Conservation Treatment

Those early cleaning campaigns (1940, 1956), initiated by Benton and carried out by untrained faculty and students from the IU fine arts department and workers from buildings and grounds, were uneven and had left the already fragile paint layer in peril. The combination of the solvents and rubbing left the paint layer under-bound and badly abraded. As the thick, unevenly applied surface coatings aged and shrank, they pulled at the paint surface, and by 1998 nearly thirty percent of the paint and ground was lifting from the wall. The surface coatings also had discolored, blurring the detail and distorting the spatial relationships of the composition.

Based on their earlier condition survey and treatment proposal the contract to conserve the murals was awarded to Radecki and his conservation team from the Indianapolis Museum of Art. Linda Witkowski and Liisa Merz-Lê alternated on a bi-weekly basis as site supervisors. The IMA team's approach to the conservation and restoration of the murals was initially vetted by the author, presented to and approved by the steering committee. Changes to the original proposal were made in consultation with the author. Aesthetic issues associated with the treatment were made in consultation with the author and Foster. The conservation team reported to the author and Winston Shindell, Executive Director of the IU Auditorium on a bi-weekly basis about the project scheduling and progress. The author made daily site visits and attended weekly contractors meetings in order to insure the careful coordination of the conservation team's needs and activities with those of the general and other contractors on site.

Part 2: TREATMENT DEVELOPMENT AND EXECUTION
by Martin Radecki

In the fall of 1997, Danaë Thimme, the head conservator at the Indiana University Art Museum, contacted the Indianapolis Museum of Art Conservation Department about the conservation needs of eight Thomas Hart Benton murals that were part of the main lobby of the Indiana University Auditorium. A long history of collaboration between Danaë and the conservation staff at the IMA had already included the conservation of two other sets of Benton murals on the IU campus. Danaë and other key members of the Indiana University Art Museum staff (Margaret Contompasis, painting conservator; Kathleen Foster, curator; and Adelheid Gealt, museum director) became very concerned when they learned about plans for the renovation of the auditorium building and that the eight Thomas Hart Benton murals in the lobby had not been considered when the renovation plans were created. They convinced the university that the murals needed to be considered in the renovation process, and worked diligently throughout the project to raise funds for the conservation of the murals.

At the request of the steering committee, the IMA's Regional Conservation staff (Linda Witkowski, Liisa Merz-Lê and Martin Radecki) conducted a one-day survey to assess the condition of the murals and prepare a preliminary treatment proposal. Their extensive experience with large mural projects enabled the IMA conservators to also provide suggestions how the university might proceed in coordinating such a large-scale conservation effort. This was of benefit because a key component in the preliminary planning was the fact that the renovation of the auditorium had to progress as scheduled, and that the murals' treatment had to be carefully coordinated with the building renovation schedule.

The university, as a state institution, required the contract for the murals' treatment to go through a bidding process. Three conservation groups were asked to bid on the project, two of whom eventually dropped out of the bidding process. The Indianapolis Museum of Art Regional Conservation Services was awarded the contract. The estimate for the entire project was just under one-half million dollars.

With a project of this scope, many issues had to be coordinated between the university architect's office, the contractors, and the university committee overseeing the murals during the renovation and the treatment process. Margaret Contompasis was the key person coordinating these details—especially those that insured the stability of the environment immediately affecting the murals. The main concerns with which we had to deal included: the installation of an adequate fume exhaust at the project site; the provision of a substantial temporary flooring to support our rolling work scaffolding; and an adequate electrical supply to allow for enough power to illuminate the work space properly.

Project Site Specifications

The murals are located in the main lobby of the auditorium, and each mural is H 12' x W 18' with the bottom of the murals 15' from the floor. In order to keep them in a proper environment during construction, a temporary room to encase the murals was built by erecting scaffolding up from the floor of the lobby and laying a floor composed of a plastic vapor barrier and plywood. This floor was 18" from the bottom of the murals, and two sets of rolling scaffolding were erected on it from which the conservators would work. The university installed a portable HVAC system in the mural room to maintain a proper humidity and temperature range.

Fume Extraction:

It was clear from our first tests that the use of a significant amount of hydrocarbon solvents might be needed in the treatment process. This led us to contract with a mechanical engineering company to design a snorkel exhaust system for the project. The exhaust system was designed to provide 125 cfm of exhaust out of four snorkels per rolling work scaffolding. The exhaust fan was mounted on the floor below to keep noise and vibration to a minimum. Exhaust ducts were in 10-foot sections with built-in rubber gaskets that allowed the sections to be easily fit together and thus accommodate any placement of the working scaffolding. As designed, the exhaust system worked well; however, for the design of similar systems in the future, 250 cfm (or more) per snorkel would be more effective. This could be baffled down to a lower level of exhaust if necessary.

Lighting:

Basic work lighting was provided on each scaffold by eight double lamp fluorescent fixtures lamped with GE Chroma 50 and 75 fluorescent tubes. General illumination was from halogen work lights, and photofloods bounced off photo umbrellas. Scandles photolamps with Philips 24 P1-L lamps were used for auxiliary light during inpainting.

Treatment

Consolidation

It was clear from our preliminary examination of the murals that the most difficult part of the treatment would be the consolidation phase. The paint has an egg medium— most likely egg white, based on its sensitivity as well as references in some historical documents (its actual composition, however, is still undetermined). The paint is more like a thin film, and when it cleaved away it curled back onto itself in many instances. The film was also quite brittle so any pressure against the lifting paint layer would cause it to break off.

Testing was done with the consolidants normally used in setting down cleaving paint layers. 5% gelatin in distilled water yielded the best results in the initial testing because the higher moisture content and temperature relaxed the lifting paint so it could be manipulated back down. Use of the gelatin did present some problems, however. Because of the viscosity of the solution, the extent that it penetrated into the ground layer was a concern. Liisa Merz-Le, who had used isinglass extensively when she was a mural conservator in Germany, tested isinglass for possible use on this project. She found that a 2.5% solution of isinglass was stronger than the 5% gelatin and was far superior in penetrating into the ground layer. The penetration factor of the isinglass had the added benefit of basically negating the need to remove the excess as had been necessary when gelatin was used.

The fragile nature of the paint layer required that an application method be devised that would allow for the minimum amount of pressure to be exerted against the paint layer. The use of a watercolor fan brush was generally successful in applying the gelatin or isinglass, but in areas where the cleaving paint was highly concentrated it was difficult to apply the consolidant and not break off tips of the cleaving paint. It was suggested that a spray application of the adhesive would be a better method. This was very successful and became the preferred method of application.

There was a general consensus among the IMA regional conservators that the isinglass alone would not be enough to stabilize the murals' cleaving problem over a long period of time. Based on their extensive positive experience using dilute Beva D-8 1:1 with water in consolidating other murals and easel paintings, the conservators conducted tests to determine if the Beva D-8 would also be effective on the murals. The results were very successful and it was decided to use the dilute Beva D-8 as a secondary consolidant in this project.

The solution of how to consolidate the cleaving paint was the most unique part of the treatment. Following is a step-by-step description of the consolidation process.

1.) A manageable area approximately 6"x 6" was sprayed with a warm 2.5% isinglass solution applied with an airbrush. The solution was applied until the area appeared visibly saturated. Drips were wicked away with a large cotton swab.

2.) The isinglass was allowed to set for five to ten minutes. A #3 round watercolor brush was then used to coax each flake of cleaving paint back into proper alignment. The warmth and moisture of the isinglass relaxed the paint layer to make this manipulation possible. In some cases the paint went back into plane on its own. In other areas, additional applications of the isinglass solution were necessary before the paint would relax so it could then be worked back down with a brush. Excess isinglass was removed with saliva applied on a large cotton swab applied in a rolling motion.

    The isinglass penetrated the ground layer more effectively than the gelatin and it was felt that it was as strong as the more viscous gelatin solution. The drying time of ten minutes before manipulation of the cleaving paint was crucial. If attempted sooner, the paint layer would not be soft enough and the ground layer would be too soft.

3.) The area was allowed to dry for three to four hours (or overnight). The isinglass was then heat set with a heat spatula or a Leister hot air gun set on .5. Some of the murals had very irregular surfaces and on these the use of the Leister hot air gun was a necessity. After warming an area, pressure was applied with the fingertips through a fine Japanese paper.

4.) In the areas where the cleavage was most severe, an application of 1:1 Beva D-8 was applied with a brush after the cleaving paint was coaxed back down and the isinglass had dried for 20 minutes. The excess Beva D-8 was immediately removed using cotton swabs dampened with triammonium citrate (pH 7) or distilled water with a pH adjusted to 7. This was done to insure that the cleaving would not reoccur since the egg yolk surface coating (which was thought to be the major cause of the cleaving problem) could never be safely removed.

5.) During the consolidation process the majority of the grime layer was removed from the murals.

Cleaning

Benton's intention that the egg yolk coating would protect the murals (as described previously) did not work and numerous abrasions had occurred during the previous cleaning attempts. Inexperienced hands had been responsible for the prior wax and varnish removal, resulting in very uneven cleanings. A number of the murals had a heavy build up of wax and varnish, while other murals were thoroughly and, in most cases, harshly cleaned, resulting in areas of abrasion. These murals had only a relatively thin layer of the most recent wax and varnish coatings.

As the result of numerous tests, the safest method for removing the surface coatings proved to be toluene applied on large, hand-rolled cotton swabs. The first passes of toluene broke down any remnants of the Beva D-8 layer and began to soften the wax coating. The subsequent passes of toluene removed the majority of the wax and the grime layer that had become embedded into the wax. The later passes of the solvent appeared to remove the most recent mastic varnish coating. Three to six total passes of toluene would be necessary before the cotton would not pick up noticeable wax or varnish coating. The large swabs were used in a rolling method, or one in which little pressure was applied against the surface due to the easy abrasion of the paint layer.

The cleaning was stopped when no discernible wax or varnish came away on the cotton swab, or if any degree of paint sensitivity was noticed. No pattern could be determined as to what areas would clean easily and what areas would be problematic. The same color would easily clean in one area and with more difficulty in the next. Generally, on Panels IX and VII the light colors cleaned easily and appeared to have less surface coating. The dark blues and blacks were more difficult in areas and normally had heavier layers of the surface coating. To further complicate the process, many areas would be blanched after the wax and varnish had been removed, and this blanching had to be reversed.

- Proposed Theory for the Paint Layer's Varying Reaction to the Cleaning Treatment:

A. The previous cleanings, which had been undertaken by Benton, faculty and students from the fine arts department, were uneven. It seems very plausible that more attention was paid to the light colors, thus leaving more layers of surface coating on the darks.

B. The white paint in many areas seems to have more of a medium paste to a rich vehicular consistency. This smoother surface made it easier to remove the surface coatings. The darker colors (dark blues and blacks) in some areas have a lean vehicular consistency and were more difficult to clean without causing bleeding from the paint. What must be remembered is that there is no consistency in how the paints were mixed: some white paints are lean and some dark paints are rich in medium.

C. A combination of both of these factors.

Blanching Problem and Reversal Solutions

The reason suspected for the surface blanching is that toluene leaches out products of the initial egg yolk coating or remnants of an earlier mastic coating. This creates microcracks in these coatings that refract light, causing a white haze to appear over the paint surface. It is surmised that because the previous cleanings are so irregular, it is likely that all the wax had not been removed; this is why the later coating of mastic varnish can be removed easily with toluene. The wax has either combined with the mastic to change its solubility, or it comes away when a wax layer beneath it is dissolved by the toluene. Visual examination during the cleaning process appears to corroborate this theory.

- Methods for Reversing the Blanching

  Many methods were tried to safely reverse the blanching:

  1. Rolling Keck II on the blanched areas worked well in many places but was not successful overall. There was also the problem that with prolonged application, paint could be removed.

  2. 1:1 isopropanol and water was also used to reverse the blanching and was very successful in many areas, but occasionally the blanching reappeared the next day.

  3. Water followed by toluene was effective in some areas but caused further blanching elsewhere.

  4. Water was used in conjunction with Keck II which proved to be very successful. The method of application was first to apply the water and either allow it to evaporate or be wiped dry with a cotton ball, followed by rolling on of Keck II into the area. This reversed the blanching almost completely and it did not return later. Because of the success of this procedure the thought of using Keck III to reverse the blanching was set aside.

  Because of the variation found in the paint and the inconsistencies of the past restorations, it was anticipated that use of more than one of these methods to reverse the blanching would be necessary.

After completing the removal of the wax and varnish layers, the conservators' attention again focused on the egg yolk layer that Benton had applied as a protective coating on the murals. This layer had been very unevenly applied, and with the discolored surface coatings now removed its visual disturbance was increased. The initial methods tested to reduce or remove the egg yolk layer proved to be only minimally effective. Since the egg yolk coating had a significant role in the cleaving problems of the paint layer, it was still felt that its removal would be beneficial. Additional testing was done to determine if enzymes could be employed to reduce the egg yolk coating where it was the heaviest.

Enzyme Testing

Lipase mixed in a 3% solution of methyl cellulose was applied to three small areas in Panel IV (the sky in the upper right quadrant) where the egg yolk coating was very prominent. The enzyme solution was applied to each of three 1½" x 1½" areas with a small brush and allowed to set for 15, 30 and 45 seconds respectively before being removed with a cotton swab and distilled water.

- Test Results:

  The 15- and 30-second set times did not allow enough time for the enzymes to react with the egg yolk layer, but the 45-second set time was adequate for this to occur.

  On the first area, an overall even yellow layer was removed but egg yolk remained, thus keeping the area yellow but changing it from a deep to a medium tone. On the second and third areas, the application of the egg yolk had been uneven, and the results were that an uneven layer was left. In the third test spot, paint came away with the portion of the egg yolk coating that was dissolved.

Following the same procedures outlined above, the enzymes were also tested on the unevenly coated areas of the dark blue paint. The results were even less satisfactory.

- Conclusion:

  The enzymes tested would only be partially successful where they worked. Due to the uneven application of the egg yolk layer, the benefit from attempting to reduce it would be minimal and the danger to the mural significant. These findings were conveyed to Margaret Contompasis who agreed that reduction of the egg yolk layer should not be attempted.

Second Phase Cleaning

In many instances, the first phase cleaning left remnants of wax and varnish due to the softening of the paint layer from successive applications of toluene. It was necessary to stop cleaning in some areas or risk abrasion of the paint layer. Second phase cleaning was planned after the paint had hardened again so the remnants of wax and varnish could be further reduced, bringing the surface of the murals to an even appearance. Toluene was the only solvent needed for the second phase cleaning; this procedure went very smoothly and without a major time demand. The only unusual factor was that there were still remnants of Beva D-8 from the consolidation phase in some areas. It was presumed that any residue of the Beva D-8 would be removed in the initial cleaning and, although the residues were not extensive, it was a surprise that they remained. The Beva D-8 was removed with toluene but it was not as readily soluble as in the initial cleaning.

Varnishing

The determination of what varnish to apply to the murals was a major concern from the beginning of the project. To aid in the decision making, test panels were constructed using an egg white medium and pigments. Half of each panel was coated with mastic and wax, and the other half with various coatings to determine which gave an appearance similar to Benton's varnish and wax coating. Matvar (the Weber product) or its formula could not be found, but Lance Mayer provided a copy of a letter written by Benton in which he gave the formula for the wax coating used later in his career. The formula was comprised of two parts beeswax to one part carnuba. Some of the test panels were coated with commercial furniture wax to determine if the appearance was very different from Benton's later wax formulation.

From this initial testing, 5% B-72 in equal parts of xylene and toluene produced the best results. Kathy Foster and Margaret Contompasis requested that a larger test be done on a section of one of the murals which would then be examined by the university committee overseeing the mural project. Test areas were created as requested, being first brush coated with 20% mastic, then partially covered in Sotheby's paste wax and Benton's own formulation of 2 parts beeswax and 1 part carnuba in naphtha. Both of the areas were partially polished with a silk-covered pad. In addition there were two areas coated with B-72: one a 5% solution in equal parts of xylene and toluene, the other 5% in Shell Sol 53.

The consensus of the committee was that the 5% B-72 in equal parts of xylene and toluene was the closest match to the mastic-covered-by-wax that Benton used. It was this formulation that was approved for use as the isolating varnish layer.

Use of B-72 provided an additional advantage. Because the murals had been badly abraded in previous cleanings, any prolonged exposure to even mild solvents would soften the paint. The need for a stable coating that could be removed with a mild solvent was essential for the murals' long-term preservation. B-72 will likely help stabilize the paint layer which is prone to cleave.

The first layer of the 5% B-72 was applied by brush, and the results varied from mural to mural depending on their condition and paint consistency. One of the murals, "Fur Traders and Pioneers," was badly abraded and took the B-72 coating very unevenly. In contrast, it was a simple operation to attain an even surface coating on the murals that were in good condition. An additional difficulty was that areas of lean paint (such as the dark greens) needed much more B-72 to bring them to the same sheen as the surrounding paint.

Final varnishing after the completion of the inpainting was a spray coat of 5% B-72 in equal parts of xylene and toluene. This coating was applied as lightly as possible to achieve the goal of paint layer saturation while trying to keep the surface coating a imperceptible as possible.

Filling

The major need for filling losses was in the seams between each of the panels, as well as a few scattered nail holes. These losses were filled with GE RTV 162 silicone sealant.

Inpainting

The extent of the inpainting to be done was discussed with the university mural committee. It was decided that all losses and damages would be completely inpainted, and if it could be ascertained what was there originally by referring to historical photographs, abrasions would be inpainted as well. Linda Witkowski planned and oversaw the compensation in these areas.

The abrasions were the most difficult areas to bring into balance. In addition, there were areas of disfiguration where the egg yolk coating had stained the paint layer; these stain lines were glazed to reduce the disfiguration. Inpainting was done primarily with Golden MSA acrylic paints, with some Charbonnel Restoring Colours used for particular needs. LeFranc and Bourgeois Medium pour la Restauration 3580 or 20% B-72 in xylene were used to increase the gloss of the paint.

Conclusion

Given the size of the murals and the extent of their structural and visual problems, the treatment enlisted the assistance of 30 conservators who came from all areas of the country. We are most grateful for their skill and professionalism. The project was completed in seven months, on budget, and without impeding the renovation of the auditorium.

We were particularly pleased with the success of the consolidation process. During subsequent phases of the treatment, there was no need to repeat the consolidation procedure in any area. Although the egg yolk coating could not be safely removed, the murals appear visually even as a whole and remain color balanced within themselves, as well as within the auditorium lobby in which they are displayed.

Acknowledgements

Conservators and conservation interns participating on the Benton mural project were: Dorothy Alig, M. Randall Ash, Sharon Battista, James Bernstein, Barbara Buckley, Neil Cockerline, Margaret Contompasis, Jean Dommermuth, Hélène Gillette-Woodard, Dawn Heller, Janet Hessling, Claire Hoevel, Liisa Merz-Lê, David Miller, Dee Minault, Laura Paulick, Robert Proctor, Martin Radecki, Monica Radecki, Laura Reutter, Bonnie Rimer, Catherine Rogers, Annette Rupprecht, Michael Ruzga, Cynthia Stowe, James Swope, Judith Sylvester, Jill Whitten, Linda Witkowski, Susan Wood. Special acknowledgement to Sue Dupuis, IMA conservation department senior administrative assistant, for her coordination of the logistical aspects and the budget for this project.

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[1] The steering committee included Adelheid Gealt, director, Indiana University Art Museum (IUAM); Winston Shindell, executive director, Indiana University Auditorium; Robert Meadows, assistant vice president of facilities and university architect; Danaë Thimme, associate director for conservation, IUAM; Margaret Contompasis, painting conservator, IUAM (committee chair); and Kathleen Foster, curator of nineteenth- and twentieth-century painting, IUAM.

[2]The initial examination team consisted of Martin Radecki, Linda Witkowski, and Liisa Merz-Lê. In addition, other participants in the project from the Indianapolis Museum of Art Conservation staff included: Laura Reutter, Laura Paulick (conservation intern), Suellen Dupuis, Mike Bir (conservation technician), Claire Hoevel, David Miller, Hélène Gillette-Woodard, Dorothy Alig, Emily Radecki (student assistant), and Mark Pease (student assistant). Contract conservation staff included: M. Randall Ash, Sharon Battista, James Bernstein, Barbara

Buckley, Neil Cockerline, Margaret Contompasis, Jean Dommermuth, Dawn Heller (preprogram intern), Janet Hessling, Dee Minault, Robert Proctor, Monica Radecki, Bonnie Rimer, Catherine Rogers, Annette Rupprecht, Michael Ruzga, Cynthia Stowe, James Swope, Judith Sylvester, Jill Whitten, and Susan Wood.

[3]"In conservation, [inherent vice is] any condition in the materials of a work of art that may cause defects to develop as opposed to extraneous causes of decay or damage." From Ralph Mayer *A Dictionary of Art Terms and Techniques* (New York: Barnes & Noble Books, a division of Harper & Row Publishers, xxxx), xx.

[4]Ross Teckmeyer, *Indiana Murals*, 1949: "It developed later that the exhibition hall in Chicago was poorly ventilated and rather damp, so that this painting of the back of the panels prevented their warping or getting into such a condition that they could not be used in the future and after 6 years in storage."

[5]In a January 25, 1933, *Indianapolis Times* interview, Benton told Arch Steinel "how it would be three weeks before he began the work of spraying Gesso, a plaster-like substance and starting the first murals...." "It 'll be a sight, this hall, when we start spraying." IU Auditorium archives.

[6]*Thomas Hart Benton: A Retrospective of His Early Years, 1907 - 1929* (New Brunswick, New Jersey: Rutgers University Art Gallery, 1972), introduction by Philip Dennis Cate, on *Modern America:* "This was the first large scale American work executed with egg tempera," xx.

[7]*The Art Digest*, 15 December, 1932, 7:6, xx (IU Microfilm).

[8]Thomas Hart Benton, *An American in Art: A Professional and Technical Autobiography* (Lawrence, Kansas: University Press of Kansas, 1969), 11.

[9]Ibid., 34.

[10]Ibid., 42.

[11]Cennino d'Andrea Cennini, *Il libro dell' arte (The Craftsman's Handbook)*, is a contemporary treatise on Renaissance painting which has been translated and edited many times.

[12]Thomas Hart Benton, *An American in Art*, 57-58.

[13]Ibid., 67.

[14]December 27, 1932, letter from F. Weber to T.H. Benton (IU Archive).

[15]Size (or sizing, as it is sometimes called) is an extremely dilute solution of a gluey or resinous substance applied to a surface in order to reduce its absorbency or porosity and make it more receptive to application of paint or another coating material. Ralph Mayer, *A Dictionary of Art Terms and Techniques*, 363.

[16]December 27, 1932, letter from F. Weber to T.H. Benton (IU Archive).

[17]Teckmeyer, *Indiana Murals*, 1949, 6.

[18]Wallace Richards, "Information Concerning the Murals of Thomas Hart Benton in the Indiana Building at a Century of Progress," p. 1, Wallace Richards Papers, AAA.

[19]"Art Students actively participated in the demonstration by helping Benton mix the base that he used for his tempora [sic] pigment. As the students shook the glass jar containing equal parts egg yolk, oil and water, Benton nonchalantly smoked a black pipe. The artist started by breaking the egg and draining the white from it, much as a cook does when starting to bake a cake. After cleaning the yolk thoroughly of white, he showed students how to

puncture its thin skin and drain the inner substance from it. Benton told the students that the correct way to mix colors was to take a small amount of pigment, place it on a glass plate and mix the egg base with it. However, his method was to dip his brush first into the base and then into the pigment. After completing the original painting in pigment and egg, Benton covered the entire drawing with a mixture of egg, oil and water. When this dried he used oil paints to bring out certain colors." *Indiana Daily Student*, xx December, 1941, xx.

[20]Wallace Richards, "Information Concerning the Murals of Thomas Hart Benton in the Indiana Building at a Century of Progress," p. xx. Wallace Richards Papers, AAA.

[21]All examination, treatment, and analytical reports are on file at the IU Art Museum.

[22]Teckmeyer, *Indiana Murals*, 1949, 3.

[23]Teckmeyer, *Indiana Murals*, 1949, 4.

[24] Wallace Richards, "Memoranda to the Director, Indiana's Commission, A Century of Progress: Report of Activities in the Preparation of the Indiana Exhibition at the Chicago World's Fair." December 19, 1932–January 27, 1933, 6. Wallace Richards Papers, AAA.

[25]Wallace Richards, "A Thomas Hart Benton Nightmare," p. 2, Wallace Richards Papers, AAA.

[26]Teckmeyer Report , 4.

[27]Walter F. Morse, "Benton's Murals End Brain-Brawn Saga" *Indianapolis Star,* April 6, 1941. IU Auditorium archives.

[28]Teckmeyer, *Indiana Murals*, 1949, 5-6.

[29]Emily Braun and Thomas Branchich, *Thomas Hart Benton: The America Today Murals* (New York: The Equitable Life Assurance Society of the United States, 1985), xx; Benton, *An American in Art*, 67.

[30]June 8,1939, letter to Mr. Ward Biddle, comptroller, Indiana University, Bloomington, Indiana, from Harry F. Caldwell.

[31]A letter dated May 26, 1939, to Herman B Wells, president, Indiana University, from Ross Teckmeyer.

[32]A letter dated February 20, 1940, from Ward Biddle, IU comptroller, to Herman B Wells.

[33]IU Auditorium archive.

[34]IU Art Museum archive.

[35]IU Art Museum archive.

[36]"Take clean rags, moistened with alcohol and rub surface. New rags will have to be continuously on hand. The panels are painted in egg tempera. They have had a preliminary coating with egg yolk and water (that is they were coated with egg and water before the first varnish and wax was put on in 1933.)

Alcohol will not penetrate this egg film so if the cleaning is done carefully, no damage come to the actual painting. After the varnish is completely removed they should be re-varnished and then coated with wax and rubbed down with soft cloth. The wax as you know removes the varnish gloss.

Mr. Engle [sic] of the University Art Dept. would be able to take charge of that."

[37] 6/10/56 article in Indiana Daily Student, author unknown, IUAM archive.

UNVEILING MONET

Mark Lewis

Claude Monet was born in Paris in 1840. At the age of five, his family moved to Le Havre on the coast of Normandy. While still quite young, he developed a talent for drawing and caricature. Around 1860, at the age of twenty he met the artist Eugene Boudin and through him was introduced to a number of artists who regularly made their way to Le Havre to paint the coastline of Normandy.

Monet's mother died when he was still a teenager and his father was unsupportive of his artistic ambitions. He did however, agree to help finance his son's artistic training in Paris under the condition that he enter the studio of Charles Gleyre. Gleyre was a highly respected and successful Academic painter at the time.

Although something of a poor student, Monet spent about a year and a half studying there in Paris. It was during this period that he developed friendships with Renoir, Sisley and Frederick Bazille with whom he was to share studio space with after leaving Gleyre's studio.

By the age of twenty five, two of Monet's paintings had been accepted to the annual salon in Paris. After this initial success, several subsequent paintings that Monet submitted to the Salon where rejected. Seeking another venue to show their works, he and a group of fellow artists put together their own alternative exhibition of the *Society Anonyme* in 1874. The title of one of his paintings shown there, *Impression Sunrise*, led to the entire group being disparagingly christened as "The Impressionists".

As a group, the Impressionists went through some hard times and many of them struggled to make a living through their art. It's hard to imagine with the immense global popularity of their works today, that this art was once considered radical and subject to ridicule.

In Monet's case, it took almost twenty years of economic hardship before his works would become widely desirable and he was finally to receive recognition and financial stability. Back in those early times, success and acceptance weren't the only problems which Monet had to face. During his honeymoon in July of 1870, war broke out between France and Germany. Being of draftable age, Monet fled the country with his bride Camille and lived in London to avoid conscription. His close friend Bazille enlisted and lost his life in that conflict.

It was a difficult time to be penniless and a stranger in London. Still, while waiting out the war, Monet met up with other refugees such as the painter, Pissarro, and the art dealer Durand Ruel. For the next decade, Durand Ruel's patronage would insure a modest degree of security for the artist and his family. While in London, Monet and Pissarro would go off together on painting expeditions and made numerous visits to the National Gallery. Paintings from this period show the artist's fascination with the light and atmosphere of London and the river Thames.

After returning to France, Monet traveled extensively and explored a number of artistic directions but always focused on the nature of light.

> ".. for me a landscape does not exist in its own right, since its appearance changes at every moment; but its surroundings bring it to life-the air and the light which vary continually... for me, it's only the surrounding atmosphere which give objects their real value."
>
> "To me the motif is an insignificant factor; what I want to reproduce is what lies between the motif and me." [1]

Associate Paintings Conservator, High Museum of Art, Atlanta, GA 30309

By the end of the 19th C., Monet was a middle aged man, successfully well off, and his paintings were much sought after. Now that he was financially independent, he was able to explore new possibilities in his art. In the series paintings of the 1890's, he began to examine the changing influence of light on a single subject. Haystacks, Poplars and Rouen Cathedral became the focus for capturing more than just a single, fleeting Impressionist moment. These paintings incorporated the elements of time and change.

For many years, Monet had been planning to return to London. He wanted to go back and paint the places that he had depicted several decades earlier, only this time he would incorporate this new vision that a multiple series of paintings allowed.

So, in the fall of 1899, and in the two winter seasons to follow, he began to paint a series of views along the river Thames. Unlike his earlier stay in London, Monet booked into one of the most elegant hotels of its day, the Savoy. He chose it no doubt for its many comforts, a fine restaurant and most of all for a room with a view. Actually, he booked two rooms; one for paining and the other for sleeping. He brought many canvases with him from France and finally settled upon three different views that he would focus his efforts upon; Waterloo Bridge, Charing Cross Bridge and the Houses of Parliament.

In the mornings, he would begin his day painting the scene from his hotel balcony, looking east towards Waterloo Bridge. The light of the rising sun coming up through the morning mists and fog would transform the scene into endless variations.

Around midday, he would change his point of view and look off from his sixth floor room towards Charing Cross Bridge. Many of these pictures include the dazzling effect of sunlight and reflections glistening on the the water. Later in the day, he would leave his hotel and remove himself to a room set up for him as a studio in St. Thomas' Hospital directly across the river from the Houses of Parliament. These paintings feature the long shadows of a winter sun set low in the sky. Many of them depict the colors of the setting sun filtered through the industrial smog and pollution of 19th C. London.

The atmosphere of London at that time was remarkably foul due to the burning of sulfurous coal which fueled industry and heated houses. The combination of light, smoke and fog created a psychedelic effect which fascinated Monet. He once told an interviewer:

> "The fog in London assumes all sorts of colors; there are black, brown, yellow-green and purple fogs, and my interest in painting is to get the objects as seen through these fogs." [2]

and on another occasion:

> "I like London so much, but only in the winter. In summer, it's fine with its parks but that's nothing compared to the winter with its fog, because, without the fog, London would not be a beautiful city. It's the fog that gives it its marvelous breadth." [3]

Judging from the letters he sent home to his wife, this process of capturing the changing effects of light was a frustrating process. He would begin on one canvas to capture just that particular effect of atmosphere and the light would change and he'd be forced to start another. As the days went by, he accumulated more and more of these unfinished sketches, until at one time, he had about 100 of them in progress.

> "Each morning it's the same, I get carried away until the weather gets in my way. Today, a day of terrible struggle, and it will be the same until I leave. Only I need more canvases; because it's the only means of achieving anything. Starting them in all weathers, all harmonies, it's the only way. At the beginning of each, you think you will find the effect again and be able then to finish them."

and:

> "I don't need to tell you that I work like a madman and that's the right term as you know, and if it weren't

for my evenings out and dinners in town, which are rather frequent, I would become stupefied with it." [4]

As it transpired, Monet wound up making three trips to London, hauling his incomplete paintings back and forth like so much baggage. In the end, he took them all back to his studio at Giverny. Between 1901 and 1904, he worked on them there trying to finish enough of them for an exhibition at Durand Ruel's gallery. The year before the exhibition, Monet wrote to Durand Ruel:

> "No, I'm not in London except in thought, working steadily on my canvases, which give me a lot of trouble. I cannot send you a single canvas of London, because for the work I am doing, it is indispensable to have all of them before my eyes, and to tell the truth not a single one of them is definitively finished. I work them out all together and I don't yet know how many of them I will be able to show. One day I am satisfied, and the next, everything looks bad to me." [5]

The London Series were finally exhibited in 1904 which was a great success. Many of the pictures were sold to notable collectors and several were purchased for museums. Even after exhibiting them, Monet is known to have reworked and changed a number of these paintings. It was at around this time period that he told an interviewer:

> "Most people think that I work fast. I paint very slowly. I am never content with my work. I let a picture go because I would work on it forever if I did not." [6]

Claude Monet went on to become one the most acclaimed artists of his time. In the first quarter of the twentieth century, he developed his marvelous gardens at Giverny, where he painted his famous Water Lily series and lived on to the ripe old age of 86.

In 1960, the High Museum of Art in Atlanta acquired one of Monet's London paintings which was first shown at The Durand Ruel Exhibition of 1904. *Houses of Parliament in the Fog* is dated 1903 and is one of the highlights of the collection. While certainly still a beautiful painting, it looks quite different from the way it did when it was first shown in 1904. Sometime after the exhibition, this painting was extensively reworked by Monet. A black and white photograph of the painting, which was taken at the time of the exhibition, shows the work to have been originally signed and dated at the lower left. In the final version, the signature appears on the lower right edge. The earlier version was painted with much less of a foggy effect. Shapes of the buildings, boat and water were more sharply defined and contrasted.

Another significant change in the painting's appearance is due to its having been glue lined many years ago. Although this appears to have been skillfully done, much of the rich impasto surface, with its numerous reworkings, has been severely flattened. Although this isn't immediately evident to the casual viewer, it's quite obvious in raking light. It also seems likely that Monet himself would notice the difference.

It is documented that Monet once showed the American artist, Lila Cabot Perry, two of his Rouen Cathedral paintings. One of these had always been kept in an enclosed wooden box, and the other hanging on a wall. The one which had been protected in its case had a richly encrusted impasto surface; whereas the one on the wall had become very smooth and lifeless in comparison. Monet lamented the changes that the latter one had undergone as a result of time and atmospheric changes. [7] Monet went so far as to have long flexible brushes custom made for him to build up the kind of textured surfaces he was after. One has to imagine that Monet would not be an advocate for the lining of paintings.

Another alteration that has very much changed the way this painting looks, is the addition of a natural resin varnish. The effect of this varnish is twofold; it has changed both the color and saturation. The yellowing of the natural resin has shifted the color scheme. The cool intensity of the blue violet tonality has been lost by the optical mixing of its compliment on the color wheel. While walking through the Louvre, Monet is on record as having said:

> "The patina, the varnish, what horrors! Do you believe the gold colored Rembrandts? What nonsense... Varnish is death to the color." [8]

More significantly, from about 1880 on, Monet clearly preferred to leave his paintings unvarnished. The optical effects that he was working so hard to capture, relied upon a matte, unsaturated paint surface. A visitor to his studio at Giverny recalled seeing the artist squeeze his tube oil paints onto blotting paper to remove some of the oil prior to painting. The resulting paint would tend to be quite lean and matte in appearance. In 1886, he was quoted as hating the change that varnishing caused in his paintings. Late in his life, when he donated the L'Orangerie *Water Lilies* to the French Government, Monet stipulated in the contract that they could never be varnished. [9] It seemed clear that the shiny, yellow saturating varnish on the High Museum's *Houses of Parliament in the Fog* was probably not what the artist intended.

Sometime before 1997, it had been noted that the painting had developed a number of small blisters in the central portion of the painting. The climate control system in the current building is quite good, but the South is subject to severe weather and subsequent power outages. Could a sudden and severe shift in relative humidity have caused internal stresses within the painting that led to inter layer cleavage?

Upon close examination, it was obvious that like many of the other London paintings, the surface had been reworked several times; first in London, then back at the studio, and after the exhibition, at which time the signature was moved. How much time elapsed between applications of paint? Could differential drying rates have set up internal stresses within the paint film? Could the glue paste lining be a factor? So, was the problem caused by inherent vice, environmental factors or both?

In many respects, the painting is in very good condition. There aren't any shrinkage cracks and only a few age cracks despite the fact that there are some thickly applied passages. In his choice of materials and techniques, little fault can be found.

Although the reverse of the original canvas is not visible due to the glue lining, Monet typically bought his canvases pre-primed and didn't seem to add any extra layers of ground. He acquired them from a number of Parisian colormen of which there were many. He is known to have used paints and prepared canvases from the firms of Mulard, Hostellet and Lechertie. [10]

French canvases were typically woven of linen and were readily available in at least six different weights and fineness of weave. The bare canvas would have been given a substantial coating of animal glue size prior to a lead white ground bound in oil. An artist could order his canvas single or double primed. The texture of the fabric and the ground would very much affect how the paint would catch on the surface, particularly in the Impressionist style brushstroke. Absorbent glue grounds, although less commonly used by the Impressionists, were also available.

It is often thought that the Impressionists, and Monet in particular, only painted on white grounds. While Monet did favor white grounds in most of his later work, before 1890 he is known to have used a variety of toned grounds. Although usually light in color, he utilized grounds which were cream colored, a warm beige, light gray or light brown on a number of paintings. *The House of Parliament in the Fog,* was painted on a plain white ground.

In an attempt to better understand the materials used in this painting, several samples were collected from losses around the perimeter of the painting. These samples were then prepared and photographed by James Martin at the Williamstown Regional Conservation Center. It was hoped that this might shed some light on the current problem of paint cleavage. The sample, (in figure 2, left side), was taken from an area of blue sky along the outer margin. In cross section, the ground appears to be composed of lead white and chalk. SEM EDS analysis confirmed this observation. When the sample is viewed under ultraviolet, (figure 2, right side), it is easier to see that there are several paint layers. This would seem consistent with Monet's extensive reworking. Directly above the paint layers, you can see the brightly fluorescing natural resin varnish. On top of this is a dimly fluorescent gray layer, which appears to be a synthetic resin consolidant.

Unfortunately, no samples could be collected from the areas that were actually delaminating. There weren't any actual losses associated with the cleavage problems in these areas. The cause of this problem is still unclear. Here are some of the possibilities which have been considered:

First, there is Monet's technique of reworking this painting over several years. This may have set internal stresses due to the different drying rates of subsequent paint layers. A common example of this sort of thing shows up in other paintings as shrinkage cracks. Paint additives and adulterants, which show up in 19th C. artist materials may also play a hand. When artists stopped making there own paints and gave that task over to professional colormen, a certain measure of control over their materials was lost.

In research conducted at the National Gallery London, medium analysis of Monet's paintings from the 1870's and 80's show primarily linseed oil in two forms, regular and pre-polymerized.[11] Poppy oil was also found, which would be slower drying and less likely to yellow. It was often recommended for alla prima work, although it can form a paint film which is more susceptible to cracking. He did not seem to make use of a number of resinous paint mediums which were readily available and widely used at that time.

19th C. advances in chemistry greatly expanded artist's palettes with a range of newly synthesized colors. Unfortunately some of these pigments and dyes turned out to be unstable. Monet himself is known to have commented on the "dreadfully unstable chrome colors." [12]

In light of Marion Mecklenberg's work on the response of various art materials to changes in temperature and humidity, it is likely that the root of this blistering problem is related to animal glue. Besides the initial sizing layer on the canvas, there is, at this point a rather substantial layer of highly reactive and hygroscopic glue which was used to line the painting onto its current canvas support. At low relative humidity, glue loses moisture, becomes brittle and contracts. As the underlying layers contracted, the upper most layers of paint and ground could have been pushed up, which commonly is seen as tenting. In this case, perhaps the paint layer was malleable and cohesive enough to form blisters. Another possibility could have been the tendency for a tightly woven canvas to shrink when it absorbs a sufficient amount of water. When the painting was glue lined some years back, the heat and steam generated in that process could have contributed to this kind of shrinkage and internal stress. Perhaps these blisters formed at that time but were ironed back down in the process.

The blisters are located exclusively in the middle of the composition and are always horizontal in orientation. It could be possible that the loosely woven weft threads of the canvas support may have contracted more than the tightly tensioned warps. The central location of the blisters may be related to the fact that the tension of an aged canvas on a stretcher does tend to drop off as it approaches the central part of the canvas. Perhaps this area just received more heat, pressure and steam in the lining process.

As alarming as these blisters were, the painting was overall, in very good condition. Apart from cosmetic concerns, there are few cracks, and hardly any losses. It didn't seem prudent to subject the painting to the rigors of a lining reversal at this time.

If the blisters could be relaxed and set down, then perhaps a sealed vitrine with the addition of silica gel would help to insure a stable environment for the painting. If heat and moisture had contributed to the paint deformations, perhaps they could also be employed to safely put them back in place.

The paint film's response to moisture was tested by covering the surface with a sheet of dartek from which had been cut a small opening which corresponded to one of the outermost blisters. This was then covered with a pup tent of blotter paper which was moistened with distilled water and then covered with an additional sheet of dartek. This allowed the slow humidification of a small section of the painting without actually touching the surface of the blister. The progress of the humidification was monitored over several hours and up to half a day by checking it regularly and examining the surface under a microscope. Humidifying isolated areas seemed a more cautious approach.

Following this initial relaxation, the test area was gently warmed with an electric spatula. Having previously set down heat blisters on a fire damaged painting, one appreciates how amazingly fragile a blister of paint can be. The blistered paint was covered with a protective sheet of silicon coated mylar during this process. This operation was performed under the microscope to monitor its progress. Initially, no pressure was applied to the surface. Heat alone was used to warm up and plasticize the paint. As it began to relax, incrementally more pressure was applied to the deformation until it returned to its original planar position. Temperature was a critical factor. Having determined that some thermoplastic manipulation was possible, the following working procedure was established. First, an individual blister was pre-humidified. Then, using micro cracks which occurred on top of most of the blisters for access, a small amount of very dilute Russian sturgeon glue was fed in. It was delivered warm, with a small watercolor brush and was approximately a 5% solution. This was done to provide additional moisture and to enhance adhesion.

A number of different consolidants were tried, including Beva 371 and Aquazol, but it was finally decided that sturgeon glue was the most effective at wicking into these very fine micro fissures. It also seemed that the aqueous delivery was the most sympathetic. Then, working with two different electric spatulas, the blister was warmed overall with a larger flat footed tip. After the blister was plasticized, a smaller tip was used to carefully iron down the surface, following the grooves of the original impasto.

Since the surface was very highly textured, a number of specially shaped tips were created which conformed to the irregular surface. These were fabricated from machine threaded steel bolts which were the right size for our rheostatically controlled soldering pencil. They were shaped and polished on a bench grinder.

The consolidation was carried out under the microscope and required 85 hours to complete. The surface deformations were, for the most part, realigned and hopefully well adhered. So far, none of them have shown any signs of having returned.

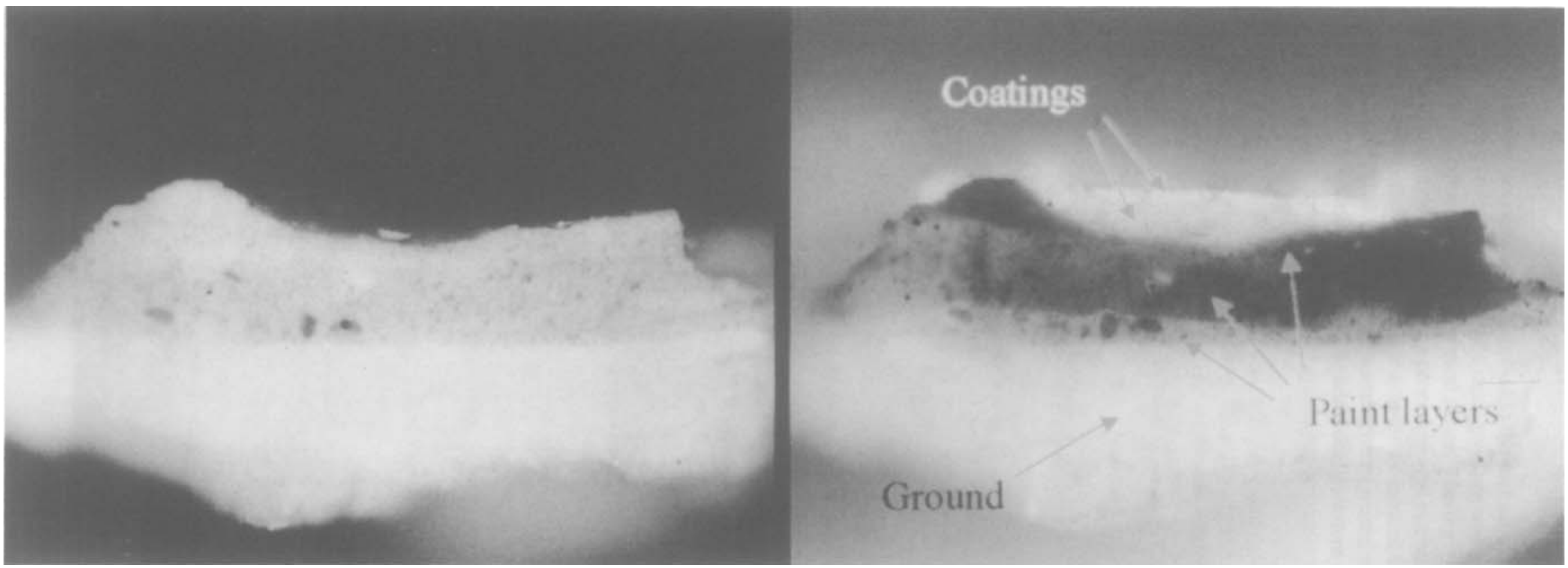
Following this structural treatment, the painting was surface cleaned with a 2.5 % aqueous solution of diammonium citrate at pH 8.0. Following the surface cleaning, a small varnish removal test was undertaken. The colors were dramatically improved by removing the yellowed natural resin coating. It wasn't just that the yellowing effect was throwing off the tonal balance of painting, the saturating influence of the varnish was itself darkening the colors. Without this saturation, the colors looked fresh and crisp like those of a pastel drawing. After a series of cleaning tests, the varnish was removed with a solution of non-aromatic mineral spirits and ethanol 2:1.

Due to its potential instability, the painting currently resides in a sealed stainless steel vitrine designed and built by George Wight, of Los Angeles, California. After some deliberation, the decision was made to leave the picture unvarnished, the way Monet intended it to be seen.

Endnotes:

1) House, John, *Monet: Nature into Art*, New Haven and London: Yale University Press, 1986. pp.28-29
2) Seiberling, Grace, *Monet in London*, exhibition cat., Atlanta: High Museum of Art, 1988. p.62
3) House, p.29
4) Wildenstein, Daniel, *Claude Monet: Biographie et catalogue raisonne*, 4 vol., Lausanne and Paris: Biblioteque des arts, 1974-85. pp.1531-32.
5) Ibid, p.1690
6) Seiberling, p.76
7) Perry, Lila Cabot, " Reminiscences of Claude Monet 1889- 1909." *American Magazine of Art* 18 (March 27) p.122
8) Swicklick, Michael, French Painting and the Use of Varnish 1750-1900. *Conservation Research,* Washington, D.C.: National Gallery of Art, 1993. p.170
9) Ibid. p.170
10) Bomford, David, Kirby, J. , Leighton, J., Roy, A., New Haven, London: *Art in the Making - Impressionism.* Exhibition cat., National Gallery, 1991. pp.44-50
11) Ibid. pp.74-75
12) Ibid. p.62

Claude Monet, Houses of Parliament in the Fog, 1903, oil on canvas, 32" X 36," High Museum of Art.



Claude Monet, Houses of Parliament in the Fog, 1903, oil on canvas, 32" X 36," High Museum of Art.
Cross section in normal light on left, ultraviolet on right. Prepared and photographed by James Martin, Williamstown, MA

THE SINKING (AND RESURRECTION) OF THE TITANIC: MAX BECKMANN'S EARLY MASTERPIECE AT THE SAINT LOUIS ART MUSEUM

Robert Proctor, Painting Conservator

The St. Louis Art Museum is renowned for having the most comprehensive collection of works by Max Beckmann in the world. Thirty-eight of the forty Beckmann paintings belonging to the museum are only part of the over 6000 art works given by the department store mogul Morton D May. Mr. May met Mr. Beckmann in 1949 when the Artist was teaching at Washington University in St. Louis, filling in for Philip Guston who was on sabbatical. Among the collection are some of the artist's lesser known works painted before World War I including *The Sinking of the Titanic*. The AIC annual meeting in St. Louis offered an opportunity to take a closer look at Max Beckmann and the history of this early masterpiece.

Beckmann is arguably one of the most complex artists of the Twentieth Century. While he never really belonged to any of the many schools, group of artists, or "-isms" predominating the Twentieth Century, most of his paintings are instantly recognizable. Although his best known works are obviously filled with overt symbolism and meaning, they defy clear interpretation.

His life was as tumultuous and complicated as his paintings. Beckmann was born in 1884 in Liebzig, Germany and became interested in painting at a very early age. At the age of ten he traded his box of tin soldiers to a schoolmate for a set of watercolors. This was an ominous foreshadow of a future obsessed with painting and flight from war.

Like many of his contemporaries, both world wars deeply influenced Beckmann's life and the development of his artistic style. Surprisingly, with all of the themes of catastrophe, conflict and human struggle that dominate his paintings, images of war are rarely found.

During World War I Beckmann suffered a nervous breakdown and was discharged from his voluntary post as a medical orderly. This seemed to mark a transition in his work from a mostly academic style to a unique style all his own.

Attacks on Beckmann's art by the Nazis began in 1930. By 1937, Hitler's campaign against Entartete Kunst or Degenerate Art culminated in a show in Munich where Beckmann witnessed Hitler's infamous speech about degenerate art on the steps of the Haus der Kunst. Included in the show were ten to twelve paintings by the artist. Several are now lost, presumably torched with over 1000 other paintings in a bonfire marking the closing of the show. On July 18, 1930, the day after Hitler's speech, Beckmann and his second wife Quappi packed up their most important possessions and left for Amsterdam where they lived in exile until 1947.

While living in occupied Holland, Beckmann, in his late fifties was called for duty by the Nazis. Much to his relief he was rejected due to his bad heart. Ironically, many of Beckmann's paintings deemed degenerate were confiscated and sold by the Nazis to help fund the war. Others were secretly sold by friends and family to support the artist. In 1941, the artist's son Peter was stopped in an ambulance while trying to smuggle his father's paintings in to Germany so they could be shipped to the United States for sale. Fortunately, the paintings were not discovered.

In 1947, after ten years of trying to emigrate to the U.S, the Beckmanns were finally granted visas and moved to St. Louis where Beckmann began teaching at Washington University.

In 1950, at the age of sixty three, the Beckmann's moved from St. Louis to NYC. On December 27, Beckmann died of a heart attack outside the Metropolitan Museum of Art on his way to see his *Self Portrait in a Blue Jacket*. The painting was being exhibited in a show at the museum entitled "American Painting Today".

Whitten & Proctor Fine Art Conservation, 402 Byrne Street, Houston, Texas

In 1956, six years after Beckmann's death, Morton May purchased two large paintings from Peter Beckmann: *The Destruction of Messina* from 1909 and *The Titanic* dated 1912-13. Their sizes alone, 100" x 105" and 104"x 130" respectively, expressed their importance to Beckmann.

The subjects of these paintings represent a less familiar academic style of painting which he abandonned after his nervous breakdown in 1915. Specifically, the artist was trying to create modern classics by capturing current events on canvas and representing them as grand themes of man's struggle against the great forces of nature. *The Destruction of Messina* depicts a catastrophic earthquake in southern Italy where 80,00 people were killed. The picture portrays convicts escaped from an insane asylum; one is being shot by a military officer as he tries to stab him. *The Destruction of Messina* was first exhibited at the 1909 Berlin Secession, where Beckmann was expected to prove himself as the young rising star. Astonishingly, this early masterpiece was harshly reviewed by the critics when first shown.

Instantly compared to Gericault's *Raft of the Medusa*, Beckmann's painting was criticized as a failed attempt at a feat of this scale. The Messina was described by one critic as deserving to be adapted as a cinema poster. Even after these discouraging reviews, with the news of the sinking of the Titanic Beckmann could not help himself at another try on this theme of man in the face of disaster. Like *The Destruction of Messina*, *The Sinking of the Titanic* was panned, this time at the Berlin Secession of 1913. Beckmann's work was eclipsed by a new group of artists out of Dresden known as "Die Bruecke".

In 1994, all forty of the St. Louis Art Museum's Beckmann paintings were sent to Stuttgart, Germany for a retrospective of the artist's work. Four sheets of Masonite® glued to the reverse of *The Sinking of the Titanic* made it too fragile to travel. In 1993, with a grant from the National Endowment for the Arts, I was asked by Paul Haner to help make the Titanic ready for its Atlantic voyage.

Translating from a letter to Morton May dated the fifth of February, 1956, concerning the sale of *The Sinking of the Titanic* and *The Destruction of Messina*, Peter Beckmann writes "These two paintings have been hanging for the last two years in Bremmen and Braunschweig and thereby I have noticed that they are not in a condition that can be rolled for transport".

A 1984 condition report in The Saint Louis Art Museum Conservation files reads:

> "Support: Light weight canvas mounted to 4 sheets of Masonite® with animal glue. Attachment is satisfactory at this date. Blisters around the outer areas from 1 to 6 inch in diameter. A Stretcher Frame is glued to the Masonite".

Also noted were concave and convex warps in the Masonite. It continues:

> "Design Structures: There were numerous losses at random over the general surface from small flaking to large areas at the bottom edge as noted in photos. Most have former fills of hard gesso. Surface coating a discolored soft-resin type varnish readily soluble in acetone".

The accompanying treatment report mentions that the varnish and former restorations were removed with mixtures of acetone and Naphtha "as needed" The blisters around the perimeter were set down with "vinyl glue using hypodermic infusion and heat", and a cradle was attached to the reverse to "restore the surface plane". The losses were "inlayed with a wax chalk filler and inpainted with Acryloid B-72®[2] colors." The painting was spray varnished with B-72® followed by a Soluvar®[3] brush coat.

Over the years, the joins in the Masonite® led to the formation of ridges on the front of the painting. The canvas was extremely fragile and threatened to split with the slightest flex of the painting.

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[2] Paraloid B-72® (ethyl-methacrylate methyl-acrylate copolymer resin, Rohm & Haas, Philadelphia, PA).

[3] Soluvar Gloss Picture Varnish® (iso-butyl methacrylate resin with silica added as a matting agent dissolved in non-polar petroleum distillates, manufactured by Binney and Smith, Easton, PA).

Somehow, in the summer of 1993, the painting was safely transported on the top of the elevator down to the conservation studio. When we first began to remove the backing, the Masonite® was found to cleave away from the canvas without much resistance. Using a variety of spatulas and knives with the painting face-up and starting from the top, the top two panels were removed. When the bottom two panels were reached a big change was noticed. Initially, we thought it may have something to do with the vinyl glue used to set down the blisters around the perimeters mentioned in the 1984 report. A Leister Labor® hot air tool was used alone and in combination with solvents and water to release the first six or so inches of the canvas, but it became evident that these two pieces of Masonite® could not be safely removed in this way.

Resigned to the revelation that the remaining panels would have to be removed by thinning them from the reverse, the painting was faced with wet strength tissue and dilute Beva® Gel[4]. The faced painting was sandwiched between layers of matboard and Fomecor® and with lots of help, it was turned over. Fortunately, the stretcher was not glued onto the reverse of the Masonite®. Instead, the Masonite® was attached to the stretcher with screws and nails through the face of the Masonite®. Unfortunately, the nails and screws could not be simply removed because the heads were covered by the painting. A hacksaw blade was slipped between the stretcher and the reverse of the Masonite® to cut the nails and screws and release the stretcher.

Removing the Masonite® and glue from the back of the canvas took several solid months of hard work. A bridge was built over the painting for access to the middle. Masonite® is murder on tools so a lot of time was spent sharpening them. Removal of the Masonite® began with a series of hand planes. Fortunately, the textured side of the Masonite® was against the canvas. When the back of the texture was reached, gouges and scalpels were employed instead.

There was still a thick layer of glue that needed to be removed. The thin, degraded canvas and the glue-bound gesso ground excluded the use of moisture to soften the adhesive. The majority of the glue was removed with a flexible shaft tool fitted with carbide bits.

After the removal of the Masonite® and glue, the pre-existing damages to the canvas were addressed. These included a foot long tear that had been sewn up like something out of Frankenstein. The stitches went through the original paint layers and were liberally overpainted. After the stitches were removed, the tear was filled with a mixture of Polyfix®[5] and acrylic gesso[6] .Wet strength tissue was then adhered to the reverse of the tear with Beva® D-8[7]. Also, a large area of loss from the bottom left corner of the canvas was inserted with a polyester fabric with a similar weave.

Areas of planar deformations were humidified over several days with repeated applications of alternating moist and dry blotters covered with weights. The reverse of the painting was infused with a dilute solution of Lascaux® P-550[8] prior to lining.

A relatively heavy weight linen fabric was prepared with two layers of Beva® Film[7] for lining the painting.

The painting was turned face-up and the facing was removed. Next it was placed on a vacuum hot table and lined with the prepared fabric.

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[4] Beva® Gel (an aqueous dispersion made primarily of ethylene vinyl acetate, acrylic resins and cellulose; Conservator's Products Co., Chatham NJ).

[5] Polyfix® (a propriatary chalk and polyvinyl alcohol based spackling compound; Lepage's Ltd., Ontario, Canada).

[6] Acylic Gesso (dispersed pigments in an acrylic polymer emulsion; Golden Artist Colors, Inc., New Berlin, New York)

[7] Beva® D-8 (an aqueous dispersion made primarily of ethlene vinyl acetate: Consevator's Products Co., Chatham, NJ).

[8] Lascaux® P550-40TB (n-butyl methacrylate resin disolved in petroleum benzine, manufactured by Alois Dietheim AG, Bruettistellen Switzerland)

[9] Beva® Film (ethylene vinyl acetate based film adhesive: Conservator's Products Co., Chatham, NJ).

The lined painting was stretched on a new ICA redwood stretcher on which the springs had been removed and replaced with aluminum tubing. The Soluvar® top coat from the 1984 treatment was removed with a mixture of petroleum benzine and xylene and poorly matching fills and retouching were removed using both scalpels and cotton swabs charged with various organic solvents.

Canvas inserts and paint losses where were filled with chalk mixed with PVOH[10].

The majority of the B-72® varnish from 1984 was left intact and it was decided that it was beyond the scope of this treatment to remove it. Although literature from both Beckmann's second wife and Max Doerner[11] state that Beckmann never varnished his paintings, more recent evidence collected from Beckmann scholars and conservators suggest that he did varnish most of his work prior to 1915.

Fills were toned with watercolors varnished locally with B-72® and inpainted with Maimeri®[12] and/or Charbonnel Restoration Colors®[13]. A very thin brush coat of Regalrez® 1094[14] , stabilized with Tinuvin® 292[15] was applied to unify the surface.

I would like to thank all of the people at the St. Louis Art Museum who allowed for my participation in this project. In particular, Paul Haner, whose calm nature often helped sooth my anxiety during many of the stressful moments throughout the treatment. And most off all, to my wife Jill Whitten who, in daily telephone calls and weekend visits to Chicago, always reassured me during some of the seemingly brutal steps of the treatment that my care was helping ensure the survival of this great painting.

[10] PVOH (polyvinyl alcohol HMW; available from Conservation Support Systems, San Diego, CA).
[11] p. 396, Max Doerner, ***Malmaterial und seine Verwendung im Bilde***, Stuttgart, Germany, 1954.
[12] Maimeri Restoration Colors (dry pigments dispersed in mastic, made in Italy by:F.lli Maimeri & C. s.r.l. Mediglia, MI).
[13] Charbonnel Restoration Colours (dry pigments dispersed in a mixture of butyl-methacrylate and cyclohexanone resins, Lefranc & Borgeois France).
[14] Regalrez 1094 (a fully hydrogenated hydrocarbon resin; Hercules Resins, Wilmington, DE).
[15] Tinuvin 292 (hindered amine light stabilizer, Ciba Geigy Corp., Hawthorne, NY).

TRANSLATING SIGNIFICANCE INTO VALUE: MUSINGS OF A CONSERVATOR AND AN APPRAISER

Victoria Montana Ryan, Conservator of Paintings
Carol O'Brien English Ph.D., Accredited Senior Appraiser (ASA)

When the owner of a cultural artifact asks "Should I have conservation treatment — is it worth it?" the answer is often difficult to come by. While it is only the owner who can make the decision, he often looks to professionals, conservators and appraisers, to guide him. Too often these professionals do not consult with each other to the benefit of the artifact. Communicating together, they may provide information to help the owner arrive at his answer. While the conservator, concerned with the physical entity, considers levels of significance an artwork may possess, the appraiser considers other factors including its characteristics of economic value. While significance and value change over time, how an appraiser translates significance into value at a given moment is a matter of great importance and an issue that has not been fully explored. A case study illustrates the unique perspectives of these two professions and the discussions that ultimately resulted in a market value for the object.

It might be instructive to define appraiser for the purposes of this discussion. While there are insurance people who appraise and dealers who appraise, here we are concerned only with the qualified, <u>*accredited*</u> appraiser. This professional, charged with estimating the monetary worth of a property, should have no vested interest in the artwork and is independent of the artwork's owner or any brokering agent. Like conservators, appraisers have professional organizations, including the Appraisers Association of America (AAA), the American Society of Appraisers (ASA), and the International Society of Appraisers (ISA), with various levels of membership. These organizations offer, even may require, educational programs to grant accreditation. The member must agree to adhere to the Uniform Standards of Professional Appraisal Practice (USPAP) as well as the specific organization's ethical tenets. These generally include the appraiser's responsibility to third parties, thorough inspection, investigation, and analysis of the property, statement of the appraiser's disinterestedness, and avoidance of unethical and unprofessional appraisal practices (ASA 3).

Appraisers' estimates of economic value are based on methodical research and informed opinion. Each appraisal must have one specific intended use, with its concomitant purpose. The purpose must be precisely defined. Accredited appraisers, some of whom are scholars within their field of expertise, adhere to standard methodology and perform extensive research in estimating value. The appraiser is also a *witness* that the property exists and an *identifier* of the artwork's value characteristics and its condition. Fine arts appraisers research specific fields of art history and the most relevant market for the artwork.

Distinguishing the multifaceted concepts of significance and value is critical to maintaining the correct balance in the communication between conservator and appraiser. Acknowledging the conservator must consider many levels of meaning or significance, our profession has declared: *In selecting a suitable treatment the conservator must consider... (the) context and use of the cultural property (historical, cultural, institutional, current and anticipated)* (AIC Commentary 21- Suitability). Conservator Ian Hodkinson, in "Man's Effect on Paintings," schematically elucidates these and other levels of significance, demonstrating that an object will have not only its original significance, but will also lose, acquire and have significance modified in continuing cycles through time (Hodkinson 55-60). Affecting these many levels of significance are not just the originators, but users, including curators, historians, collectors, conservators, and appraisers, also may be added to the list.

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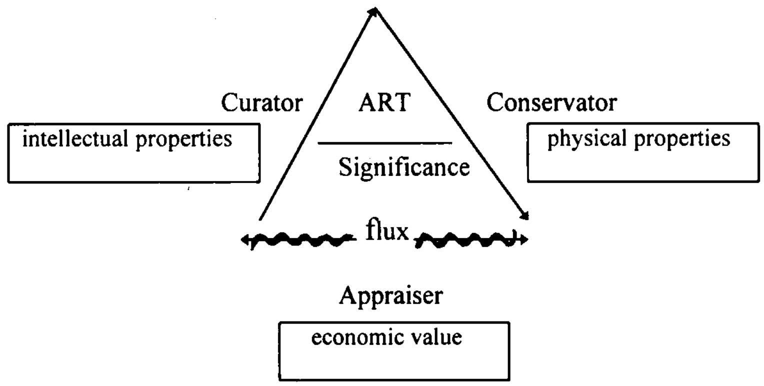
Value, on the other hand, is the monetary worth of an object. Value may be included as one of the levels of significance. To arrive at an economic value an appraiser will consider the pertinent value characteristics. These characteristics include, but are not limited to artistic merit, quality, desirability in its relevant market, period of execution, rarity, availability, provenance, and condition. It is the characteristic of condition to which the conservator may contribute facts beyond the appraiser's observations and where dialogue can serve the object.

Concern for the "facts" of an object establishes the relationship between the conservator and the appraiser. Communication is especially important when the conservator's contributions may assist the appraiser in forming an opinion and determining a value. Both professionals are well aware that an object's significance and value (inherent and assigned) are in flux and change with time. A simple diagram may illustrate the relationship.



While conservators hold that monetary value must not compromise the quality of our treatment choices, the fact is that when we stabilize to preserve, that action may add market value (a culture's decision to preserve adds a level of significance that *de facto* adds a measure of value). On the other hand, art historian Cathleen Hoeniger suggests that in the search for the original, extreme cleaning efforts have relegated some artworks to storage and states that their "value has actually fallen as a result of the cleaning" (Hoeniger 152). Clearly the conservation treatment and the interpretation of the artwork have a bearing on the value. While it has been observed that "the value placed on works of art in the marketplace (and in some cases, their intrinsic value) has engendered much of the damage that art historians and conservators struggle with today" (Watson 10), as conservators, we cannot pretend that value simply does not exist.

How then is an appraiser, estimating economic value, to interpret conservation efforts? While some might argue that the appraiser's task is of no concern to the conservator, it is the conservator's knowledge of previous treatments and conditions that may hold the key to the analysis, assessment, interpretation of the artwork. Without communication, the appraiser may be left uninformed in interpreting the conservation of an object. The appraiser's research, perhaps providing extensive detail on the history or provenance of an artifact that might otherwise be unknown to a conservator, may assist the conservator in developing more informed treatment choices. The conservator discerns physical facts while the appraiser's product is a researched, written, opinion, based on facts from many sources (including the conservator). Professional discussions between the two can provide the most information.

Aspects of one case study may best illustrate how, in one instance, significance was translated into value through the discussions of the conservator and the appraiser.

The Painting:
This 17th century Italian painting, depicting two men pulling at the robes of a voluptuous woman entering her bath, illustrates the apocryphal story of *Susanna and the Elders*. Susanna, the virtuous wife of a respected Jew, was so beautiful that she aroused the lust of two lecherous elders, who spied on her as she bathed in her private garden. They threatened to accuse her of adultery unless she responded to their advances, which she refused to do. Thusly accused, Susanna was tried, found guilty, and sentenced to death. She was saved, however, by the prophet Daniel who, upon hearing their conflicting stories, exposed the true motives of the elders. Artists free to paint the beauty of

the human form while interpreting a religious theme have often depicted the story. Sometimes viewed as an allegory of virtue over lust and deceit, or as the victory of righteousness over evil, the story was later interpreted as "a symbol of the church menaced by pagans" (de Grazia 102).

The painting's owner engaged a moving company to transport the painting and in the process of removing it from the wall, the painting was torn. Cardboard was placed directly against the surface of the painting which was then placed in a "cage" of wooden slats, and transported a great distance. After contacting the conservator, the distraught owner instructed the moving company to deliver the unopened "crate" to the paintings lab. Clearly, poor handling and inappropriate packing methods created problems for the painting and then exacerbated them. As conservation examination and treatment commenced, the owner requested that an appraiser be called.

Conservation Examination and Treatment:

On removing the painting from this packing, the conservator observed a nameplate attached to a flimsy liner that served as a frame. This nameplate, along with a handwritten note attached to the reverse of the painting, identified the artist as Domenichino. Immediately obvious were gouges and abrasions due to direct contact of the cardboard. The lined, oil on canvas painting, which is H. 187.0cm x W. 191.8cm, exhibited two "new" tears and several older repairs as well as planar distortions. The new tears, through both the original open weave bast-fiber canvas and the closed weave linen lining canvas, were accompanied by loss of the ground, paint and varnish layers along the torn edges.

As previously noted the conservator's observations of the painting's condition informed the appraiser's interpretation of the work. After thorough examination of the painting, the conservator suggested to the appraiser that the older repairs, which were stable and in no need of removal, might be of historical significance or curatorial interest. The appraiser, who might otherwise have been unaware of this possibility, could now more knowledgeably consider condition in translating significance into value.

The lining was still functioning adequately except in the areas of the new tears. Given the overall dimensions of the piece, these were relatively small areas and considering the age of the work and the materials used, it was determined that localized repairs would stabilize the painting without putting it at risk. The painting was first surface cleaned and then the old degraded natural resin varnish was reduced using ethanol. Areas of overpaint that were easily solubilized were removed and older retouchings done in oil paint were retained. Many old fills, if in good plane, were left in place, but those that were out of plane were removed. The areas around the tears were locally humidified to bring the canvas back into plane. The tears of the original and lining canvases were first aligned and then repaired using a combination of sturgeon glue and small bridges of polyvinyl acetate. Older repairs that were still stable and deemed to be of possible historical significance or curatorial interest were left in place, but were locally humidified where necessary to improve planar conformity. New fills were added using proprietary polyvinyl acetate copolymer filler (Modostuc®, Plasveroi) toned with watercolors. The painting was revarnished using damar stabilized with Tinuvin 292® and retouched using pigments in stabilized damar resin. Completion of the conservation treatment returned the painting to an exhibitable state.

Appraisal:

Since it was possible to return the painting to an exhibitable state, the purpose of the appraisal assignment was to estimate the cost-to-cure (the problem) plus diminution of value (if any). For this painting, the appraiser's methodology consisted of attempting to find similar sales in any market, analyzing and interpreting those sales in order to estimate the economic value of the painting as of the date the damage was discovered, and arriving at a valuation equation, estimating the total amount of loss.

Whether conservator or appraiser, we recognize that some styles of art and some specific artists sell well in certain periods, and not in others. What makes the market change? Certainly curators and art historians have an influence, but the key element is the collector. Collectors select value characteristics, such as artistic merit, period of execution, rarity, provenance, and condition, and will pay more for the presence of these characteristics. The absence of these characteristics will bring less money for the artwork. In the case of *Susanna and the Elders,* the appraiser had three important factors to consider in order to estimate the average retail replacement cost of the painting: attribution, market research, and diminution of value.

The initial curatorial consultation indicated that the painting was not by Domenichino (Dominico Zampieri, b. Bologna, 1581—d. Rome, 1614), but rather suggested the artist was Bartolemeo Biscaino (b. Genoa, 1632—d. 1657). Experts on two continents were contacted, one an authority on Domenchino, and the other an expert on Biscaino, and supplied with color transparencies of the painting. The Domenichino scholar confirmed the painting was not of that artist's hand. The Biscaino scholar stated the painting was not by Biscaino and in fact was not even Genoese. This expert showed the transparency to another scholar of Italian 17th century painting, one whose expertise is the southern half of the Italian Peninsula. This scholar declared the painting to be the work of Giovanni Battista Beinaschi (Piedmontese, b. Fosano, 1636—d. Naples, 1688). The appraiser requested that these ranking experts in 17th century Italian painting commit their findings in writing.

Once attribution was determined, the appraiser proceeded with the necessary market research. A primary source, published auction prices may not be ignored by the appraiser. Unfortunately, in this instance there were no Beinaschi paintings offered in the United States before the date of the damages to *Susanna and the Elders* to provide a record of auction prices. The appraiser next searched for similar paintings in any market, auction or retail. Once the auction and retail sales were analyzed, interpreted, and adjusted, the appraiser was able to estimate the average retail replacement cost of the painting. This accomplished, the appraiser turned to the question of diminution of value.

A change in attribution may affect the economic value, but it does not determine diminution of value. While previous restorations of historical interest may not diminish the value of a painting, new damage certainly does. The appraiser, assessing diminution, has two information resources available: auction houses and dealers. Experience demonstrates that auction houses disclaim condition as well as authentication for works executed before 1876. Condition reports, if available, are limited. Thus, auction market records are not used in dealing with diminution of value questions.

Dealers can elucidate the market (that is collectors') reaction to different categories of damages to an artwork. After careful consideration of qualifications, including shared methodologies and ethical standards, five independent dealers were contacted. Each dealer was asked if they had a matched pair of works (same artist, subject matter, style, size, provenance and publication record) in which one of the pair had only historical repairs and the other had both historical repairs and new damages. Based on the responses the appraiser extrapolated that new damage to a certain percentage of the canvas resulted in a certain percentage of diminution of value. The appraiser confirmed the final findings with others, including auction house personnel. It is important to clarify that in this particular case, diminution of value was based neither on re-attribution nor (quality of) conservation treatment, but rather was based on the extent of damages (tears) to the painting. The completed appraisal document, incorporating research and a valuation conclusion, and the conservation treatment records are intended to remain with the painting, important in documenting the history of this culturally significant artwork.

Susanna and the Elders provided an opportunity for the conservator and the appraiser to engage in a professional dialogue that was beneficial not only to the individuals, but ultimately to the artwork. Although the conservator and appraiser work independently, by having an awareness of differing viewpoints and a sensitivity to each other's professional ethics and limitations, a synergistic communication can develop between disciplines more complementary than polar.

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Fig. 1 Giovanni Battista Beinaschi (1636-1688). *Susanna and the Elders*. Oil on canvas. After treatment.

CHANGES IN PLACE, CHANGES IN CONTEXT: THE CONSERVATION OF AN ETHIOPIAN ICON

Erica E. James

An Ethiopian diptych was accessioned into the National Museum of African Art permanent collection in 1998. The diptych is composed of two icons and the style is attributed to one that developed in Ethiopia between 1630-1700 A.D. The 17th and 18th centuries in Ethiopian art are described as the Gondarene period. Gondar was the capital of Ethiopia established on the northern shores of Lake Tana and it soon became a cultural center giving rise to a style based on the fusion of western models with Ethiopian iconographic ideals. There was a saying "Who wishes to learn painting must go to Gondar."

The creation of icons is traced back to the 15th century and they are usually seen as single panels, diptychs or triptychs. In the 15th and 16th centuries, as least three European painters are recorded as living in Ethiopia including the Italians Gregorio Bicini and Nicola Brancalion. One of the oldest organized states known to the history of man, Ethiopia has been influenced by Christianity since the fourth century by civilizations from the Mediterranean, Asia, the Middle East and Africa. Traditionally, the icons were stored in the sanctuary or treasure house of churches or monasteries. The subject matter in the 15th and 16th century icons all follow traditional Christian themes with the Virgin Mary the most popular theme.

The icons are constructed from wood either from the olive tree or "wanza" tree, a type of cedar. Ethiopian diptychs and triptychs usually come from the same wooden board and this board is usually rough hewn out of the truck of the tree with an axe. These boards are taken from the center of the tree, or pith, and the wood work is done while the wood is still green because after the wood ages, it is too hard to work. The board hewn from the tree is cut into panels and one panel is split down the middle to achieve the two panels required for a diptych. This is very apparent as diptychs often exhibit similar warping characteristics. Although the two icons discussed here have not been analyzed for their wood type, their warping is similar leading the conservator to believe that they came from the same board. Finally, the panel was chiseled out so that a surrounding ridge became a framing element. This ridge is the earliest type of framing element recorded in western art and is apparent in both icons in the diptych.

Initially, the wood was primed with a layer of gesso but starting in the 17th century a cotton cloth was adhered to the surface of the panel which provided an even surface for painting on the roughly hewn board. The cloth was adhered to the board with a hide glue and was embedded under a thick coating of gesso which was probably composed of gypsum bound in an animal glue. The painting itself was composed of a variety of pigments and although analysis has not been performed on the icons discussed here, previous research has determined that the pigments were, in general, as follows: reds were cinnabar (a red mercuric sulphide found in northern Ethiopia), yellow was derived from orpiment (an arsenious trisulphide found in eastern Ethiopia), green was derived from a mixture of orpiment and indigo, blue was derived from indigo that was probably acquired from India, black was derived from charcoal and white from gypseous chalk. Both the black and white were found in Ethiopia. Only in one case was it found that smalte (pulverized blue glass) was used for blue coloration and the sources for this point to Italy. After the 17th century, madder was used and probably was imported from Portuguese Jesuits. The paint layer was generally thinly applied and paint was often applied to the raised ridges of the frame and to areas outside the main presentation surface. The paintings prior to the 17th-century were unvarnished although paintings after this time were often given a vegetable lacquer varnish.

Erica E. James, 1518 Mill Race Road Baltimore, MD 21211

The conservator will discuss the treatment of one of the icons of this diptych. In summary of construction, the icon is executed in distemper (est.), pigment in an animal glue binder, on a plain-weave, medium-weight, cotton cloth. The cotton cloth is artist-primed and the ground is white in color. The cloth is probably adhered with a protein-based glue to the wood panel. The paint layer is unvarnished and matte in appearance.

There are three scenes in the icon, stacked visually on top of each other. The bottom scene is divided into two parts. In the left-hand portion of the bottom scene is an area that shows the central female figure, Mary, sitting wearing a *maphorian*, or a garment composed of both a shawl and hood. Her eyes are downcast and her hands are in a prayer position. A halo surrounds her head and twelve figures, possibly the twelve disciples, sit in front of and around her forming a "u-shaped" grouping. Counting clockwise from the proper-left side of the disciples, the fifth and ninth disciples are handing Mary what appears to be white sheets of scripture. In the right-hand portion of the bottom scene, the central figure wears a red robe with gold trim around the neckline. The figure stands in a crescent-shaped niche that may represent a boat or a heavenly body such as a moon. A halo surrounds the figure's head and the figure is "bound" by a sash. The figure is flanked by six angels, three on either side who each have halos and wings. Their heads peer out of the "rainbowed" clouds at the large central figure whose hands are in a prayer position. The central figure is Mary but a much rarer depiction of the Virgin. In this depiction, Mary is always pictured standing in a crescent and is not necessarily depicted wearing a maphorian.

The middle scene of the icon contains an image of Joseph, Mary, Jesus, and a female attendant. On the right is the bearded figure of Joseph. He is gesturing to the right with two fingers toward Mary and an Ethiopian inscription that likely describes the scene. Mary sits atop a donkey and wears a blue maphorian. She suckles the baby Jesus who is wearing a yellow robe. Mary also has a black umbrella covering her head. The Holy Family are all represented with halos unlike the female attendant in the far left. She wears a red robe under a yellow maphorian. Directly behind her is a more elaborate umbrella.

The scene at the top of the icon contains four figures, one almost completely lost due to earlier water damage. The figures sit against an orange background except for the damaged figure who stands against a black background in the far left. The figure on the right sits above a small temple. He has a halo and reaches out to hold the middle figure who wears a red robe with a white neckline. The middle childlike figure, Jesus, has a halo and longer dark hair. To the left of Jesus and the seated figure is Mary who wears a red robe with a blue maphorian and also has a halo. She sits on a yellow stool and gently hands her child to the figure on the far right of the scene. Although there is a substantial amount of paint loss in the left-hand portion of the scene, there is evidence of the damaged fourth figure who wears an orange robe under a yellow shawl. This figure has a halo and appears to be male. The figure is wearing clothing that mimics the clothing worn by the males in the previous scenes.

Upon arriving into the lab, the wood panel had a slight concave warp and an overall undulation to its surface causing a nonplanarity of both the wood panel and cloth surfaces. There was earlier moisture damage leading to buckling, tidelines and paint insecurities. The cloth layer was delaminating from the wood panel around the edges and in specific areas in the main images of the icon. There was substantial loss and active flaking throughout the ground and paint layer as well as a layer of surface grime. There were two types of cleavage dispersed throughout the painting: cleavage of the paint from the ground and cleavage of the ground from the cotton cloth.

The treatment of the icon proceeded as follows.

The areas of loss and active flaking were consolidated with a 10% solution of Beva 371® in xylene. The solution was applied with a brush to the unstable portions of the paint layer and stabilized the areas of insecurity while maintaining the matte characteristics of the paint layer.

After consolidation, a cleaning protocol was established for the paint surface. In cleaning, the priority was to maintain the matteness of the paint layer and use techniques that would clean the paint layer yet maintain its original unvarnished appearance. Since the paint was inherently matte and potentially vulnerable to aqueous methods of cleaning due to its protein binder, a naptha gel was chosen as a grime cleaning agent. The gel contained naptha, a mineral spirit with 7 ½% aromatics, Carbopol 954®, a polymeric thickening and gelling agent, and Ethomeen C-12®, a surfactant. All areas were rinsed thoroughly with naptha after use of the gel. This was performed conservatively as use of the solvent could potentially cause tidelines or blanching. This gel cleaned much of the paint surface successfully although it was observed that it did not completely dissolve the grime and mineral residue that had accumulated from the water damage on the left side of the icon.

At this time, it was noted that a small amount of water could be used to clean the paint layer so a weak chelating gel was chosen to clean these areas of accumulated grime and mineral deposits. A chelator is a chemical component which is attracted to grime and, unlike plain water, will reach into a paint layer and pull out grime. This gel contained deionized water, two drops of Triton X-100® (a surfactant), acetic acid to a pH of 4.7- 5.0, and 1.5 grams of methyl cellulose (4000 centipoids). The least swelling of a protein-based glue occurs at a pH of 4.8 so this is the point at which the protein binder is its least soluble. Acetic acid, the chelator, was used to lower the pH to this level and had weak chelating ability which did not endanger madder or lake pigments which might be present in the paint layer. All areas were thoroughly rinsed with distilled water after application of the gel. The rinsing process was thorough but again performed conservatively as use of water could potentially cause tidelines or blanching. After rinsing, a small piece of blotter was laid adjacent to the area to absorb any excess dampness. The use of this gel proved successful in most areas that had grime residue however the blue portions of the painting were sensitive to the gel. The blue pigment seemed to absorb and wet too readily indicating the possible use of a vegetable-based pigment like indigo whereas the other pigments in the painting were probably mineral-based.

Upon consultation with Richard Wolbers, Painting Conservator, at Winterthur Museum, a cleaning protocol was chosen for the blue design areas on the painting. Excess water with one drop of acetic acid and one drop of Triton X-100® were added to a small portion of the naptha gel to create an emulsion. An emulsion is a solvent, or chemical-based, substance that has the ability to pick up water-based grime. The emulsion cleaned the blue areas with limited success and the areas were rinsed thoroughly with naptha since the emulsion was mainly solvent-based. Although this solution contained acetic acid, it was such a small amount as not to affect the blue paint layer. Although this final cleaning technique was limited in the removal of grime and mineral deposits from the blue areas, the overall appearance of the icon was considerably improved and it was not necessary to attempt any other cleaning methods on the blue paint surface.

While the cleaning of the paint surface occurred, it was noticed that there were several wax accretions on the surface of the paint layer. The wax accretions were thinned down with xylene and mechanically removed with a scalpel. Mechanical removal was required solely in a few areas because the use of a solvent threatened to spread the wax beyond its boundaries and cause staining and saturation of the surrounding matte paint.

The upper-left corner of the icon was humidified to relax the buckling cloth layer. This buckling is most likely a direct result of previous moisture damage to the cloth layer. The moisture probably caused the delamination and buckling of the cotton as well as a tideline which exists in the uppermost image of the icon. The delaminated and buckling upper-left corner and delaminated edges of the cloth layer were relaxed with a vapor treatment using humidification. This was performed by placing Mylar® then humidified Gore-tex® between the cloth layer and wood panel and blotter board, Plexiglas®, and weights on top of the paint surface. The blotter board was changed when it had absorbed moisture. This method of application was allowed to set for several hours to insure greater relaxation and avoid unnecessary shrinkage of the cotton cloth layer. After humidification was completed, the upper-right corner and cloth edges were secured with strips of polyester fabric which were coated with Beva 371®. The polyester fabric measured 0.7mm in thickness. Around the edges of the cloth layer, the fabric was cut into strips with straight edges but in the upper-left corner the fabric strip was given serated edges to maintain a smooth appearance in the main presentation surface.

Filling was begun in areas of ground loss with a whiting bound in sturgeons' glue. Since the areas being filled were thoroughly consolidated with Beva 371®, they were not further isolated from the filling material. A 30% solution of Acryloid B-72® in acetone was used to isolate areas surrounding the loss to prevent ghosting, or a spreading out of the filling material. After filling was completed, the Acryloid B-72® was removed with acetone. The acetone did not affect the paint layer and evaporated quickly.

Inpainting was completed in the areas of loss using gouache watercolor in order to mimic the matte quality of the surrounding original paint. These areas were isolated locally with a 15% solution of Acryloid B-72® in acetone to prevent a staining of the original ground and to isolate the added fills. The technique of retouching used is a derivation of the Italian technique called "tratteggio" which is often used on Italian panel paintings. Tratteggio is based on the theory that there are three dominant tones that can be abstracted from any painting and that these colors, combined in the losses in small vertical strokes, create a neutral color that blends in with the painting and although the loss is invisible from several feet, it is apparent from several inches thereby leaving the retouching obvious to the close examiner. Different variations of tratteggio and other similar Italian techniques are called "rigatini." The inpainting used on the icon does not just use vertical strokes but those that follow the image as well. During discussions, it became evident that the original design that once filled the losses was not known therefore a retouching technique was used that was close to the appearance of the original paint yet remained evident as restoration. If it was known what had been in those losses by referencing past documentation or looking to other icons by the same artist, the conservator may have tried to emulate the artist's original touch thereby leaving the retouching invisible. Although the icon was not an Italian panel painting, after consideration of the considerable Italian influence on Ethiopian iconographic craft, the conservator decided that it was an appropriate method of retouching to use, as well as the desire for the retouching to remain evident to the viewer.

In the end, consolidation of the insecure paint layer, several cleaning steps, and filling and inpainting maintained the matte appearance of this unvarnished Ethiopian icon. The conservator would like to thank Steve Mellor, Dana Moffett, Lydia Puccinelli and Bryna Freyer all of the National Museum of African Art and Catherine Metzger, Joyce Hill Stoner, Richard Wolbers, Quentin Rankin and Ann Creager, Painting Conservators.

TREATMENT OF BLANCHING IN AN *ITALIAN LANDSCAPE* BY JAN BOTH

Bradford A. Epley*

During 1997 and 1998 an *Italian Landscape* by Jan Both in the collection of the Fitzwilliam Museum, Cambridge underwent conservation and restoration treatment. Due to blanched surface coatings and paint layers the painting had remained in storage for several decades. The treatment of the painting provided several research opportunities. Of primary interest was to what extent the artist's working method and materials had contributed to the painting's present appearance. Of additional interest was to what degree the painting conformed to blanching characteristics established by other researchers. Finally, the treatment provided the opportunity to explore alternatives to traditional blanching treatments, such as solvent reforming and the application of drying oils.

The Artist

Although the exact date of his birth is unknown, Jan Both was probably born in Utrecht between 1615 and 1618.[1] Both Jan and his elder brother Andries were apprenticed to the Utrecht academy, though at different times. While Andries is recorded as having been a pupil of Abraham Bloemaert between 1624-25, there are no such specifics for Jan's training.[2] Following his apprenticeship in Utrecht, Jan travelled to Italy. His brother Andries had been in Rome since 1635. By Easter of 1639 Andries and Jan were living together in the parish of San Lorenzo, where they resided until 1641. During their stay both brothers were members of a notorious fraternity of Northern landscape painters in Rome called the Bentvueghels (birds of a feather), best remembered for their drinking bouts, nicknames, and the initiation ritual of a mock baptism before a statue of Bacchus.[3] Sometime in the first quarter of 1642, Jan and Andries set off for home. Unfortunately, Andries drowned in a canal in Venice in March of 1642, after which it is likely that Jan returned immediately to Utrecht. Once back in Utrecht Jan continued to paint scenes of the Italian campagna. In 1652 Jan was buried in Buurkirk, Utrecht.

Materials and Technique[4]

Both's paintings depict general Italian landscapes bathed in a warm southern light populated by small groups of peasant travellers, or the occasional nude mythological gathering. Rich foreground passages, together with dense woods and vast panoramas, are contrasted against one another in the complex compositions which are characteristic of Both's most ambitious late works. The predominant overall warm browns of his early paintings developed into the various cool greens and blue-tinged browns of the late works. Though not dated, the Fitzwilliam's *Italian Landscape* is signed. Due to its large scale, overall palette, and composition, the painting has been placed amongst the later works of the artist's career, between 1647 and 1652.[5]

For this particular painting Jan Both utilized a double ground. The lowest layer is reddish-orange in color and contains red, yellow, and brown earth pigments with a large proportion of silicate material. The dark grey upper ground consists of lead white and charcoal black, with lesser amounts of yellow earth and chalk. On top of a broad sketchy underdrawing, Both established the overall tonality of the various regions within the painting. The dense forest on the left side was underpainted with a dark paint consisting of black pigment, chalk, and pale

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[1] Marten Jan Bok, Jan Both in *Masters of Light: Dutch Painters in Utrecht during the Golden Age*, New Haven 1997, pp. 377-78.

[2] Malcolm Waddingham, Andries and Jan Both in France and Italy, *Paragone* 15, no. 171 (1964), pp. 13-34.

[3] For descriptions of the Bentvueghels see Lynn Orr, *Masters of Light: Dutch Painters in Utrecht during the Golden Age*, New Haven 1997.

[4] Pigments were identified using polarized light microscopy, EDX, and paint cross section analysis. For a more detailed analysis of the materials and techniques used see Bradford Epley, Jan Both's Italian Landscape: Materials, Technique, and Treatment, *Bulletin of the Hamilton Kerr Institute*, 3, 2000 (publication pending).

[5] James D. Burke, *Jan Both: Paintings, Drawings, and Prints*, Dissertation, New York 1976, p. 34.

smalt or glass. The light-infused regions on the right side were underpainted with a pale green paint consisting of lead white, green earth, smalt, and a small amount of red earth. The subsequent greens, blues, and browns of the foliage were made by varying the proportions of a complex mixture of pigments. These upper paint layers contain mixtures of ultramarine, smalt, green earth, a copper blue, yellow and red earth, lead tin yellow, a yellow lake, chalk, lead white, and black in varying proportions. The figures and livestock were added last, painted thinly and deftly directly on top of the landscape in mixtures of predominantly earth pigments and lead white.

Probable Causes and Possible Solutions

The term blanching merely describes a general appearance, a whitish opaque haze, which may be the result of distinctly different causes. Migration of components of the medium, the fading of a lake cast onto a white substrate, or residues from previously applied coatings may each result in a highly light scattering surface. The blanching in the *Italian Landscape* appeared to be primarily related to light scattering and a lack of medium at the surface of a severely abraded paint film. Previous research into blanching of this type has focused primarily on the works of Nicholas Poussin, Claude Lorraine, and Gaspard Dughet.[6] While various media and layer structuring have been suggested as possible common causes, the most consistent similarity of blanched passages found in paintings by Claude and Dughet lies in the pigment content. The affected passages almost always contain significant amounts of chalks and silicates. As most of the blanched passages contain green earth and yellow ochre as well, the abundant chalks and silicates may simply be present due to their association with the earth pigments in their natural sources. However, chalk may be present as an extender added by the artist, as an adulterant in lead white, or as the substrate of a yellow lake pigment. In any case, these chalks and silicates are often found amongst the finely ground complex mixtures of ultramarine, green earth, yellow and red ochre, and lead white which are characteristic of paintings by Claude and Dughet. In fact this mixture is sometimes referred to as the "Claude mixture". It is this same mixture which is found in the blanched passages of the *Italian Landscape*. In the mid-1630's Both, along with Herman van Swanevelt, Nicolas Poussin, Gaspard Dughet, and Claude Lorrain, took part in a commission from Spanish agents to paint a series of landscapes for the Buen Retiro Palace in Madrid.[7] While only circumstantial, this evidence suggests an association of landscape painters in Rome in the seventeenth century may be the possible common source for this green paint mixture.

Most of the abovementioned pigments utilized in the painting are hygroscopic, or have associated hygroscopic materials such as chalks and clays; they tend to adsorb water onto their surface. For films of such hygroscopic pigments dispersed in an oil medium, the danger is that any water adsorbed on the pigment surface will compromise the pigment/medium bond.[8] Changes in relative humidity can cause this adsorbed layer to fluctuate in thickness causing disruptions between the pigment and the medium. Where the interface between pigment and medium is not intimate there is an increase in light scattering and decrease in saturation. These tiny gaps, or micro-voids, may be only fractions of a micrometer in diameter, but in combination may have an impact on the overall appearance of the paint film. Therefore, the difficulty in saturating certain blanched paintings appears to arise from the development of micro-voids and a lack of interlayer cohesion within a paint film. Regardless of the treatment method, the presence of these pigments and their responsiveness to humidity ensures the ongoing potential for the development of new voids within the film.

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[6] Karin Groen, Scanning Electron Microscopy as an Aid in the Study of Blanching, *Bulletin of the Hamilton Kerr Institute*, 1, 1988, pp. 48-65. See also Martin Wyld and Joyce Plesters, Some Observations on Blanching with Special Reference to the Paintings of Claude, *National Gallery Technical Bulletin*, 4, 1980, pp. 49-63, and Aviva Burnstock and Timothy Green, *Blanched Paint: General Meeting Notes 28/11/90*, The Association of British Picture Restorers, London 1990.

[7] For a detailed description of this commission, see Jonathan Brown and J.H. Elliot, The Marquis of Castel Rodrigo and the Landscape Paintings in Buen Retiro, *Burlington Magazine*, 129, 1987, pp. 190-94.

[8] Stefan Michalski, A Physical Model of Varnish Removal from Oil Paint, *Cleaning, Retouching, and Coatings: Preprints of the Contributions to the Brussels Congress*, edited by John S. Mills and Perry Smith, International Institute for Conservation of Historic and Artistic Works, London 1990, pp. 88-9.

It is not certain to what extent such paint films would exhibit blanching if left untreated. More often than not, however, these paint layers have been exposed to high concentrations of moisture, most likely through cleaning. Their integrity and appearance have been dramatically altered. Methods of saturating blanched paint films have been reported in the conservation literature and fall into three categories: reforming of the paint medium using solvent treatments, the introduction of a medium such as a drying oil into the paint film, and the application of saturating surface coatings.

Solvent reforming treatments utilizing dimethylformamide have successfully reformed paint layers and may be the only option in the most extreme cases of blanching.[9] Unlike surface coatings or media impregnation, solvent reforming addresses the problem of blanching by essentially dissolving the medium, causing the light scattering micro-voids to coalesce into a more continuous film. The process permanently confers an irreversible new structure on the film. Furthermore, the various layers and medium components may differ in their sensitivity to the solvent, resulting in the potential for an intermingling of layers as well as the possible separation of different phases of complex binding media.[10] The application of a drying oil addresses blanching in a similar manner, though with the addition of new material.[11] Acting ostensibly as replacement binding medium, the drying oil fills the voids within the film. Once cross-linked, the added oil is irremovable and will eventually be susceptible to the same embrittlement as the original film. Natural resins of low molecular weight and high refractive index, such as mastic or dammar, have also been utilized to saturate less severe blanching. Most often these varnishes are applied utilizing a slow evaporating solvent such as turpentine.[12] However, any applied coating subject to future removal should utilize solvents of the lowest possible polarity to minimize the problems associated with the pigment/polar solvent interactions mentioned above.

The Treatment

Conservation History

The Fitzwilliam's *Italian Landscape* had been previously lined and slightly enlarged, possibly in the 18th century. Furthermore, curatorial records indicate that the painting underwent treatment with "spirit vapors" in the 1930's to correct areas of blanching. When the painting arrived at the Hamilton Kerr Institute for treatment it was difficult to determine the exact nature of the blanching. In addition to the blanched appearance of several passages, there was a considerable accumulation of surface dirt and discolored varnish layers. At this point it was not certain to what extent the blanching could be remedied. However, removal of the discolored surface coatings would improve the overall tonality and aid in the assessment of the blanching.

Cleaning

Cleaning therefore proceeded, utilizing mixtures of mineral spirits and IMS (industrial methylated spirits, or denatured ethanol). Upon removal of the varnish, there still appeared to be a barrier preventing the penetration of the working varnish and subsequent saturation of the paint. After testing several solvent and aqueous mixtures, a 2% (weight of solute to volume of solvent, hereafter w:v) solution of trisodium citrate at pH 7.5 was found to remove a brown discolored layer from the entire surface of the painting. The swabs were wrung by squeezing and tapped on a dry blotter prior to their application to the surface of the painting. The treated areas were subsequently rinsed three times with deionized water, allowing drying to occur between each application. The exact nature of this coating was difficult to characterize through either solubility or staining of cross sections. As the coating was distributed fairly uniformly across the entire surface, it was most likely the residue of a facing adhesive or other coating applied previously to improve the saturation of the surface.

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[9] Herbert Lank and Viola Pemberton-Pigott, The Use of Dimethylformamide Vapor in Reforming Blanched Oil Paintings, Conservation and Restoration of Pictorial Art, edited by Norman Brommelle and Perry Smith, Butterworth, London 1976, pp. 103-09.

[10] Groen, p. 65. See also Sibylle Schmitt, Examination of Paintings Treated by Pettenkofer's Process, *Cleaning, Retouching, and Coatings: Preprints of the Contributions to the Brussels Congress*, edited by John S. Mills and Perry Smith, International Institute for Conservation of Historic and Artistic Works, London 1990, pp. 81-4.

[11] Burnstock, pp. 6-7.

[12] Burnstock, pp. 6-7.

Upon removal of this surface coating, the paint layer appeared extremely blanched in certain passages. It was possible to momentarily wet out the surface with either solvents or certain varnish formulations. When the surface was wetted with a solvent, such as mineral spirits, the solvent immediately sunk in leaving the surface again blanched. In order to maintain the saturation a working varnish of Regalrez 1094 was utilized. However, the same problem was encountered with the varnish as with the solvents-- it immediately sank in and left the surface unsaturated. Furthermore, mineral spirits evaporated too slowly and allowed the varnish to sink in. Only by utilizing a high resin concentration of 60-70% (w:v) in xylenes was any semblance of saturation maintained. At this concentration the varnish was very apparent on the surface and the saturation still not sufficient for all areas of the painting. Therefore, an alternative would have to be devised for the final varnishing.

Varnishing
On the macroscopic level, the surface of the paint in question was seriously abraded. There appeared to be a lack of medium at the surface of the paint layer, leaving the surfaces of some pigments slightly exposed. Additionally, the paint structure itself was riddled with tiny fissures. In cross sections examined under both reflected light and the scanning electron microscope, these tiny fissures are readily apparent within the paint layers. The micro-voids related to the pigments, the fine fractures within the paint, and the abraded surface conspired against attempts to saturate the paint film. Furthermore, the extensive craquelure created even more potential for capillary penetration of varnish away from the surface. The fineness of the micro-voids and the disrupted surface required a low molecular weight varnish to maximize penetration and levelling. Yet a low molecular weight resin's very mobility was a detriment to achieving maximum saturation due to the multiple avenues away from the surface provided by the craquelure and the tiny fissures. What was needed was a means of capitalizing on the strengths of the varnish while limiting the degree of its mobility. Both natural and synthetic low molecular weight resins were tested in various solvents and at various concentrations. Regalrez 1094 provided both the best saturation and prospects for future removal in aliphatic or solvents of low aromatic content.

The first experiment was to rapidly increase the evaporation rate of the solvent. The no-flow point would be reached much more quickly allowing the resin to remain on the surface where it was needed. A petroleum spirit with a boiling range of 30-40°C was chosen due to its rate of evaporation and negligible aromatic content.[13] The second stage of experimentation involved reducing the concentration of the varnish from the 60-70% (w:v) solution that was previously required. This avoided the development of a thick varnish. The lower concentration maintained an initial low viscosity to allow for wetting to occur while discouraging a thick build-up of varnish. The varnish concentration was taken as low as 5% (w:v), but this did not adequately saturate all areas of the painting. For the final application a concentration of 8% (w:v) was chosen. The rapid evaporation of the solvent required the painting to be varnished in numerous small areas. The size of the painting, approximately 5' by 7', meant that it would be difficult to apply a uniform coating. Prior to varnish application, the entire surface was wet out with mineral spirits[14] applied with a wide brush. The varnish was applied with cotton wool pads wrapped in silk. As Regalrez 1094 is readily re-soluble once applied, care was taken to minimize the overlap of varnish applications and apply the varnish in irregularly shaped areas. The varnish was lightly rubbed into the surface until the varnish began to pull at the silk. Any tidelines that developed were quickly feathered-out using a small circular bristle brush. The above procedure was continued across the entire surface of the painting (see Figure 1).

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[13] The particular solvent was chosen from the BDH Chemical Supply Company's range of petroleum spirits which are differentiated by boiling range. Unfortunately, information regarding neither the exact evaporation rate nor aromatic content was available from the company. Empirically, the evaporation rate was similar to a solvent such as acetone; the solvent evaporated almost immediately upon contact with the surface of the painting.

[14] As with the petroleum spirit above, specific information regarding the evaporation rate and aromatic content of the mineral spirits was not available from the manufacturer. The mineral spirits utilized contained approximately 7-11% aromatics and had an evaporation rate significantly slower than xylene.

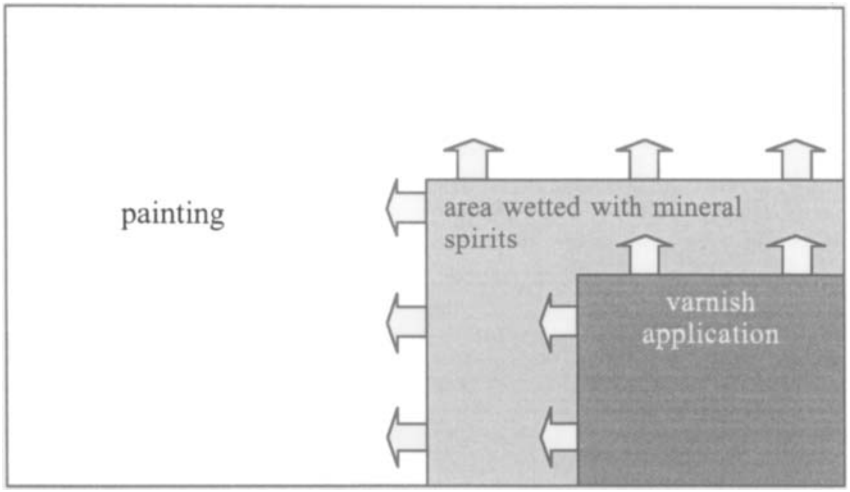


Figure 1: The diagram shows the process of varnish application. Initially mineral spirits were applied with a brush to an area larger than that to be varnished. Before the mineral spirits evaporated, the varnish was quickly rubbed onto the surface using cotton wool pads wrapped in silk. The working time was approximately 10 to 15 seconds before the varnish dried. An adjacent area was then wet with mineral spirits and the procedure repeated until the entire painting was varnished. Care was required when applying the mineral spirits to avoid dissolving the adjacent varnish.

Prior to retouching the painting received 5 light spray coatings of 12% (w:v) Regalrez 1094 in a 2:1 mineral spirits: petroleum spirit (30-40°C boiling range) mixture. The retouching was carried out with dry pigments in Paraloid B72 using 1 methoxy propan-2-ol as the solvent. Following retouching, the painting received 4 more spray coats of the above varnish. Although the varnish applications were numerous, the low resin concentration and rapid rate of solvent evaporation of each application minimzed the varnish build-up. The resulting varnish provided a saturating effect while allowing the subtle gloss differences between various passages to be maintained.

The blanching of paint films is by no means completely understood. The removal of the light scattering surface coating with the trisodium citrate solution permitted access to the damaged paint below. The use of a chelating agent for the removal of a coating in direct contact with a paint film presents certain risks. Precautions, such as limiting the moisture content of the swabs, thorough rinsing, and use of solutions at near-neutral pH were taken to minimize the effect of the treatment on both paint film and pigments. It is difficult to establish exact varnishing parameters, as cases will vary in their extremity of blanching. Obviously the slower the evaporation rate you can get away with the more control you will have over the appearance of the varnish and its manipulation. As blanching may be a cyclical phenomena, it is hoped that the above treatment allows for its reversal in aliphatic solvents while maintaining a flexibility for the blanching to be re-evaluated and retreated at any given time should the need arise.

STUDIO TIPS

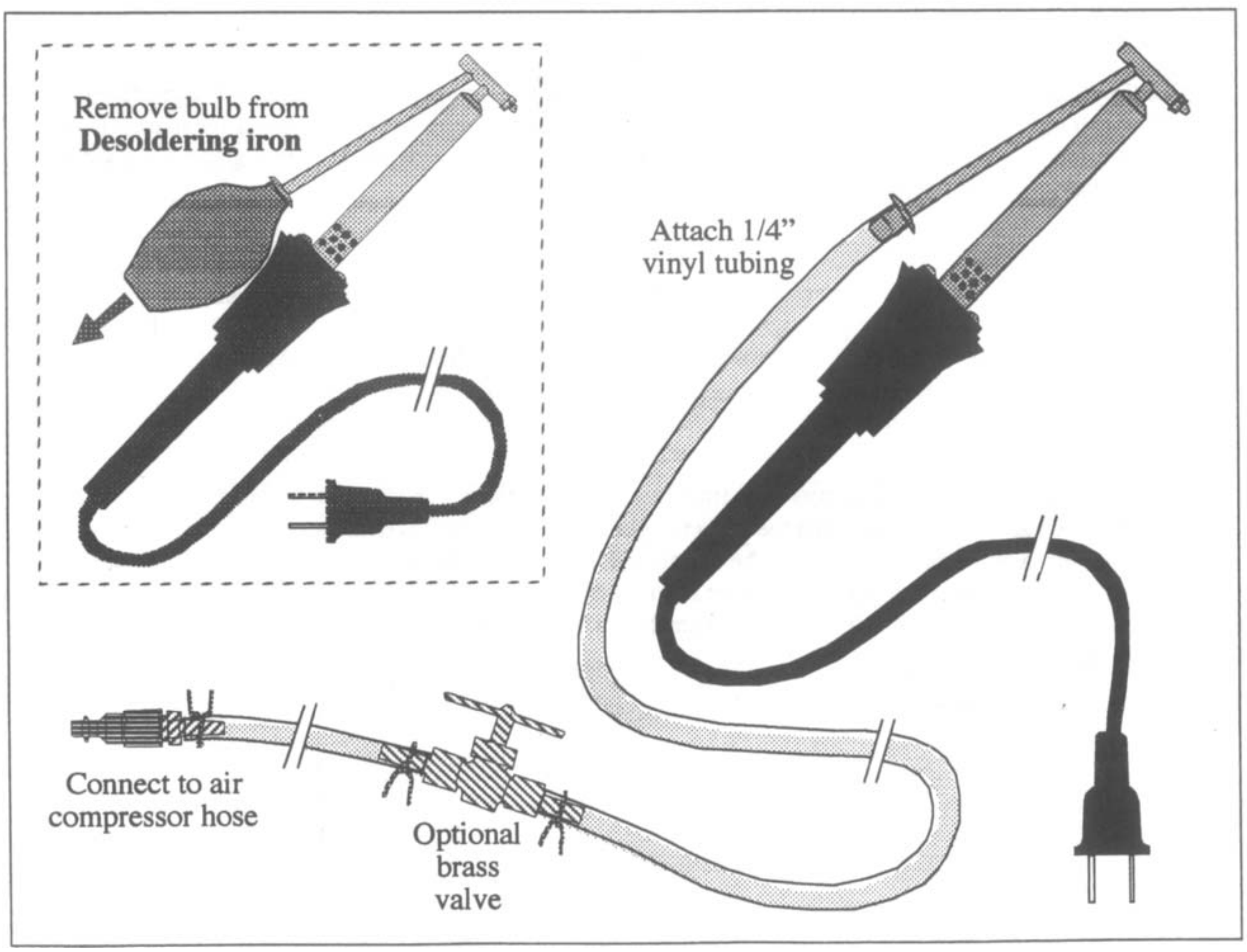
A SIMPLE HOT AIR TOOL MADE FROM A DE-SOLDERING IRON

Mark van Gelder

This studio tip is a way to make a very simple Hot Air Pen by modifying a De-Soldering Iron. Hot air pens are handy tools for locally heating a small area (such as a lifted flake of paint) by means of a gentle flow of hot air, without having to actually touch the surface being heated. You can observe a material (such as a dot of consolidant) beginning to soften or flow, and have direct access for any manipulation of the warmed surface that may be necessary.

A de-soldering iron is normally used to remove unwanted solder. It works like a regular, electric soldering iron, except that it has a hole in the tip connected to a rubber squeeze bulb (like a small turkey baster) on the handle. The operator first squeezes down on the bulb, places the tip on a join until the solder melts, and then releases the bulb, sucking up the solder. Radio Shack sells a 45 watt de-soldering iron for about ten dollars (cat. no. 64-2060-A).

To make the de-soldering iron into a hot air pen, just pull off the rubber bulb and replace it with a piece of tubing that is connected to an air compressor (or an aquarium pump that will produce an adequate air flow). Quarter inch diameter clear vinyl tubing fits onto the Radio Shack de-soldering iron very well.



If you have a have a "quick-release" fitting on your air compressor hose, you can attach the corresponding

Art Conservation Services of Austin, 4604-B Evans Avenue, Austin, TX 78751

quick-release part onto the vinyl tubing from the hot air tool using a standard connector and a small hose clamp (all these materials are available at most hardware stores).

The hole in the tip of the Radio Shack de-soldering iron is quite small, but the tip is threaded and replaceable, so it can be easily removed, drilled out and then screwed back in to create a larger opening. Radio Shack sells extra tips for $1.29 (cat. no. 64-2062), and ones labeled "iron clad" for $1.99 (cat. no. 64-2061), so you can even make a set of tips with various diameters holes.

The air flow at the compressor needs to be adjusted down almost to zero. To further fine tune the stream of air, a small flow-valve (like those made of brass for 1/4" copper tubing) can be installed at a convenient point along the hose, using short sections of copper tubing and hose clamps on either side of the valve. Place the valve far enough from the tool handle so it won't interfere with an object being worked on.

The tool can be plugged into a rheostat, (such as those made specifically for controlling the temperature of soldering irons), if a project requires especially low heat as well as a minimal air stream. I usually just plug mine directly into an electrical outlet, set an appropriate air flow, and adjust the working distance to the object's surface as needed.

When setting up, I get the air flow adjusted about right, put the tool where it isn't pointed directly at a surface, and let it warm up for a few minutes before using it. Once it has equilibrated, it maintains a very constant temperature. since the tip only contacts the steady stream of air.

Unlike the elegant hot air pens offered for sale, this one lacks a built-in way to determine the temperature of the air flow. You can test it by pointing it at thermometers, temperature indicating strips, samples of the materials you plan to use, etc., but I've usually found that just gradually moving the tip towards my hand will give me a good sense of an appropriate working distance.

BLACK GLOVES FOR INPAINTING

Mark van Gelder

Buy a pair of long black costume gloves next Halloween, and use them when inpainting on dark surfaces. It is much easier to see what you are doing when the reflected glare from your hand is eliminated from the surface of the picture. Snip out just a bit of the finger tips on the thumb and index finger for better control and grip. The costume gloves are usually made from some type of synthetic fabric, which can be a little slick, and doesn't breath very well, but they are stretchy, so one size fits all. If you have small hands you might be able to find some nice cotton ones in a vintage clothing shop.

FIXING PAINTINGS IN WORK STRETCHERS WITHOUT FLATTENING THE TACKING MARGIN

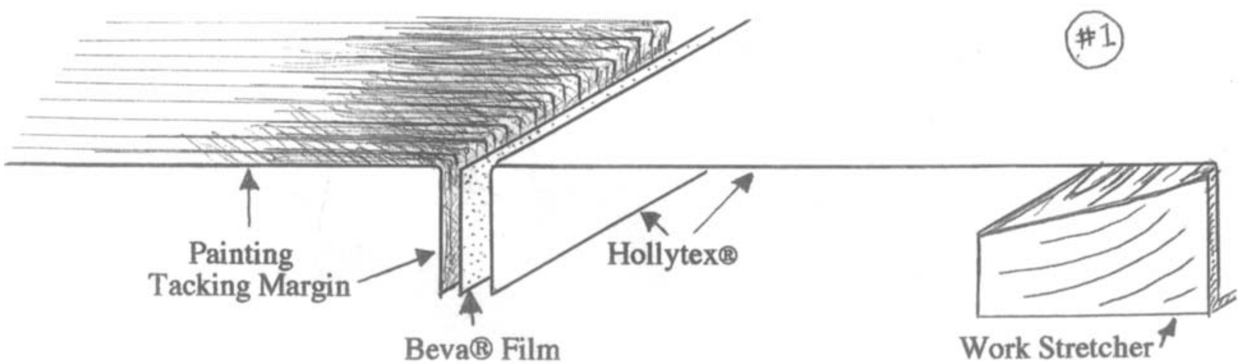
Robert Proctor, Painting Conservator

The following tips are different methods to suspend a painting in a work stretcher while maintaining the fold in the tacking margins. It is often helpful and possibly better for the paint layers to avoid flattening the tacking margin during a treatment.

Hollytex®, Kraft paper or mylar (or other suitable material) can be used. A right angle fold is made in the Hollytex® to mirror the folded edge of the tacking margin. The Hollytex® is then affixed to the outer edge of the tacking margin with BEVA® film (diagram #1). You may want to support the "bridge" where the folded right angles meet with wet strength tissue so as not to put too much stress on the fold over edge of the painting (diagram #2).

Another method has been developed to make the attachment mechanically using Bulldog clips, Fomecor® (or mattboard) and BEVA® film as follows. In this method no BEVA® is attached to the painting. Four pieces of Fomecor® are cut to a length slightly shorter than each tacking margin and twice as wide as the tacking margins. Iron BEVA® film to one side then score the Fomecor® down the middle lengthwise on the non-BEVA® side (so that it can function like a hinge). You will also need folded Hollytex® strips as in the method above to suspend the painting in the work stretcher. Remove the silicone Mylar carrier from the BEVA® and iron the Hollytex® to one side of the Fomecor® covering only half (diagram #3). You will be placing the two right angle mirror folds of canvas and Hollytex® together as you did above. The scored Fomecor® sits over these folded edges to support them. One side is ironed to the Hollytex and the other side contacts the canvas but is not attached. The folded Fomecor® (mattboard) is then placed over the tacking margin and clamped in place with Bull dog clips down the length of each tacking margin (diagram #4). The uncovered Beva® keeps the tacking margins from slipping out when under tension and the Bull dog clips act like a constant tension, spring stretcher. This allows for a little give if too much tension is applied (for example, in the unfortunate occasion that the canvas shrinks rather then expands when placed in a humidity chamber).

After using one of the above methods you are ready to attach the painting to the work stretcher. Velcro® is used to attach the Hollytex® to the work stretcher in the following manner. Using the self-adhesive type Velcro®, adhere the back of the hook side (plastic side) of the Velcro® to the tacking edge of the work stretcher (the outer edge). attach the loop side (fuzzy side) to the hook side. Center the painting in the work stretcher face down. Expose the adhesive backing of the loop side along one edge of the work stretcher and fold the Hollytex® over onto the adhesive (diagram #5). Next, do this on the opposite side making sure there is enough tension to properly support the painting when suspended. Repeat this on the last two sides. It usually helps to separate the hook and loop and staple the loop part of the Velcro® onto the Hollytex® to secure it in place. The Hollytex® can then be cut perpendicular to the edge of the stretcher every few inches to allow for proper adjustment of the tension when the painting is restretched onto the work strainer (diagram #6).



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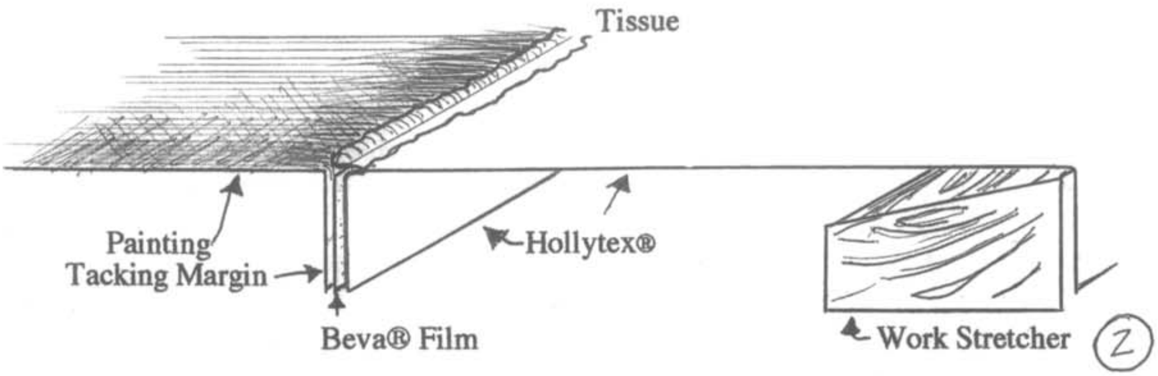
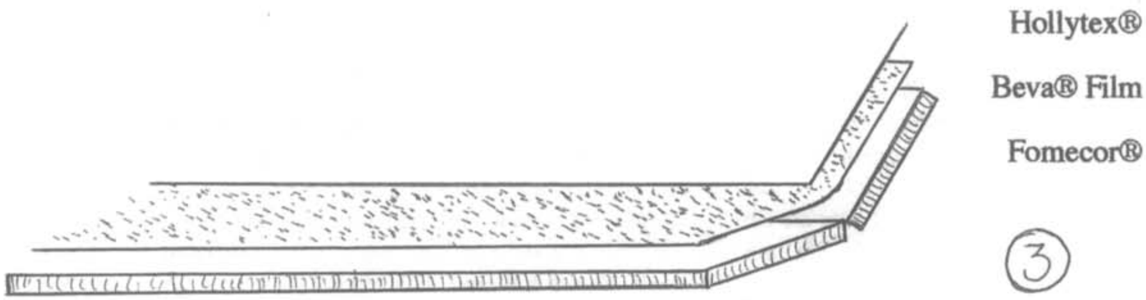
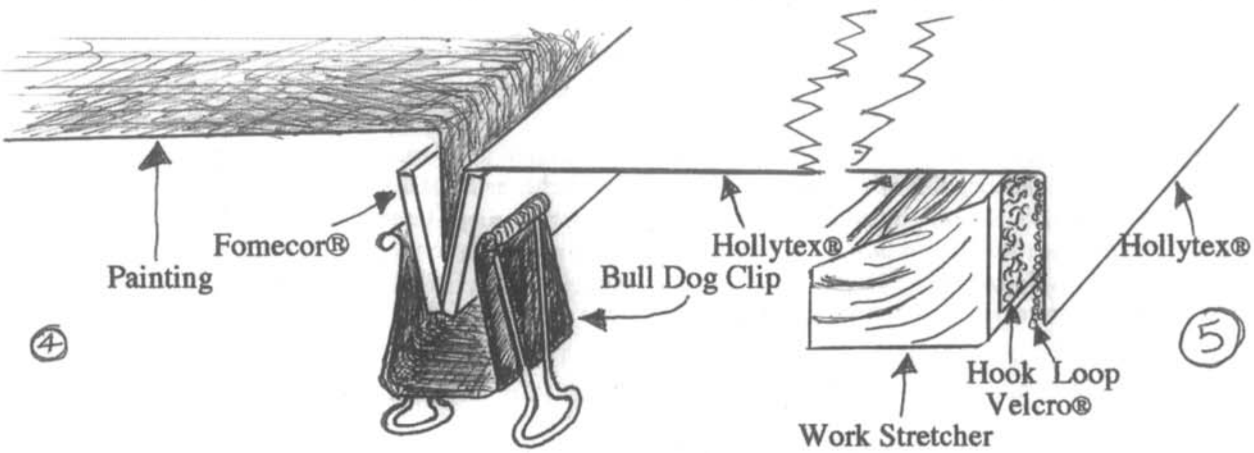

Tissue
Painting
Tacking Margin
Hollytex®
Beva® Film
Work Stretcher
2


Hollytex®
Beva® Film
Fomecor®
3


Painting
Fomecor®
Hollytex®
Bull Dog Clip
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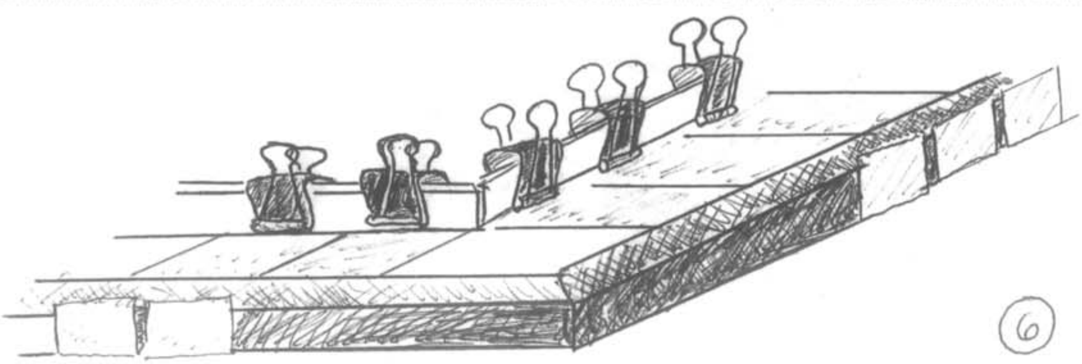
Hollytex®
Hook Loop
Velcro®
Work Stretcher
5


6

AN INEXPENSIVE MINI-SUCTION TABLE

Kenneth B. Katz

Scrap aluminum honeycombed panels and cardboard allowed me to fabricate mini-suction tables that greatly enhanced the efficiency and results of treatments. The first mini-suction table was made out of surplus aluminum honeycomb panels. The panels are composed of a honeycombed section and two aluminum skins. One can pull off one skin like twisting off an old sardine can with key. The remaining surface is drilled with holes at equal intervals in a grid pattern. Fome core is adhered to the unsheathed bottom at the borders so that a plenum is formed. I then placed PeCap 7-60HD over the covered surface using metallic duct tape. The whole structure is then placed over a table with a hole that accommodates the nozzle of a vacuum cleaner. The nozzle is shoved into the exposed hexcel grid and then turned on. By placing the painting over the mini suction table, flush, a workable vacuum is achieved that can draw adhesive into cleavage and tears. If covered with a dartek membrane, cleavage and tears can be put back into plane. The size of my apparatus was 8" x 12"

The use of cardboard came about because I needed to treat a tear that was over the stretcher member. I took a small sheet of one-ply cardboard, took off the bottom which was then placed over a smaller mini-suction table, fabricated as described above. This apparatus was 3" x 3". The cardboard measured 3" x 7" and I poked small holes in the end of the upper surface. The cardboard is oriented so that the channels run perpendicular to the aluminum platform. It is attached to the panel with metallic duct tape. Sure enough, when the vacuum was placed under the small platform, the air was sucked out through the channels and provided a suction under the canvas that was over the stretcher member. The thinness of the cardboard allowed me to wedge it between the stretcher and lower part of the canvas.

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STUDIO TIPS: TEAR REPAIR, CONSOLIDATION, INPAINTING

Carolyn J. Tomkiewicz , Conservator of Paintings

TEAR REPAIR: "RE-TENSIONING"

Once a canvas support is interrupted by a tear, the forces holding the canvas in plane are disturbed. When examining old tear repairs, it has been noted that tears tend to "reappear" in the form of tenting and that lining or mounting-onto "stronger" secondary supports does not necessarily prevent movement of the canvas. Two tears found to be out of plane on two 19th-c. American paintings with different treatment histories were re-treated. The first tear, four inches in length, with frayed edges and an extending three inch perpendicular tear, had been previously wax-resin lined to canvas. The second tear, five inches in length with a straight edge, had been repaired with lead putty and a heavyweight canvas patch. These treatments were reversed as much as possible and the tears re-treated locally. First-time tears with no interfering previous adhesive were approached differently. In preparation for reestablishing tension, flaking along the tear should be locally consolidated. Where not previously treated, 3 - 5% Salianski Kremer sturgeon glue was used. Once the paint layer was secure, the fibers were sized, aligned, woven and readhered with a greater percentage sturgeon glue, gelatin or stronger synthetic consolidant, if appropriate. Medium weight Hollytex coated with BEVA® 371 film was cut into 1/16-inch wide strips and used for "re-tensioning" the tear in the first painting, as this adhesive was compatible with residues of wax-resin from the lining. Long fiber kozo Japanese tissue coated with 20% Acryloid B-72 and cut into 1/8-inch wide strips showed good adhesion for "re-tensioning" the tear with residual lead putty. Strips tested ranged from 1/2 - 2 inches in length. The first strip was heat-sealed along the tip of its width to one edge of the tear, pulled across the tear parallel to the direction of lost tension and heat sealed to an intact section of the canvas. The following strip was heat sealed to the edge of the opposite side of the tear and pulled across the tear in the opposite direction of the first strip. Continuing along the tear, the strips were adhered to alternate sides, pulled in opposing directions and heat-sealed, until the entire tear was "re-tensioned". Branching tears were "re-tensioned" according to the direction of the tear, always returning tension parallel to that lost. The strips were cut in varying lengths to distribute the "pull". The pull of these fine strips in opposing directions from the edge of the tear to an area of more stable canvas bridged the tear and recreated tension to keep the edges of the tear from tenting. Tests were carried out involving several other cases of both frayed and straight edge sharp tears with good results in regaining tension. No impression from the strips was noted on the recto in any of the cases treated. The strips were left on to maintain sufficient tension so that lining could be *eliminated*. The "re-tensioning" of the painting with the five-inch straight edge tear previously patched was monitored for five years; the canvas remained in plane with no sign of recurrent tenting. The formerly wax-resin lined canvas was somewhat brittle and missing all tacking margins. Although the method of "re-tensioning" held the complex tear in plane, the decision was made to re-line in a vacuum envelope with BEVA® 371 flocked onto fine linen. **Warning:** All paint surfaces should be tested for heat resistance prior to the application of any heat-seal adhesive. The use of a marble surface with a silicone-release interlayer reduces heat conduction to the front of the painting. An Archivart® Tycore® insert (the cut edges of which are covered with Archivart® Barrier Paper) that is cut to fit the open space between the stretcher and the canvas and attached to the backing board, affords adequate protection if no lining is carried out.

CONSOLIDATION: ALTERNATIVE TO FACING

A severely contracted, water-damaged American painting from the mid-20th c. was treated. Aquazol 200 was used as an adhesive to hold tented, flaking and dislodged paint in place. It was applied at a concentration of 4 - 5% in distilled water with the addition of a few drops of isopropyl alcohol as a wetting agent, touched to the edge of the insecure areas with a fine brush and allowed to dry. When all flakes were held in place, the ambient humidity was increased to relax the canvas enough for local stretching in a Dutch method. This eliminated the need for a facing during the procedure of expanding the dimension of the canvas. Advantages of using Aquazol 200 as the adhesive over natural glue or other synthetic adhesives were noted. Dislodged flakes could be readily moved into place with the application of a minute amount of water to reactivate the adhesive. Aquazol could also be readily reactivated with heat in the "burnt finger" technique (application of heat with a hot spatula from the reverse) for the final needed local expansion of canvas, thus avoiding the overlapping of flakes. The tip of the forefinger was moistened to avoid sticking to the surface while the lifted area was gently pressed down during the "burnt finger" procedure. Aquazol 200 is compatible with gelatin and sturgeon glue, either of which can be added later to increase adhesion and reduce water sensitivity. Deformation from local expansion could be easily flattened with the suction plate or traditional methods.

BEVA® 371 solution was applied through the reverse of two severely tented, water-damaged early 19th-c. American portraits. Again, no facing was used as this would have interfered with the dislodged and overlapping flakes. After expansion in a Dutch method, an alternative set-up to using a hot spatula in the "burnt finger" technique was employed. A 60W light bulb on a goose neck, "C" clamp lamp was attached to a dimmer. A watch glass was held to the light bulb with a section of nylon stocking tied to the lamp housing to lessen the curve administered to the canvas. The temperature of the light bulb could be adjusted to allow flow of the adhesive. The heat source was removed, replaced by a second watch glass and the flakes adhered by pressing through silicone release Mylar with the forefinger. The soft undulation resulting from the expansion could be corrected by increasing ambient humidity and weighting under blotters.

INPAINTING: PIGMENT & MEDIUM ADMIXTURES

During the treatment of an early 15th-c. Sienese triptych, the natural ultramarine robe of the Virgin of Humility was more closely matched by adding the clear mineral, "Mountain Crystal", to the commercially prepared, fine, synthetic pigment found in the *lefranc & bourgeois* "Charbonnel" inpainting colors used. "Mountain Crystal" was obtained through Dr. Georg Kremer at Kremer Pigments in Aichstetten, Germany, tel. 011.49.7565.91120. This colorless crystal was used to lighten colors and maintain their brilliance without adding white. During the same treatment, the gilded decorative border on the Virgin's robe was discretely compensated by using 20% PVA-AYAB (or Mowilith 20) in ethanol mixed with pigment to simulate the brown, discolored, residual, original mordant. When adequately dry, gold leaf was applied and adjusted for color and gloss with *lefranc & bourgeois* "Charbonnel". Where transparent glazing was needed to imitate discolored varnish, Kremer "Powdered Stains" (metal-complex dyes) were used in PVA-AYAB in ethanol.

In the case of a contemporary oil painting sensitive to aliphatic solvent, inpainting was carried out in watercolor with the admixture of a small amount of Lascaux 498HV to maintain yet lessen its sensitivity to and reversibility in water. This mixture was also tested and found useful on an American 19th-c. oil-wax painting not only because of its good adhesion but also its similarity to the original in surface gloss and its reversibility without affecting original paint layers. In still another case Aquazol 200 at 20% in deionized water was used as the adhesive with cellulose powder and whiting for filling a two-inch diameter interlayer cleavage loss on a contemporary oil painting having a high wax content. Aquazol 200 was mixed with watercolor for inpainting the loss. The adhesion of the fill to the surface of the infrastructure of this mixed media painting was good, and the surface gloss of the inpainting approximated the original. Reversibility remained aqueous on a surface that was affected by other polar and non-polar solvents.

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A TIP ON MICA PIGMENTS, AND A NOTE ON MY EXPERIENCE WITH HYDROGENATED HYDROCARBON VARNISHES

Chris Augerson

Inspired by the treatment of icons that we had just seen, I provided a tip for the inpainting of losses of gold leaf, using tinted, mica-pigments. Because these are even more transparent than the gold leaf itself, and tend to show the undercoats more. Therefore, when painting on a red color like the tyipcal bole, it is best to use the yellower, brass-colored mica pigments. Overlaid onto red, these appear more gold than the gold-colored mica pigments actually do.

I also wanted to mention preliminary experiments that I've conducted usung Regalrez ® 1094 (Hercules), the most stable of the relatively stable resins, proposed for use in picture varnishes by Rene de la Rie and Christopher McGlinchey (1990). Like other low molecular weight resins, it is brittle and must be mixed with a small amount of another component to render it flexible. De la Rie (1993) proposed synthetic rubbers for this purpose, including the more stable sort, styrene-ethylenebutylene-styrene (S-EB-S) block copolymers such as Kraton ® G1650 (Shell). But it is probable that, with artificial aging, the addition of the S-EB-S block polymers decreases its removability in mild aliphatic/aromatic solvants.[1] A resin film containing 90% Regalrez ® 1094 and 10 % Kraton ® G1650, after a large amount of artificial aging, is eventually rendered non-removable in toluene.[2] To further prolong the solubility/reversibility of these varnishes in mild aliphatic/aromatic solvants, de la Rie recommends the addition of « HALS » stabilizers.[3] One disadvantage of these Regalrez ® 1094 varnishes generally is that they are generally too high in gloss.

Some of the varnishes that I've tried using contain beeswax (bleached beeswax, formerly available from Conservation Materials, Sparks NV) rather than the Kraton ® synthetic rubbers. A mixture of 98 parts Regalrez ® 1094 with 2 parts beeswax dissolves in mineral spirits containing less than 0.1 per cent aromatic content (Shell m.s. 200 HT). This is, for concerns of solubility and of low toxicity, very interesting. With only two per cent beeswax the varnish remains too glossy, and a matting agent like fumed silica would be necessary to be added as well ; it also may remain too brittle for use on most painted surfaces. Adding more beeswax, and a little more aromatic solvent to aid its dissolution, would render the varnish more flexible, and should yield varnishes of appropriate gloss. However, the varnish mixtures with beeswax remain not fully tested and their aging properties are not yet

[1] The data being unavailable for the very long-term artificial aging of pure Regalrez 1094, I note the respective change in the removability of the other hydrogenated hydrocarbon studied, Arkon ® P90 (Akawa), upon the addition of Kraton ® G1650 (de la Rie, 1993, his figures 2 and 6).

[2] However, it should be noted that thereafter it is removable in mixtures of toluene and acetone (eventually in pure acetone only). It should also be noted that the amount of artificial aging is 15 times that which causes dammar varnish to become non-removable in toluene (de la Rie, 1993, his figures 2 and 6).

[3] These hindered amine light stabilizers are radical scavengers. A 2% addition of Tinuvin ® 292 (Ciba-Geigy) enables the Regalrez ® 1094 : Kraton ® G1650 (9 :1) mixture to remain removable by a 3:1 mixture of cyclohexane : toluene, for a duration that represents a 57-fold improval, over the removal after artificial aging of dammar varnish (comparing figures 2 and 6 of de la Rie, 1993).

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certain. I cannot yet recommend them for use, with or without added stabilizers. It is my hope that tests will show them to be relatively stable. The painted carriages that I have recently been treating are typically finished with a complex series of glazes and varnishes, in this respect much like certain paintings, particularly of the late 19th century. Even after much aging, their surfaces are often sensitive, even to toluene. I dream of being able to protect them with a varnish as beautiful as a natural resin varnish, but differs in that it will always remain removable in low-aromatic mineral spirits.

Finally, a tip regarding the brush-application of the hydrogenated hydrocarbon varnishes, easily done with only a little patience. It does not go on evenly ; it is best to let it dry thoroughly, before applying a second application. If streaks or thin spots remain after the second coat dries, touch them up with a brush with a VERY little amount of varnish to yield a more perfect surface. To achieve this, I first swirl the liquid varnish in its jar so that it mounts the sides of the jar, and then touch the brush to the side of the jar, above the meniscus.

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