1995 AIC PAINTINGS SPECIALTY GROUP POSTPRINTS

Saint Paul, Minnesota • June 9-10, 1995

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The American Institute for Conservation of Historic and Artistic Works

1995

AIC PAINTINGS SPECIALTY GROUP POSTPRINTS

Papers Presented at the Twenty-Third Annual Meeting of the American Institute for Conservation Saint Paul, Minnesota June 9-10, 1995

Compiled by Joan H. Gorman

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POLYETHYLENE SHEETING AND FRESH OIL PAINT: A STICKY PROBLEM

James Bernstein* and Ria German**

Readers are alerted to the interaction between polyethylene sheeting and fresh or incompletely cured oil paint. Severe damage to a recent painting brought the unfavorable juxtaposition of these two materials to our attention, a phenomenon not widely known by art caretakers. We will describe the problem, explore the physical and chemical dynamics present, and describe the treatment of the altered painting. Painting conditions, treatment options and precautions with fresh or recent oil paintings will be considered.

CASE STUDY / BACKGROUND

In 1988, Bay Area artist Mike Henderson completed the painting <u>Oldies and Goodies</u>. This good-sized work, approximately six feet square (h 70 inches x w 70 inches), is composed of multiple layers of oil paint, applied in appreciable thickness to a medium weight stretched canvas. The paint topography featured dabs of impasto, as much as an inch high, distributed at regular intervals over the surface. The painting was purchased six months after completion (February 1989), at which time it was wrapped in polyethylene sheeting and stored enclosed until 1994, when it was requested by the Oakland Museum (Oakland, California) for inclusion in an exhibition featuring the collection of Bay Area art enthusiast and wine maker René Di Rosa. When the painting arrived at the museum, it was evident that the plastic wrapping had stuck to numerous areas of the painting. Due to active insect infestation, the painting was fumigated in its wrapping in a 70% carbon dioxide bubble envelope for a period of one month. The painting was then brought to James Bernstein's conservation studio for removal of the plastic wrapping and restoration of deformed paint.

The painting had no frame. Neither "L" profile travel frame nor edge collar were introduced to separate the wrapping from the painting surface. The polyethylene sheeting was pulled taut across the painting face, wrapped around to the back, and sealed with plastic tape. It is not known if pressure to the upper-most paint was exclusively caused by the sheeting, or if the painting had been subjected to other external pressures during the five years in storage that followed. Sealed in its polyethylene package and literally 'cooking' in paint vapors in proximity to plastic, the paint had become firmly stuck to the sheeting. Much of the artist's brush work and impasto had been altered. Previously thick dabs of paint were now appreciably flattened; thinly painted, light-colored background areas were wet to the point of running. In each instance, the sheeting had become firmly attached to the areas containing the highest concentration of white paint.

INVESTIGATION OF PAINT FORMULATION AND DRYING

One of the satisfactions conserving modern paintings is the opportunity to contact artists to ascertain working materials and methods. In the Fall of 1994, Mike Henderson was interviewed, and recalled using Classic® Artists' Oil Colors manufactured by DanacolorsTM for this painting and for most of his mature works. He employed the paint straight from the tube with no additions, and all colors were dry to the touch at the time of the painting sale. This was the first instance he heard of one of his paintings undergoing visual and physical change from contact with plastic. ¹

A chemist for Danacolors^{TM²} related that Classic[®] Artists' Titanium White Oil Color D272 is composed of titanium dioxide (most likely with added zinc oxide) ground in refined safflower oil, with the addition of a paint drier of their own manufacture.³ Given drying times for a 1 mil paint thickness at average temperature and relative humidity are 1-2 days to touch; hard cure is rated at 7 weeks to 3 years depending on application thickness.⁴

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A number of artist's white paints are formulated with slow drying oils, such as nut or flower seed, that yellow less with age than linseed oil, thereby producing a 'whiter' paint. To counteract the difference in drying time between slow drying and typical tube colors, manufacturers routinely add driers to the formula. White lead, the traditional artists' oil white, is itself a drier, and is noted for producing tough, quick-setting films. Due to its toxicity, it has become increasingly difficult for artists to obtain, and has been replaced in great part by titanium dioxide, and to a lesser extent zinc oxide.

Safflower oil is a semi-drying oil with an iodine value of 130.⁵ The iodine value is a measure of unsaturation and relates to the number of double bonds present in the molecule. Oils with higher iodine values contain more double bonds, which are chemically reactive sites for the attachment of oxygen⁶. Increased drying and oxidation is associated with the increase of double bonds, and an oil without double bonds will not dry.⁷ Through the process of oxygen conversion, oil paint undergoes chemical and physical change to form a hardened film. The process is greatly accelerated by the addition of heat and light.⁸

The relationship between iodine value and drying is demonstrated in the following table:

	IODINE VALUE	CLASSIFICATION
Linseed	155 - 205	Drying Oil
Safflower	130 - 150	Semi-drying Oil
Walnut	120 - 150	Semi-drying Oil
Poppy seed	120 - 150	Semi-drying Oil
Castor	< 100	Non-drying Oil
Cottonseed	< 100	Non-drying Oil

STAGES OF DRYING FOR OIL CONTAINING FILMS

The stages of drying for oil containing films are: solvent evaporation, oxidation, thickening or polymerization, and gellation. At the gellation stage, a continuous network is formed, however the film is still soft. Oxygen conversion continues until the film becomes hard, and finally brittle.⁹

In the conversion from a liquid to a solid material, oil paint goes through the following overlapping phases:

- Induction period oxygen absorption is negligible. Oils contain natural anti-oxidants that must be destroyed before natural oxidation can commence.
- Oxygen absorption the film absorbs 10 12% of its weight in oxygen.
- Polymerization phase the oil polymers join in a structure or framework throughout the film and it is now a gel, containing liquid material within the framework of a solid.
 - Reactions are more rapid at the surface where there is more contact with oxygen.
- Surface Dry the surface of the paint is a continuous solid material; oxygen absorption continues.
- Through Dry the paint film still contains liquid material, keeping it flexible.

Complete conversion to a solid material is greatly retarded by poor accessibility to oxygen and perhaps by non-drying stearic and oleic components found in the oil.

THE ROLE OF DRIERS

Driers are generally combinations of metallic soaps of lead, manganese and cobalt. The effect of using a mixture of dryer metals is greater than the sum of the individual components. Cobalt has the greatest drying ability, but because of its strength, it causes the formation of a surface skin. This reduces the diffusion of air to the film and retards through drying of the paint. Since drying of oil is accompanied by expansion, the development of a surface skin over a soft under layer is likely to produce wrinkling¹⁰. Manganese is the second most active drier metal, combining both

surface drying and through drying capabilities¹¹. The main value of lead in a mixed drier is to promote through drying, catalyzing the gellation phase of film formation¹². The DanacolorsTM drier is also an amalgam of drying agents (12% cobalt alkonate solution, 12% Zirconium, 4% calcium naphthenate, an auxiliary drier/catalyst, in a diluent of mineral spirits). ⁴

THE INHIBITION OF DRIERS

The Marketing Coordinator for DanacolorsTM related an occurrence in the commercial sign painting industry where paints containing driers were applied to a vinyl substrate and never dried. He surmised that the function of the driers were "counteracted" by the vinyl. He suggested that a component (a plasticizer) in the vinyl might inhibit driers in the paint formulation.¹³ Ironically, the literature for the DanacolorsTM Oil Colors recommends, "...may be applied to interior/exterior canvas wood, metal surfaces, glass, plastic, vinyl and leather..." ¹⁴

POLYETHYLENE MANUFACTURE AND COMPONENTS

Polyethylene is a versatile material, viewed as relatively stable, inert, inexpensive, and available in a great variety of weights, sizes and formats. Used extensively for the protective wrapping of paintings, polyethylene sheeting is an excellent moisture and environment barrier, and is especially convenient for over-sized work.¹⁵ While the impermeability of polyethylene is generally regarded as an advantage, in the case of fresh oil paint this quality interferes with the exchange of air and the oxidation of the paint film. Of further concern, the general-purpose, hardware store variety of polyethylene sheeting typically used for wrapping of paintings is of variable quality, mostly non-archival. Physical irregularities abound and a slippery, gritty feel or substance is often observed on the plastic surface. Speaking about the composition and manufacture of this material, one independent polymer chemist described a formula component called "slip", which acts as a lubricant, keeping the plastic mixture from sticking to equipment during manufacture. Another polyethylene industry representative¹⁶ also acknowledged the use of "slip", which he described as mostly talc and silica. If too much is added, the excess is carried to the surface, forming a residue. He reiterated that nothing is applied directly to the polyethylene surface.

In an article by R. Scott Williams of the Canadian Conservation Institute¹⁷, he states that "To produce a useful plastic, ... [a] polymer must be modified by the incorporation of additives,..." He indicates that the concentration of plasticizers and fillers varies as greatly as 10 to 35%. Incompatibility between a polymer and the additives results in the migration and exudation of the substances to the plastic surfaces. "As a result of diffusion ..., additives can migrate to surfaces where, if they are not volatile, they collect as a discrete exuded layer (this property is sometimes used intentionally in the case of slip agents and anti stats). If the exudate is removed, a new concentration gradient is set up and more additive migrates to the surface to replace the lost material." The mechanisms for the diffusion are thoroughly described in his paper. Some of the additives that Williams mentions are classified as antioxidants. He describes chemical reactions taking place within plastic that are very similar to the oxidation of fresh oil paint. Oxygen is absorbed and dissolved in the polymer, and then diffuses to reactive sites on the polymer macro molecule. The table that follows is from William's article:

PLASTIC ADDITIVES	
 Plasticizers 	• End-use Modifiers
• Stabilizers	- colorants (organic/inorganic dyes and pigments)
- antioxidants	- reinforcing fibers
- heat stabilizers	- fillers and extenders
 Processing Aids 	- UV absorbers
- internal lubricants	- antistatic agents
- mold release agents	- antiblock agents
- slip agents	- barrier coatings
- blowing agents	- laminating process
00	

In the case of the Henderson painting, even after removal of the polyethylene and exposure of the art work to air, the paint remained extremely resistant to drying. We believe that a component of the plastic transferred to and arrested the progressive drying of the paint.

The transfer and interaction of components in polyethylene was noted in the textile industry as early as the 1970's. Yellowing of fabrics was observed in textiles that had been wrapped and stored in polyethylene. In 1983, Kenneth C. Smelz surveyed research on this subject and identified the plasticizer "Butylated Hydroxytoluene (BHT), present in almost all polyethylene wrappings or bags..." as the source, noting "...diffus(ion) out of the polyethylene(and) migration into fabrics and interaction with nitrogen dioxide in polluted air to produce yellowing of textiles, especially whites"¹⁸. This phenomenon presents a special threat to paintings where exposed passages of natural or white canvas are an integral part of the painted design. The potential exists for color shift of oil paint colors as well.

Physical defects in polyethylene sheeting also have negative consequences. Inclusions (hard lumps), creases, wrinkles and other abnormalities have been known to leave disfiguring imprints and deformations in malleable paint.

PAINT AND POLYETHYLENE EXPERIMENT

To observe the drying behavior of the DanacolorsTM® Artist White and the result of direct surface contact with, and storage in, polyethylene, eight mock-up panels were prepared. Each 8 x 10 inch pre-primed canvas on wooden strainer was given a base coat of DanacolorsTM Titanium White Classic® Artists' Oil Color. The base coat with horizontal band of impasto was allowed to dry to the touch, and then large dabs of the same oil paint were applied and the paintings were set aside to dry. When fabricating the panels, we noted a very strong, irritating solvent odor off-gassing from the paint for an extended period [The MSDS sheet for the paint only refers to a solvent content of 1% mineral spirits]. The panels were allowed to dry to the touch (5 weeks from time of fabrication). Holding two controls aside, the test panels were successively wrapped in polyethylene sheeting and sealed completely with clear packaging tape, one every three weeks.¹⁹ The panels were photographed four months later.

OBSERVATIONS

The outwardly dry appearance of a recent painting can be misleading. Like chocolate-coated truffle candies, thick applications of rich paint may display a firm outer crust that conceals a fundamentally wet center. The large paint dab on Panel B, a control that was exclusively air-dried for four months and never wrapped, was cut in cross-section to reveal that the core was still very wet, as if fresh from the tube. It was disturbing to discover that after four months the total firm skin thickness of a one inch high ball of impasto was less than a 32nd of an inch.

Looking at the wrapped samples after three weeks to four months in polyethylene, the following was observed:

- Panel C the first (freshest) panel wrapped shows oil exuding from the paint.
- Panel D shows less free oil, but deformation from the plastic.
- Panel E associated with a break in the paint skin, there is oozing of wet interior material,

clinging to and traveling along the smooth plastic.

Panel F - the impasto dab broke in three places, resulting in triple-fold exudation.

Panel G - the impasto shows deformation with no breaks or oozing.

Contact and pressure from polyethylene may cause stretch, flattening and rupture of paint formations. This enables oozing of wet color from the interior. 'Cooking' of unpolymerized oil paint, in combination with drying inhibition from polyethylene sheeting plasticizers, encourages further liquification of an affected region. The conclusion may be drawn that the wetter a painting is when wrapped and the longer paint remains sealed in direct contact with polyethylene sheeting, the greater the potential for deformation and loss.

CONSERVATION TREATMENT OF HENDERSON'S OLDIES AND GOODIES.

The polyethylene was carefully cut away from areas that were free, leaving plastic wherever adhered to sticky paint. During treatments such as this, it is important to leave affected areas covered until prepared to treat each individual region; once uncovered, paint may begin to dry, becoming hard and less workable. Several different approaches were essayed to separate the plastic from the paint. Chilling with ice was not successful since it affirmed attachment. Heating by warm air blowing softened the center of the paint too much, leaving paint adhered to both interfaces. Direct contact warming of the top plastic surface was the method that proved most satisfactory. Heat was applied very briefly with a small tacking iron. The plastic was then slowly peeled away at a very low angle; this was crucial, to avoid upward pull, lifting and loss of paint. Since the paint was extremely wet, a tool was needed to physically separate the paint from the plastic. An indispensable instrument was a thin, flat antique bone hoop slip stay, stropped periodically with silicone (transferred from a few drops of fluid applied to a dry blotter square).²⁰ Almost no paint was lost.

With the polyethylene removed, it was apparent that under colors had traveled to the upper design layers. Unwanted drips and flows covering the top of original paint needed to be removed. The bulk of the deposits were pared away with spatulas, followed by rinsing of the residual color with micro-swabs of fast evaporating aliphatic and aromatic hydrocarbons (60% toluene: 40% heptane). Insects entrapped in the sticky paint (towards the painting perimeter) were removed with tweezers. Since the paint remained very droopy, the painting was turned periodically during the treatment (rotated 180 degrees) to discourage further changes of configuration from gravitational pull.

Further physical manipulation (reforming) of the deformed original was necessary. The still-soft, flattened paint was modeled and tooled to simulate the appearance of the original brush work and impasto. Since no detailed documentation of the surface topography existed, undamaged paint formations were used as reconstruction models. Stiff bristle brushes lubricated with odorless thinner were successful for resurfacing some areas; in others, the lubricated collar stay worked best to restore brushstroke 'grooves'.

TECHNIQUES FOR WORKING ON SOFT PAINT

A few comments about materials and technique are offered:

• Dry Systems. Dry methods of paint manipulation performed at room temperature are generally not particularly effective. Localized controlled warming from a tacking iron or heated air instrument (sometimes with and sometimes without the use of silicone release mylar) may be useful to temporarily soften paint and facilitate manipulation.

• Wet Systems. It is often helpful to use water as a tooling lubricant, the water readily beading up due to surface tension with the fresh oil paint. If natural fibers from wrapping paper have become adhered to a paint surface, moisture may be useful to assist in the swelling and removal of the attachments. In some instances, an extremely mild solvent may work as a lubricant or to swell the upper surface to release adhered or entrapped materials.

• Spatulas and Instruments. Metal from steel spatulas or surgical instruments may mark paint or leave a gray-black residue, especially upon paints of lean consistency. Preferable instruments are Teflon spatulas, ivory/bone instruments, wood/bamboo spatulas, or a Letraset® hardball burnisher.

• Cotton wool swabs. Cotton wool fibers can become readily embedded in soft or tacky paint. Make custom mini-swabs, wrap them tightly and pre-wet with them water, then dip into a solvent mixture (if appropriate). Saliva, often substituted for water in the cleaning of paintings, may have a strong solvent action on fresh oil paint, thinning or dissolving certain washes or glazes; for modern paintings, deionized water is usually safer.

• Brushes. Lubricating and cleaning solutions are often best applied by brush. Soft hair brushes are less abrasive than cotton wool and do not leave fibers behind. Select larger size brushes for holding appreciable liquid, smaller sizes for minimal liquid and greater control. Brush rinsing of the surface may also be helpful for etching or matting down excessively glossy surfaces created by polyethylene or tooling activity. Rinsing with a fast evaporating mild solvent such as heptane (or a mixture of heptane and toluene if necessary) and immediate blow drying may help to reduce localized superfluous surface oil and gloss.

Ideally, after any physical reforming procedure, a lengthy drying period would be allowed (several years for a painting as wet as this) to enable adequate set and isolation prior to the introduction of any restoration materials. The Henderson painting, however, remained visually unexhibitable, and because of immediate exhibition intentions, inpainting was requested. Color compensation was accomplished by using dry pigments dispersed in a mixture of heptane and petroleum benzine, applied to the painting surface with very small brushes (Winsor Newton Series 7 Kolinsky sable watercolor brush, # 00 size). This enabled great precision and control. Excess binder from the rich original paint was

sufficient to hold the pigment. Since incorrect pigment applications are not readily removed, it is essential to apply color with extreme accuracy and restraint.

Upon completion of treatment, an "L"-profile collar of foam board was attached to the painting before wrapping and transportation of the painting to the Oakland Museum. After two months on exhibit, the painting was refit with a collar and wrapped in polyethylene (temporarily) and returned to the Owner. Contrary to our recommendations, the painting was initially returned to storage and left wrapped in polyethylene! Reiterating the importance of exposing the painting to air so that drying may proceed, the painting was unwrapped and remains so.

DRYING REQUIREMENTS OF MODERN PAINTINGS

Film formation may require anywhere from five to fifty years to dry to a firm 'set' depending upon the materials, techniques and subsequent environmental exposure. Rich soft, slow-drying, non-drying, wet or tacky paint, used either locally or overall, may take an especially long time to dry, possibly never setting properly. A list of just a few of the many artists whose works exhibit soft or tacky paint, even after up to fifty years of drying, includes *Ross Bleckner, Joan Brown, Bruce Conner, Willem DeKooning, Richard Diebenkorn, Hans Hofmann, Brice Marden, Joan Mitchell, Od Nerdrum, Nathan Oliveira, Hassel Smith, Clyfford Still, Donald Sultan, Cy Twombly.* It is important to remember that works from one period of an artist's *oeuvre* may differ greatly in materials and behavior from works from another period.

INHERENT FACTORS: MATERIALS AND TECHNIQUE

Frequently problematic colors include:

- Whites (non-yellowing formulations);
- Lakes/dyes cast on transparent particles and pigments requiring lots of medium: alizarins, madder, phthalocyanines; yellows, oranges, greens; darks, siccatives;
- Blacks (often very rich to insure saturation and gloss);
- Additives waxes, bitumens, oils, mediums: "Old Master exotic a"; old paint-diluent slurries;
- Specialty paints not formulated for artist use, e.g., anti-corrosion or rubberized coatings;
- Incompatible materials.

Techniques that contribute to inherent material problems are rapid layering of paint, heavy build-up of paint, and painting over earlier dried (often dirty) paintings. Paint films that exhibit wrinkling, alligatoring and skin formation defects indicate premature drying of the top layer(s) of paint. In many instances, as in the Henderson, the materials may be of high quality but are not used in a traditional manner.

INDICATIONS OF PROBLEM PAINT

A thorough examination is essential to identify rich, soft or potentially wet paint in modern paintings. This includes careful study of the face, edges and reverse, and the testing of each color in multiple locations by a variety of means: visual, olfactory (smell), contact sensitivity, heat sensitivity, aqueous agents, and slow and fast evaporating aliphatic hydrocarbons. Tell-tale signs of a rich or still-wet painting structure include high gloss, a 'wet' look, oozing medium, tacky surface, entrapments (inclusions of hair, insects, finger soil), soft or spongy to the touch, wrinkles, fissures, pronounced thickness, and oil-soaked canvas reverse. In extreme cases, drips of oil color may travel down the painting or fall to the floor directly below where a picture hangs.

CONTRIBUTING FACTORS

Unfavorable environmental conditions will inhibit the set or cross-linking of oil paint and may temporarily or permanently increase flow, tack and adhesion of paint to wrapping materials. Temperature extremes, elevated humidity, lack of air exchange (as found in cold damp studios), unclimatized transit and poorly designed storage environments are especially undesirable. External forces will exacerbate unfavorable climatic conditions, increasing the damage potential. Particularly to be avoided are wrapping materials under tension and in direct contact with the paint surface, handling pressure, objects leaning against paintings, stacking wrapped paintings with surfaces against boards or other paintings, and pressure from transport blankets or ropes.

POLYETHYLENE WRAPPING CAVEATS

- The quality of polyethylene sheeting products varies greatly. Polyethylene should not be assumed to be a 'clean' product, safe to place in contact with paintings. Obtain quality grades (ideally archival) of polyethylene for wrapping fine art and artifacts.
- Components found in polyethylene may transfer to the paint surface and inhibit full oxidation of incompletely dried oil paint films, especially those containing slow-drying oils, such as safflower.
- Plasticizers and additives in polyethylene may migrate into passages of unpainted canvas in the painting design, and combine with atmospheric pollutants to cause yellowing of fabric, especially whites.
- In a sealed environment, non-volatilized components in a painting structure may have a solvent-like effect over time, allowing a seemingly dry painting to 'cook' and soften.

WRAPPING, TRANSIT AND STORAGE RECOMMENDATIONS

- "L"- profile edge collars (card or foam board, secured to sides or rear) should be used for wrapping unframed paintings, or paintings whose frames do not allow sufficient separation between the wrapping material and the picture surface.
- "L" profile floater frames are recommended for travel and storage. Off-gassing frame or crate construction materials (such as resinous raw wood) should be avoided or thoroughly sealed.
- Recently completely oil paintings should not be stored in polyethylene or other material envelopes that do not allow sufficient air exchange and oxygen to reach the paint surface. If a clean, stable environment can be provided, store paintings unwrapped.
- If a painting is to be stored wrapped, allow air holes in wrapping. Pre-wrap paintings in clean materials, such as silicone release or glassine paper, being certain that no material touches the surface. A crisscross grid of webbing may be stretched across the top of the "L" profile frame to help keep wrapping materials away from the paint.
- After transit, unwrap paintings promptly.
- Storage ideals of low temperature and minimum air change are not appropriate for fresh or not-fully-aged paint. Exhibit paintings rather than storing in early years, providing moderate air exchange and humidity.
- Solvent-based fumigants should be avoided; these may have a softening effect upon fresh paint.
- Painting reverses should not be sealed completely with backings early on; a sealed reverse inhibits vapor escape.
- During exhibition, spacers should be set between paintings and walls to allow for air exchange.
- Provide clean environments, especially until paintings lose their tack stage.
- Explore new materials for protective wrapping of paintings.

CONCLUSION

Artists, gallery personnel, registrars, curators, conservators, and all handlers of art need to be informed of the unfavorable consequences of coupling of polyethylene wrapping and fresh, soft or sticky oil paint. With appropriate identification and precaution, early alteration and damage to modern paintings may be prevented. Further research is greatly needed on this phenomenon, as well as alternative safe wrapping materials and systems for the protection of modern works in transit and storage.

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END NOTES

¹ Telephone interview (Ria German) with artist Mike Henderson, January 1994.

² Telephone interview (Ria German) with Ray Benedetti, Chemist, Danacolors[™], a division of Triangle Coatings, Inc., 1930 Fairway Drive, San Leandro CA 94577-5631. (800) 4-PAINTS, January 1994.

³ 12% Cobalt Alkonate solution, 12% Zirconium Drier, Auxiliary Drier (catalyst), 4% Calcium Naphthenate, in Mineral Spirits.

⁴ Triangle Coatings, Inc. DanacolorsTM D200 Series Artists' Oil Colors A General Overview. San Leandro, CA:DanacolorsTM, 3/94, pp.1-2.

⁵ Gettens, R. J. & G. L. Stout, Painting Materials A Short Encyclopedia. New York: Dover Public, Inc., p. 59.

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⁹ Fuller, (Unit One), p. 24.

¹⁰ Fuller, (Unit Two), pp. 19-20.

¹¹ Stewart, William J., *Paint Driers and Additives*. Federation Series on Coatings Technology, Unit Eleven. Philadelphia: Federation of Societies for Paint Technology, 1969, p. 17.

¹² Fuller, (Unit Two), pp. 19-20.

¹³ Telephone interview (Ria German) with Tom Neale, Sales Service Manager, TRM Manufacturing, La Miranda, CA 90637. (714) 523-8640, May 1995.

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¹⁵ National Gallery of Art, <u>Art in Transit: Studies in the Transport of Paintings</u>. Editor Marion F. Mecklenburg.; and <u>Art in Transit: Handbook for Packing and Transporting Paintings</u>. Editors Richard, Mecklenburg and Merrill. [Proceedings of the Conference and Workshop, London 1991]. Washington, D.C: 1991.

¹⁶ Telephone interview (Ria German) with Tom Neale, Sales Service Manager, TRM Manufacturing, La Miranda, CA 90637. (714) 523-8640, May 1995.

¹⁷ Williams, R. Scott., "Composition Implications of Plastics Artifacts: A Survey of Additives and Their Effects on the Longevity of Plastics", Canadian Conservation Institute, *Saving the Twentieth Century: The Conservation of Modern Materials*. [Proceedings of Sept. 15-21, 1991 Conference Symposium, Ottawa, CA] Edited by David W. Grattan. CCI, Ottawa: 1993. pp. 135 - 153.

¹⁸ Smeltz, Kenneth C., "Why Do White Fabrics and Garments Turn Yellow During Storage in Polyethylene Bags and Wrappings?" *Textile Chemist and Colorist*. Vol 15, No. 4, Apr. 1983, 5 pp.

¹⁹ Panel C wrapped 5 weeks after fabrication; Panel D wrapped 8 weeks after fabrication; Panel E wrapped 11 weeks after fabrication; Panel F wrapped 14 weeks after fabrication;, Panel G wrapped 17 weeks after fabrication.

²⁰ Use of silicon fluid on paintings is not recommended. In this instance, it was the only substance that enabled manipulation of paint with minimal loss.

VARNISHES: AUTHENTICITY AND PERMANENCE A REPORT ON THE OTTAWA COLLOQUIUM

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Abstract

A synopsis is given of the ideas discussed at the Colloquium Varnishes: Authenticity and Permanence held September 19-20, 1994 in Ottawa. Questions have risen amongst conservators regarding the conclusions which were reached at this event. It was the intent of the organizers, Dr. Leslie Carlyle and James Bourdeau, to provide a forum for a diverse group of paintings conservators to meet and discuss their varnishing options in the context of two days of papers by conservators, scientists and art historians with a special interest in varnish studies. Speakers were chosen in order to cover several areas: the development of modern synthetic coatings which have found their way into the standard repertoire; recent developments of new low molecular weight polymers and their modification to mimic the behaviour and handling of natural resins; the necessity to evaluate the appearance of paintings and their varnishes in a museum both individually and as a collection; techniques used in the identification of degraded natural resins; the development of techniques which prolong the lifespan of natural resin varnishes; studies of traditional materials and recipes, and research into historical attitudes towards varnishing and their bearing on modern concepts of authenticity.

Although the organizers did not wish to promote one technique or material over another, it was inevitable that some of those present felt encouraged to re-evaluate their approaches to varnishing. This was reinforced, of course, by the two-day Workshop, following the general meeting, which permitted those who attended to try many of the materials which were discussed at the Colloquium.

One of the aims of the Colloquium was to clear up some of the confusion about the longevity, reversibility and appearance of some of the modern synthetics versus that of traditional natural resins. Although Acryloid B-72 does change slightly in polarity, thus solubility, under lighting with a high UV component, its stability is still unrivalled. Its problems in matching the appearance of lower molecular weight, high refractive index varnishes were discussed. Dammar was put in its place, historically, as a varnish of fairly recent introduction which has become a "cure-all" for those seeking an "authentic" appearance for their pre-modern paintings. Questions were raised regarding whether or not water-clear varnishes are appropriate for paintings of certain historical periods.

Principal themes which emerged at the Colloquium were that materials at our disposal have a range of visual and ageing characteristics and that some do not warrant a blanket condemnation simply because their longevity is slightly less than optimum; that paintings under our care can be seen both as historical objects and as modern images and that much more work needs to be done to augment our understanding of authenticity before it can be of consistent use in guiding our varnishing decisions.

Introduction

On September 19 and 20, 1994, the Canadian Conservation Institute held a Colloquium at the National Gallery of Canada, in Ottawa, as a forum for the discussion of current attitudes towards picture varnishes. the meeting, *Varnishes: Authenticity and Permanence*, was organized by me and Dr.Leslie Carlyle, who is also a Paintings Conservator at CCI. This paper is intended to give a brief overview of what topics we intended to cover and what sort of ideas arose from the papers and discussions at the event. The Colloquium was followed by a two day Workshop where 20 participants were able to handle and test a comprehensive range of historical and modern varnishes. I will not discuss the Workshop at length, but I will make passing references to its content.

Our rationale for choosing the speakers allowed us to cover some very important areas which fit with our theme of *permanence*, meaning the longevity of varnishes, their stability and removability, or lack of it; and

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authenticity, meaning the historically appropriate physical characteristics, the materials and the appearance of a varnish within a period context. The purpose of this paper is to help clarify some of the opinions which I have heard over the past year, about what the Ottawa Colloquium recommended that we should or should not be using.¹

Thirteen speakers from North America and Europe made presentations at the Colloquium. The first day began with a substantial talk by René de la Rie in the form of a review of his work on the deterioration and stabilization of natural resin varnishes. This was followed by a discussion of new work by him on Regalrez 1094 and the use of polymer modifiers to control viscosity and handling along with a section on practical applications by Jill Whitten of the Art Institute of Chicago.

Permanence

To set the stage for a discussion on permanence, Alan Phenix, Lecturer in Conservation and Technology at the Courtauld Institute of Art, London, spoke on *Synthetic Resins as Surface Coatings* and tried to give a general picture of the properties, benefits and limitations of synthetic resins up to the more recent work done by René de la Rie.²

Polycyclohexanones

Alan outlined a very useful, albeit notoriously complicated, history of the development of polycyclohexanone varnishes, the commercial versions of which date back to 1937 when Winsor & Newton offered AW-2 for sale as Winton Picture Varnish.³ The physical problems and poor ageing characteristics of AW-2 and the early MS-2 prompted the development of the hydrogenated forms of cyclohexanone which we all know as MS-2A, MS-2B (Howards of Ilford) where the carbonyl groups are reduced in the presence of hydrogen to hydroxyl groups. Historically MS-2A was a combination of cyclohexanone and methyl-cyclohexanone, but under its current producer, Linden Chemicals,⁴ it is made entirely from methyl-cyclohexanone, thus forms a more flexible film than did the old MS-2A. Alan had little praise for Ketone Resin-N (BASF) and Laropal K-80, which are

² The focus of coatings research since the 1930's has vacillated between attempts to provide tough coatings designed for protection and permanence versus coatings with handling and aesthetic properties closer to those of natural resins. Alan Phenix briefly summarized the use of polyvinyl alcohols and polyvinyl acetates in conservation. PVOH is subject to crosslinking and has problems adhering to non-polar surfaces. The PVA's are classed Feller A1 in stability but, over time, most conservators have rejected the PVA's for finishing varnishes because of their low refractive index and glass transition temperatures. in PHENIX, A., "Synthetic Resins as Surface Coatings", *Varnishes: Authenticity and Permanence - Proceedings on Audio Cassette*, Canadian Conservation Institute, Ottawa, 1994. PVA's tend to saturate poorly and can imbibe much dirt and the rather high viscosities hinder film levelling on textured paint; therefore, most conservators have restricted the use of PVA's to that of a varnish interlayer to control uneven saturation.

³ AW-2 was advertised as a synthetic polymer combined with a "secret" plasticiser to produce a varnish which had none of the disadvantages of dammar and mastic. The resin was developed in the 1920's by BASF in Germany. The "secret plasticizer" was probably the methylated cyclohexanone monomer. AW-2 did, in fact, have its own disadvantages, which were an unacceptably high gloss and brittleness. in ibid.

⁴ Dr. Vincent Routledge, Linden Chemicals Ltd., 18 Trinity Court, Birchwood, Warrington, Cheshire WA3 6QT, tel. 0925 850220, fax. 0925 850220

¹ For a detailed and fairly accurate summary of the content of many of the talks at the Colloquium, I would direct you to the review published in the January and May 1995 Western Association for Art Conservation (WAAC) Newsletter, Vol. 17, No.'s 1 & 2.

produced entirely from cyclohexanone saying that they are less stable than MS-2A and rapidly develop film defects from auto-oxidation. Their films become more polar, i.e., more difficult to remove, than do films of natural resins, after ageing under similar conditions.

Alan later responded to questions about mixtures of these varnishes during the panel discussion, that a varnish study from Poland by a researcher by the name of Jerzy Chabach who had tested a range of butyl methacrylates mixed with Laropal K-80 reported that some butyl methacrylates seemed to retard the loss of solubility of the Laropal in non-aromatic hydrocarbon solvents while others like Plexisol P-550 seemed to speed up the loss of solubility of the mixture, the word of caution being not to use mixtures carelessly since one might find unexpected solubility characteristics upon ageing.⁵

Acryloid B-72

At the Colloquium, an effort was made to clarify some of the hearsay and opinion about Acryloid B-72. I think that even those who supported its use did not shy away from discussing the drawbacks associated with its visual characteristics in varnish films. Among others, Robert Feller and René de la Rie clarified yet again why this should be so (high molecular weight, high viscosity, low refractive index) and of course conservators complained about its "plastic" appearance, its "poor" gloss and its inability to saturate certain oil paint films. It reaches a no-flow point rapidly after application, thus it does not level well on textured paint surfaces. These effects can be minimized by the technique of application, and the choice of a slow-evaporating aromatic solvent like Super Hi-Flash, also sold under the name of Cyclosol 53 by Shell. Alan Phenix suggested that at the Courtauld they have solved the saturation problem by applying a polycylclohexanone like Laropal K-80, which has optical properties closer to that of dammar, as a top coat over the B-72 base varnish coat. His theory, which was corroborated by René de la Rie, is that "saturation" is really a light refraction phenomenon occurring at the air/varnish interface and not the varnish/paint interface. This is something I will have to prove to myself. I would like to caution that when using top coats, solvent "compatibility" of both coats is important to avoid fogging of the top coat by the migration of residual solvent from the base coat.

In his paper at the Colloquium, *Paraloid (Acryloid) B-72 as a Varnish for Paintings*, Stephen Hackney of the Tate Gallery, London, felt that the medium gloss of B-72 is fine for the vast majority of paintings exhibited in galleries which have diffuse lighting from skylights. It does seem that the gloss of B-72 is not immutable, however, and I hoped that I was able to show in my own work that gloss factors like distinctness-of-image can improve in films of B-72 as it ages, a phenomenon which I attribute to "cold flow," which Eddie de Witte has attributed to UV-induced depolymerization in films of B-72 during artificial ageing.⁶

Regarding the alleged solubility changes of Acryloid B-72, Alan Phenix remarked that data published by De Witte and Gossens-Landrie reported a significant change in its polarity after the <u>equivalent</u> of 70 years of gallery ageing. He mentioned two other studies, one of which was an adhesives study in which FTIR and pyrolysis gas chromatography were used to determine that molecular changes had occurred in films of B-72 after ageing. And he noted another adhesives study by Jane Down at CCI observing the development of acidity in films of B-72 after UV and light ageing.^[1] Stefan Michalski's review of published data, *Yellowness and Removability:*

⁵ Winsor & Newton Conserv-Art varnish is an example of a commercialy available mixture of a polycyclohexanone and a butyl methacrylate although the manufacturer has apparently added an undisclosed stabilizer to the product. At the Varnishes Colloquium a conservator from the Brooklyn Museum remarked that the Kecks had used a mixture of Resin AW-2 and n-butyl methacrylate years ago and it has produced a surface which saturates well and has developed a particularly beautiful gloss over the intervening years.

⁶ De Witte notes an increase in the gloss of his samples of B-72 films aged under a Xenon lamp at 20,000lux and 30°C for 211 hours. He attributes this phenomenon to a lowering of the T_s due to the depolymerization of the acrylic under UV, in DE WITTE, E., *The Influence of Light on the Appearance of and Stability of Varnishes*, Bulletin de l'Institut Royal du Patrimoine Artistique XVII, 1978/9, pp. 106-121

How Much change? How Fast? How Important?, suggested that polarity changes under so-called museum lighting conditions are measurable in removability tests; however, any measured solubility changes are minor when compared to those of most of the other standard varnishes aged under the same conditions. Robert Feller noted that short wavelength UV will seriously deteriorate films of B-72, but one doesn't encounter this kind of energetic UV under typical museums lighting conditions. There was some questioning of Stefan's comments about anomalous data on the ageing characteristics of B-72 as reported by Eddie de Witte in 1978.⁷ Although de Witte doesn't mention the UV output of the Xenon lamp used in his ageing (450W air-cooled lamp at 20,000lux and 30°C), he does conclude that there is no change to films of B-72 after ageing, when the UV is filtered out. When exposed at high intensities to the unfiltered Xenon lamp, his B-72 samples did deteriorate and pit as would be expected. The consensus about B-72 seems to be that its degradation is dependent on UV wavelength and light intensity.

Yellowing reports are less substantial. I, myself, have seen yellowed B-72 on samples aged under UV at CCI; however, I feel that the film thickness of the samples tested played a role in their appearance, and that the solvent used to make the samples may have contributed to this effect. Solvent choice and purity is very important for the long-term stability of any varnish film. I think that it is safe to assume that any varnish solution will have a limited shelf life and should be used immediately. As Rene de la Rie reminded us, any solution will oxidize faster than a dry film.

To summarize this material we can say that if you are able to achieve good visual results with Acryloid B-72, you should continue to use it since I think we were able agree that its longevity and reversibility are superior to that of any other varnish.

Mastic & Dammar

Continuing with the theme of permanence, Stefan raised the issue that the effects of the interaction of a varnish with its substrate have been largely ignored, except for the previously cited study by Eddie de Witte in the Bulletin de l'IRPA in 1978⁸, and substrate effects may play a significant role in the solubility changes in an aged varnish film. In her presentation, Anne Ruggles, of the National Gallery of Canada, raised the issue of varnish/paint film interactions from a practical point of view, that re-varnishing with, in her words, a strong varnish solvent too soon after cleaning a paint film with alkaline agents, can encourage the migration of some pigments into the varnish film. If we take important cautions like Anne's into account, the main point expressed during the Colloquium concerning dammar varnishes was that a predictable change in solubility is tolerable depending on the substrate's sensitivity.

The perception of yellowing in dammar or mastic is not so much dependent on the formation of auto-oxidation by-products as much as it is determined by film thickness. Filtering is very important throughout the UV range up to 400nm whether it is used over a light source or in a UV barrier top coat, which I discussed in my own paper, since either will increase the lifespan of a dammar film by a significant factor. I was able to demonstrate the difference in the efficiency of several UV absorbers and I think that it is important to know the spectrum of the UV barrier material used. Several UV absorbers I have tested do not absorb in the long wavelength region from 370 to 400nm and do not provide full UV protection. It is important then to scrutinize the spectra of your UV barrier filters, either in the manufacturer's literature or by direct spectrophotometric measurement, because each will have a unique UV cut off.

The question was asked whether or not filtering of UV from a light source was as efficient a means of protection of a varnish as was the application of a UV barrier top coat. The short answer was yes; however, it was noted at the Colloquium that incandescent light from halogens, which are becoming more and more popular

⁸ ibid.

⁷ ibid.

with exhibition designers, contain a high proportion of UV and one must be vigilant in ensuring proper UV filtration.

Authenticity

Authenticity of Materials

Part of the problem in determining the authentic appearance of historic varnishes is the identification of the materials used on specific paintings. As we know, rarely do original coatings survive; however, the methods used to detect and identify traces of original coatings are an important part of this discussion about original appearance. Two papers were given at the Colloquium on the identification of natural resin varnishes.

David Rainford, speaking for Jaap Boon from the FOM Institute for Atomic and Molecular Physics in the Netherlands, *Mass Spectrometric Identification of Natural Resins and Their Degradation Products In and On Paintings*, spoke first on the use of pyrolysis mass spectroscopy (py-MS) both electron-impact ionization type (EI) and chemical ionization type (CI) followed by an account of his work with pyrolysis Gas Chromatography-Mass Spectroscopy (py-GCMS). Rainford felt that the main difficulty in GCMS appears to be in predicting the derivatized compounds which are read in the mass spectrometer, new compounds arising from random chain scission and reformation and isomer-derived products with different molecular weights thus different peaks, etc. Shellac, for example, produces eight new compounds under py-GCMS.

The following paper by Raymond White, of the National Gallery, London, *Some Examples of the Identification of Natural Resin Varnish Components in Paintings*, was a very practical one on the difficulties in tracing oxidized and fragmented derivatives of historic resin coatings. The crux of his paper, which was read by Robert Feller since Raymond could not attend the Colloquium, was that the identification of degradation by-products, fragments or secondary components from their primary sources is possible with GCMS as long as one follows fairly strict rules of lab "hygiene" to avoid contaminating samples. There is no substitute for experience on the part of the person running the analysis assisted by a good database of secondary indicators. Raymond also identified several of the secondary indicators and the genus from which they derive.⁹ He prefers FTIR microscopy to situate possible functional groups in order to make sense out of a jumbled mix of data from a heterogenous sample put through GCMS. Both he and Bob Feller stressed that co-operation between the conservator and the conservation scientist during the sampling and analysis was vital to avoid unnecessary tests and wasted samples.

Continuing this discussion about the identification of historic materials, but from the perspective of those who originally used them, Leslie Carlyle, spoke about the difficulties in *Reproducing Traditional Varnishes and Problems in Representing Authentic Surfaces for Oil Paintings*. She detailed the preparation of two

⁹ Raymond White mentioned the abietadienes from pine resins producing dehydroabietic and 7oxodehydroabietic acids. In thick varnish films and varnish protected from photo-oxidation such as that found under the rebate, one might find traces of pimaric and sandaracopimaric acids. Other places to look for hydroxy and 7-oxoderivatives of dehydroabietic acid are resinous oil glazes hidden beneath superimposed paint layers. Copper, verdigris-pigmented varnishes often have much of the primary source indicators intact. A traces of sandaracopimaric acid with little of the dehydroabietic acids can indicate the presence of sandarac, and in his experience, some of the primary indicator often survives the high-temperature running of this resin. By contrast, as we might expect from the high temperatures required in processing, little in the way of primary indicator remains in copal varnishes. Mastic is easily detected by GCMS since moronic acid is a primary indicator which is resistant to oxidation under ambient conditions. It is usually present with lesser amounts of oleanonic acid and where protected by superimposed later varnishes, paint or a rebate, traces of tirucallol may be present. in WHITE, R., "Some Examples of the Identification of Natural Resin Varnish Components in Paintings," *Varnishes: Authenticity and Permanence*, Unpublished paper submitted to the Colloquium, Canadian Conservation Institute, Ottawa, 1994.

representative historical varnishes - a mastic spirit varnish prepared with turpentine, Neal's Fine Mastic or Picture Varnish published in 1833, and a copal oil varnish. I would suggest that you read the Varnishes Handbook which Leslie and I prepared for our Workshop in order to get an idea of the variety of ingredients and preparation methods used to recreate these historical varnishes. When diluted with turpentine, following instructions from her historical sources, Leslie noticed that the copal oil varnishes she prepared had a much less glossy appearance than that of the spirit varnishes. She found that stock solutions of mastic at 31%, which was within the solids content recommended in a mid-19th century source, gave a much glossier varnish that any of the others including dammar which was prepared in the same fashion. The differences between the appearance of these varnishes and that of dammar is significant. Dammar is a resin of recent introduction as a varnish material and those who use it on paintings from before the mid 19th century hoping to recreate an authentic appearance might reconsider its use in light of the appearance of true, historic picture varnishes.

Authenticity of Appearance

This led us to discussions about the authenticity of appearance, the way historical materials may have been used and research into the attitudes to the appearance of paintings within an historical period.

Colour

Some discussion touched on the colour of historical varnishes. Leslie Carlyle noted that oil resin varnishes based on the copals were slightly yellow even when applied in thin coats which were diluted with turpentine. She also felt that because she observed mastic yellowing rapidly under light with a UV component, that artists who normally used this material would have been used to its vellow tint. Although she raised the point that tinted, stable modern varnish could be considered as a way of imitating this traditional appearance, she was not ready to suggest that there is enough agreement on authenticity of appearance to allow the accurate colouring of modern varnishes. This is not something that the Varnishes Colloquium could recommend. An 18th century image of Johann Heinrich Füssli and a friend "Smoking a Picture" in 1774,^[2] may not be without ambiguity since it is probably in the nature of a caricature like Hogarth's Time Smoking a Picture, but it does document a practice of the day to give a painting a romantic tint, a gallery tone, the gold tone of Rembrandt, or the kind of colour which inspired the 18th century collector and co-founder of the National Gallery, Sir George Beaumont (1753-1827) to write "a good picture like a good fiddle should be brown." ¹⁰ The preference for the gallery tone would cetainly have been connected to the burgeoning antiques trade of the time, and certain artists did succumb in varying degrees to this vogue for the darkened varnish. Finding a terminus post quem and a terminus ante quem for the practice of tinting varnishes would be difficult, if not impossible. Stray references to tinting varnishes abound in various artists' manuals from the 16th to the 19th centuries in Europe and are counterbalanced by an equal number of references to clear, colourless varnishes as desireable for paintings. In the 16th and 17th centuries some discussion in small, humanist and art theorist circles was focussed on imitating classical painting by re-creating the dark varnish of Apelles as found in the classical texts of Pliny. This is a quite different concern than was the Antiques-driven, popular love of "brown pictures" in the late 18th century.¹¹

¹⁰ A. van Schendel and H. Mertens, De restauraties..., zit bei Marijnissen 1976, vol. 1, p 366 in BRACHERT, T. Patina Von Nutzen und Nachteil der Restaurierung, Callwey, München, 1985, p. 46

¹¹ The popular preference for the warm patina probably developed simultaneously with the concept of the "Old Master." In the latter half of the 18th century and into the 19th century, the English would go on a "Claude hunt," an excursion into the countryside to look for italianate landscapes like those of Claude Lorraine aided by a small, darkened convex mirror called a "Claude Glass." The mirror made the landscape reflected from it look as if it were veiled by a brown varnish. Dr. Leslie Carlyle has provided me with several late references to "Claude reflectors" manufactured by Thomas Fischer available for sale in 1879 and Claude glasses recommended in 1886 as a tool to aid in the painting of landscapes, in Collier, J., *Manual of Oil Painting*, Cassel & Company Ltd., London, 1886, p. 27. By the late 19th century the Claude hunt was likely the preserve of Academicians, Sunday painters and dilettanti. Peter Bicknell has recently presented evidence that the term

However, without simple and unambiguous historical justification for tinting varnishes on <u>specific</u> works of a <u>specific</u> painter, our approach to varnishing must err on the side of caution. When evidence from the historical literature points to an artist's preference of varnish <u>because</u> of its tendency to yellow, to the artist's intentional tinting or colouring of a varnish for whatever purpose,¹² the materials for revarnishing should respect this, as far as it is possible and within the limits of reversibility as defined in our codes of ethics. Whether or not the smoking of a painting by an antiquarian, a collector or a connoisseur merits that same respect is open to debate and would depend on the importance of a painting's provenance.

Gloss

Both René de la Rie and Alan Phenix raised the issue of the complexity of the phenomena of appearance and how important it is to educate the eye regarding optical properties of varnish films, particularly that of gloss. Alan noted that the debate over optical properties cannot hope to reach a resolution until our ability to understand and more importantly describe optical phenomena becomes more formalized. It is not enough to describe a varnish as "good," "glossy," or even "saturating" when these terms mask very complex physical and optical phenomena behind what we see. In the later Workshop discussions, Nancy Binnie, a conservation scientist at CCI, and René de la Rie helped to define a few of the gloss concepts like sheen, reflection haze, specular reflectance and distinctness-of-image. We also set up an apparatus for the visual evaluation of gloss differences for the examination of varnish test panels based on an ASTM Designation (D 4449-9). The important point we tried to reinforce was that, with training and practice, the eye can distinguish these phenomena and that they should be used as a point of departure in our descriptions of the appearance of surface coatings.¹³

Historical Attitudes

Historical attitudes to the appearance of picture varnishes in Italy and France from the 13th to the 19th centuries were subjects discussed in the final three papers of the Colloquium.

Kathleen Hoeniger, Assistant Professor of Art History, Queen's University, spoke on *Early Italian Paintings: Varnishing and Aesthetics*, concentrating on 14th century Sienese painting. She concluded that gilded backgrounds, especially punched gilding was never varnished since it destroys the contrast between the shimmer of the punchwork and the darkness of the flat gilded areas, a contrast which was of real spiritual and metaphorical importance. The 13th and 14th century attitudes to the varnishing of <u>painted</u> areas are more difficult to determine. Apparently varnishing was used on occasion either on the entire painted surface or on selected areas. She presented evidence that Simone Martini left his painted areas un-varnished; however, since he did use varnish on occasion we must back up any decision to varnish paintings from this period with

[&]quot;Claude Glass" is a misnomer particular to the 19th century. According to him, in the 18th century, the reflecting mirrors were properly called "Gray's Glasses, " or "Landscape Mirrors" and even the "Claude Lorraine." This latter was apparently fitted with filters which gave various tints to satisfy the mood of the viewer who preferred their landscapes with a "Gilpin" tint or numerous other shades, in Bicknell, P., *The Picturesque Scenery of the Lake District 1752-1855*, St. Paul's Biographies, Winchester Omnigraphics, Detroit, 1990.

¹² Caspar David Friedrich apparently wrote that he preferred the yellow tones of mastic for his paintings. C. D. Friedrich in Briefen und Bekenntnissen, München 1968, S. 94f in op. cit. BRACHERT, p. 48

¹³ For further reading on the subject of gloss, the following references may be of help: "Standard Test Method for Visual Evaluation of Gloss Differences Between Surfaces of Similar Appearance," *ASTM Designation : D 4449-9*; "Standard Test Method for Specular Gloss," *ASTM Designation: D 523-89*; HUNTER, R.S., *The Measurement of Appearance*, Wiley Interscience, New York 1975; SÈVE, R., "Problems Connected with the Concept of Gloss," *COLOR Research and Application*, vol. 18, no. 4, 1993, pp. 241-252.

documentary evidence, otherwise we are safer to resist the urge to varnish and unify the surface.

Helen Glanville, Lecturer, MST Sorbonne, Authenticity in the Application and Use of Varnishes in Seventeenth Century Italy, reminded us of the significance of the "Naturalistic School" in Italian painting, descending from Leonardo, where the <u>original</u> varnish was very important since its artist-application made it part of the original effect of the painting. Lanfranco, Guercino, Caravaggio and Luca Giordano were all adherents of this approach which avoided thick varnishes with overall gloss. The "Academic School," which descended from Raphael through Guido Reni and Domenichino, apparently preferred the "high finish" of an even varnish; however, Helen remarked that Poussin had hinted in a letter, that for at least one painting, *The Israelites Collecting Manna*, Louvre, that the surface was not to be glossy; i.e., it was to be unvarnished.¹⁴ Helen's point seemed to be that one must not adopt a standard approach to the varnishing of paintings from this period, that our contemporary aims of saturation and overall, uniform varnish gloss may be wrong for paintings of the "naturalistic school" of Leonardo, Caravaggio, Guercino and the Venetians.^[3]

The final paper on historical attitudes to varnishes was presented by Vojtěch Jirat-Wasiutyński, Associate Professor of Art History at Queen's University, who spoke on *Attitudes to Varnish in Nineteenth Century France*. The intellectual climate at the beginning of the century, in the writings of Bouvier (1827), Mérimée (1830), even Delacroix (1850) favoured clear, colourless varnishes and railed against the "romantic tint"¹⁵ which was, Vojtěch suggested, a preoccupation which we can confine in France from the middle 18th to the early 19th

¹⁵ In the 1850's Delacroix commented on the varnish removal of the Marie de Medici cycle at the Louvre. He and his contemporaries were concerned about the appearance of yellowing varnish and were well aware of the damaging effects of repeated varnish removals but Delacroix himself felt that to achieve the appearance of bright saturated colour, varnishing was a necessary evil. Bouvier, in his 1827 treatise, felt that varnish was essential for the unification of the surface but lamented its yellowing. He called on the chemists of the day to develop a substitute for resin varnish which would not yellow or deteriorate. Mérimée's De la peinture à l'huile, 1830, stressed that good varnish is one which is "incoloré" or without colour. He recommended that one could first coat paintings with a copal oil varnish which would resist the damaging effects of further cleanings when a mastic varnish in turpentine were applied as a top coat. in JIRAT-WASIUTYŃSKI, V. "Attitudes to Varnish in Ninteenth Century France," Varnishes: Authenticity and Permanence - Proceedings on Audio Cassette, Canadian Conservation Institute, Ottawa, 1994. Mérimée noted that "Since copal varnish is always slightly amber, most painters are reluctant to use it, such that one would never achieve the same lack of colour as with mastic." ("Mais comme le vernis au copal est toujours un peu ambré, beaucoup de peintres répugneront à l'employer, tant qu'on ne parviendra pas à l'obtenir aussi peu coloré que celui de mastic.") MÉRIMÉE, J.-F.-L. De la peinture à l'huile ou des procédés matériels employés dans ce genre de peinture depuis Hubert et Jean Van-Eyck jusqu'à nos jours, Mme. Huzard Librarie, Paris 1830, facsimlie EREC, Puteaux, 1981, pp. 89

¹⁴ What role did varnish play in what Helen Glanville calls the "high finish school" of Guido Reni and Domenichino versus the "naturalistic school" of Lanfranco, Caravaggio and Luca Giordano? Malvasia, the Bolognese chronicler, writing in 1678 said that Guido Reni of the former school was careful to complete his bozzetto and allow it to dry for a long time before laying over it the finishing colours so that none of the colours risked sinking into the coarse ground, whereas Guercino painted *alle prima*, allowing his bozzo to be his final work thus permitting many of the colours to sink into the as yet un-hardened ground or allowing the bare ground to show for certain parts such as the mid-range tints. This Glanville equated with the Venetian school where, as the Venetian Marco Boschini (1613-ca.1703) wrote, one must "retouch," i.e., finish, only in parts allowing the ground to show through in other parts, and this is what makes the figures appear "round" (sic), i.e., naturalistic. Helen also quoted Boschini who in 1660, criticized the Dutch for their preference for varnishes with overall gloss, that it simply was used to hide their inability to depict the effects of nature in paint as did the Venetians. in GLANVILLE, H., "Authenticity in the Application and Use of Varnishes in Seventeenth Century Italy," *Varnishes: Authenticity and Permanence - Proceedings on Audio Cassette*, Canadian Conservation Institute, Ottawa, 1994.

century. By the 1880's, Monet and Degas preferred unvarnished, matte surfaces which approached the look of pastels. But for his "dry period" in the 1880's when he imitated the effects of monumental decorative fresco, Renoir, by contrast, did not appear to object to varnishing and later even gave his dealer explicit instructions to apply varnishes to his paintings Pissarro apparently specified the use of glass in his frames as an alternative to varnishes as did Gauguin, with a few notable exceptions.¹⁶ All three of the art historical papers demonstrated, again, that it is unwise to generalize about technique, especially without knowing the historical context for specific paintings. Making informed decisions about the varnishing of paintings of minor painters or of unattributed works presents the real challenge in the absence of hard information about an artist's preferences or practice.

Conclusion

If consensus was reached at all at the Colloquium, it was that the materials we can choose for our picture varnishes have varying degrees of permanence, and in certain cases, the requirements of a treatment may justify the use of a material which may yellow faster than another or perhaps increase somewhat in polarity over time if the less stable material has a much greater aesthetic advantage. Some of you may consider this heresy, but the compromise isn't heretical, only the practice is, if carried to extremes by some conservators. Our hope is not that conservators who like the feel of dammar and mastic will find implicit permission here to coat a solvent-sensitive painting with an unstable natural resin. I agree with the perspective of Marion Barclay, of the National Gallery of Canada, that we should avoid what she calls "inflexible perfection," the exclusive use of any one "state-of-the-art" varnish as a cure-all for everything in a collection. Many of you who have experience with collections in which all the paintings are coated with the aid of a single varnish recipe will recognize the caution. There is an argument to be made that we should take the measures necessary to make paintings appear pleasing to our eyes, rather than to try to guess what pleased the eyes of generations long dead. I feel that this tension, this dichotomy between authenticity, which is a fashion in itself, and contemporary taste, is implicit in many of the decisions we make about varnishing. There isn't a responsible conservator who wouldn't set limits on the authenticity of picture varnishes because of the instability of the materials used in historic recipes.

Acknowledgements

I must thank my co-organizer, Dr. Leslie Carlyle, whose energy during the preparations for this meeting was formidable. The help we received from the Fine Arts Lab, Extension Services, Nancy Binnie and the CPR lab and Carl Bigras and Kate Helwig of the ARS Lab at CCI was much appreciated. We were indebted to Anne Ruggles and Marion Barclay of the National Galley who smoothed over many a rough spot at the venue.

¹⁶ Gauguin liked the matte but saturated effects of wax coatings and recommended the use of wax coating when writing from Tahiti in the 1890's regarding instructions about the restoration of his paintings. Vojtěch Jirat-Wasiutyński warned that this instruction must not necessarily apply to his easel paintings since he was concerned at the time about working within the tradition of decorative mural painting where, in France, marouflaged paintings are usually given a final coat of wax. More confidently, he was able to say that, by the mid-1881, Gauguin had adopted Pissarro's preference for unvarnished paintings displayed behind glass which was used to "finish and protect" the picture. in JIRAT-WASIUTYŃSKI, V., op.cit.

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FANNING THE FIRE: AN ALTERED JACKSON POLLOCK

Thomas J. Branchick Conservator of Paintings/Dept. Head

The subject of this paper is a large painting by Jackson Pollock, <u>Untitled #12, 1952</u> (signed lower right, Duco Dev-o-lac aluminum paint on pre-primed linen). It was acquired by Nelson A. Rockefeller from the Sidney Janis Gallery in New York City in December of 1952. It was the one painting that sold from that exhibition and was a radical turn for Pollock, who previously was producing a series of black and white compositions. (<u>Blue Poles</u>, Pollock's masterpiece, followed <u>#12</u>.)

The painting was brought by Rockefeller, then Governor of the State of New York, to the Executive Mansion in Albany. On March 3, 1961, a fire broke out in the Mansion, several other works owned by Rockefeller were destroyed, and the Pollock was certainly damaged. The '61 restoration was performed by Jean Volker and assistants at the Museum of Modern Art in New York, where the painting was cleaned with water, brushed with varnish, and placed in a Dutch method strainer. The large salvaged chunks of "lavatized" Dev-o-lac, which actually fell to the floor during the fire, were readhered with PVA emulsion. These compositional elements are approximately 1/4" in paint thickness. The entire canvas was wax lined to linen and the very blistered areas were infused with 30% polyvinyl acetate. Wax was removed with petroleum benzine followed by a xylene, Soilax, ammonium hydroxide cleaning. Synthetic varnish was brushed overall and the canvas was attached to a LeBron expansion bolt stretcher. Sheldon Keck, Paul Coremans and Robert Feller were contacted to investigate if any possible means could be determined to resuscitate a fire-damaged pigment or medium. The reports were conclusive that nothing could be done. The most altered areas were the yellow and red pools of Dev-o-lac, a plasticized nitrocellulose paint manufactured by Devoe and Reynolds, Inc. (Louisville, Kentucky), and the thin red washes in the upper section of the composition. A total loss was claimed and the picture was retained by Rockefeller, who in 1974 gave it to the State of New York to join the ninety plus works Rockefeller and his commission selected to grace the new Empire State Plaza Government Complex in Albany, where it was installed and remained for the next twelve years in the Plaza Manager's office, subject to benign neglect, cigarette smoke from the office receptionists, and an addition of what was reported to be a soy sauce application from packets that accompanied a take-out meal order by office personnel.

In 1985, eight paintings in the Plaza Art Collection were viciously attacked--slashed and graffitied by a deranged shoe shine operator. Examination and proposals led to various treatments, and in one painting, an artist copy, but this activity brought up the subject of the long neglected Pollock. In 1986, at the request of Barnabas McHenry, Chairman of the Empire State Plaza Art Commission, examination and the opening of cleaning windows was performed, with possible restoration as the end result. The documentation was reviewed and cleaning windows opened, beginning the discussion of options and directions with the Curator of the Collection, Tammis Groft, McHenry, and the Art Commission. Williamstown Conservation Center trustees, conservators and art historians were consulted. It was decided to undertake a reconstruction, emphasizing that the process results would better represent Pollock than the current image. The painting was removed from its installation and transported to the Executive Mansion, where discussion was held at a Commission meeting in July, 1986.

Barnabas McHenry then solicited the support of Eugene Victor Thaw. Thaw and art historian Francis V. O'Connor were the co-editors of the 4-volume catalog raisonné on Pollock, published in 1978 by Yale University Press. Thaw was brought to Albany and this letter was received:

Williamstown Art Conservation Center 225 South Street, Williamstown, MA 01267 Dear Ms. Groft:

I enjoyed very much meeting with you on Monday and studying the painting by Jackson Pollock which was damaged in the 1965 [sic] fire at the Governor's Mansion.

On the basis of that examination conducted with you and your restorer, I can unquestioningly support another effort to restore this painting to something more adequately reflecting the artist's intention.

The painting is overall less damaged than I had feared and those parts which have suffered most are susceptible to much more accurate reconstruction, with the help of existing photographs, than had been done in the very unsatisfactory earlier restoration.

I wish you well with this project, and should you go forward, I would be happy to visit the laboratory in Williamstown to see the work in progress.

I am sure that the late Lee Krasner, who's *[sic]* executor I am, would support an effort to save this important image by Pollock.

Sincerely yours, [signed] E.V. Thaw and Co., Inc. Eugene Victor Thaw

On November 10, 1987, the painting and proposed treatment were again reviewed at an Art Commission meeting hosted by Matilda Cuomo, First Lady of the State of New York, at the Executive Mansion. The proposal was presented with Mylar overlays superimposed over a photo enlargement of the painting to explain the intent and extent of restoration. The problem areas were what to do, if anything, about the altered and/or missing red washes at the top of the canvas. It was proposed to thinly apply a red wash of acrylic following the existing tide lines to "represent" and that is a key word in the proposal, and was clearly explained at the meeting. The scarred areas of the "lavatized" Dev-o-lac were to be filled and levelled with microcrystalline wax and "pour inpainted", a previously never used term, to imitate the original. The treatment was accepted, contract ratified and a schedule determined.

There was then a curatorial change. Groft was replaced by Dennis Anderson in 1988, and another treatment review proceeded. Anderson still is Curator of the Collection. In March of 1989, treatment began at the Conservation Center in Williamstown. Dirt, grime, tobacco smoke, and soy sauce were removed. Varnish was removed. A gel containing abietic acid was used selectively to remove residual carbon. Residual wax from the lining was removed. BEVA 371 was selectively used as a consolidant, and then began the reconstruction as I quote from the proposal:

Utilizing available before-fire-damage photographic reproduction, reconstruct damaged areas as follows

- a) Blistered and cratered areas of paint will be filled with microcrystalline wax, acrylic emulsion colors, and solvent base retouch colors.
- b) Thinned or missing red washes will be reconstructed using gouache or water color with an isolating coat of B-72 Acryloid.
- c) Glazing damaged colors with solvent base retouch colors (to be determined in conjunction with curatorial inspection).

Final inspection by necessary curatorial personnel.

The reconstruction was completed using nine of the twenty plus reproductions as resource information.

During the academic year of 1989/90, Francis V. O'Connor was the Robert Sterling Clark Visiting Professor of Art History at the Williams College Graduate Program at the Clark Art Institute to which the Conservation Center is attached by a tunnel. His presence at the Program enabled him to view the work in progress and upon completion. I asked that he put his reaction in writing; excerpted here are some paragraphs from the six-page letter written to Dennis Anderson on May 7, 1990:

As is well known, <u>Number 12, 1952</u> was damaged in a fire at the Governor's Mansion during the early 1960s, and subsequently further damaged through neglect over the ensuing years. In general, the initial heat damage caused considerable paint loss and early restoration processes further changed the appearance of the work; the later neglect (hanging, for instance, for years in a guard room and exposed to food stains and tabacco *[sic]* smoke) soiled and discolored the canvas.

The present state of the painting is this:

The later damage has been for the most part corrected through cleaning the entire canvas.

The lower third of the work is quite recognizably Pollock, since it was the least damaged, and still retains, except for a small area to the left, the brightness and clarity one associated with his facture. Here three things stand out, and they constitute a standard against which the rest of the restored painting can be judged: 1) the fresh background behind the crisply painted forms,) the artist's exploitation of the gloss and matte properties of the black duco used for the major structural forms throughout the works, and 3) the sharp edges (technically "tide edges") of the thin washes and dots of colored pigment throughout this area which give them character and definition. In general, 1) and 3) are lost in the Sections B [middle] and C [top] of the painting while the black forms mentioned in 2) remain intact throughout the work with varying degrees of dulling.

The middle third of the work...has been heavily restored, with thick areas of puddled paint...completely re-constituted. This section appears rather lifeless in contrast to the lower Section, but the forms and colors (are) back in place, and nothing overtly untoward is visible-- except that the puddled paint displays, as is inevitable, flow forms different than in the original. The deadness of this area is typical of other restored Pollocks -- such as the top of <u>Number 1, 1948</u> in The Museum of Modern Art, New York (the top 20% of which which *[sic]* was also damaged in a fire), and several paintings in the Peggy Guggenheim Collection in Venice -- and similar to what happens when Rothkos are relined.

The top third of the painting...which was thinly painted and which suffered the greatest heat damage and consequent paint loss, is not, in my judgement, acceptable. It is a loose approximation of what was there originally, which makes no attempt to emulate the visual evidence to be found in color plates made from the undamaged painting. More serious is the complete loss of a major form...quite typical of the artist: the inverted, rounded crescent that appears in the right corner...in subtle washes of yellow on yellow. This is clearly visible in the color reproductions and black and white photos of the undamaged painting, and is now invisible on the restored work, covered as it is by new washes of color applied by Branchick. There is also in Section C [top] a number of black forms that correspond in outline but not always in character to the crisp, brilliant blacks to be found in the lower third of the work.

In discussing the above matters with Branchick, he has twice indicated his complete agreement with the following assessment: that Section A *[lower]* at the bottom is Pollock...the middle is Pollock himself, and Section C at the top his alone (except for the surviving black forms) *[and aluminum and green]*.

He has also indicated to me that the original thinking about and planning for the restoration of this work stipulated that a "reconstruction" or "recreation" of the painting precisely following the visual evidence remaining of the undamaged [sic] state of the work, and that he later opted, after consultation with the committees involved, for a policy of "representation", by which he means a loose approximation of the visual evidence that makes no attempt to replicate what can now be seen in photographs of what was once there. ...

Here it must be understood that we are dealing with a ruin that was once a masterpiece of <u>gestural</u> painting, <u>in which the formal and iconic results of the artist's spontaneous, but</u> <u>nevertheless experienced, paint application constituted the essential subject matter of the</u> <u>work</u>. Thus whether to intervene a "representation" or a "recreation" upon the surface of such a work raises basic issues of authenticity and ethics, and I do not believe they have been faced squarely by all concerned in this matter.

It seems to me that a decision has to be made by a select committee of experts as to just how far this restoration ought to be taken. The options would seem to be these:

1. Leave the painting as it is today and described above. This means, as <u>Number 12, 1952</u> is now a Pollock/Branchick, that it be exhibited as such.

2. Remove all restorations and leave the cleaned painting as the fire left it. This means exhibiting a ruin -- and explaining its circumstances.

3. Trace every detail of the original onto the upper part of the canvas with projectors and re-paint it to match what can be seen in the color reproductions of the undamaged work as closely as possible. In other words, do as complete a <u>recreation</u> of the original as is possible -- and so exhibit it.

4. Remove the major restorations -- such as the reconstituted puddles of color and the red and yellow washes in Sections B and C [the middle and top sections] and replace them with simple flat areas of inpainting to show what is missing -- and exhibit it with such explanations as are needed.

5. Mask the upper two thirds of the canvas...[middle and top] with a properly ventilated translucent material so Pollock's strong black forms and color areas can be seen through it in a generalized way, and only the lower, completely authentic, third of the painting...can be seen directly. ...

<u>Concerning the display of this painting</u>, there has been some discussion of "signage" or a "storyboard" to make clear to the public that the work it is seeing has been extensively restored. Should this painting ever be judged exhibitable, then I think some such strategy is <u>absolutely</u> <u>essential</u>, since no matter what is done to the work, it will never be completely a Pollock again, and that must be made emphatically clear to the viewer. This seems especially important in that the painting is going to be highly visible. It is owned by the State of New York and is to be displayed in its spectacular State Capitol complex to a generally lay audience not familiar with Pollock or his work. Since the general public has enough trouble with "abstract" art as it is, the prominant *[sic]* display of seriously damaged and extensively restored paintings that do not fully convey the character of the original, ought to be explicitly explained. This could be an important educational factor for the public and might well help to justify the display of such a painting at all.

[signed] Francis V.O'Connor, Ph.D. Robert Sterling Clark Visiting Professor of Art History

Copies of this were sent to both McHenry and Thaw, who together viewed the completed treatment in June of 1990. The reaction and subsequent directive from that viewing was interesting. They were astounded by the image, but if it could be taken to this level, why not take it to a more exacting reconstruction, as is cited by O'Connor as option #3. Initially, I was taken aback. The collaborative decision by conservator, curator and historian was certainly revised, and it meant removing many hours of work. The area of focus was the top red washes and a higher reflectance, meaning varnishing the black enamel to increase its reflectance. Discussions ensued; a new proposal was drafted:

- 1) As is indicated on the 4x5 after-treatment transparencies, remove the current glazes and undercolor in the upper third of the canvas.
- 2) Apply a white ground layer, incorporating as much as possible the integral thin designs of the original.
- 3) Re-execute the yellow as per the 8x10 transparency.
- 4) Re-execute the red washes as per the 8x10 transparency.
- 5) Adjust the reflectances of the black enamel.

Treatment will use overhead projectors, slide projection and a grid system.

The treatment was approved in August of 1990 and the second effort completed in October. The painting was installed with the returned vandalized works in a re-hanging of the collection with the new state-of-the-art security system in place.

I met with Anderson, McHenry and Thaw. Thaw wanted an enhancement of the ground passage at the upper edge and a darkening of three small black enamel drips. This was executed and they viewed the treatment complete and a success.

The painting now hangs in the Empire State Plaza and its label reads:

Originally owned by Gov. N.A. Rockefeller. In 1961, the painting was damaged in a fire that swept through the New York Executive Mansion, where it was on view. Some immediate restoration efforts were undertaken, and in 1974 governor Rockefeller gave the painting to the Empire State Plaza Art Collection. Through the generosity of the Empire State Plaza Art Commission, this painting was returned to a state which approximates the original painting. Today it is considered the most important work of the Collection.

O'Connor's remarks are only one of the several reactions to the treatment. Controversial as it is, opinions vary from very supportive, noncommittal (usually from those who dislike abstract painting) to total disagreement (purists who revere abstract painting).

It was an interesting collaboration of opinions that directed the treatment, and these opinions platform a number of issues. Although O'Connor, to my knowledge, has not viewed the painting after the second reconstruction, he has used the painting in a College Art Association lecture he gave last year in New York City, where he cited the work as a "Pollock with a limp, but at least it can walk". His talk was entitled "Form as Authenticity in Art and History". His issue was that the fire and subsequent reconstruction was a violation of the original form vs. the authentic form. This subscribes to the whole idea of action or drip painting as representing the physical deed of the moment in time made tangible in the form of a sign. Can any conservation treatment recreate that process? <u>Absolutely not</u>. But it can unify or reconstruct to better visually represent an intent. In varying degrees, that concept applies to inpainting on any period of painting. Is there a point where a painting becomes dead art or is beyond any hope of conservation intervention? As subjective a decision as that may be, it certainly is not one individual's decision, and would vary from case to extreme case.

What is still at issue is the signage. The curator argues not to put up a didactic label with photographs and treatment explanations. He always points out that he knows of no other museums which exhibit heavily restored paintings and label them as such. Anderson feels that the existing label cites the restoration and, if needed, access to the file is available. Finally, it has been clearly demonstrated that if in the future an opposing viewpoint mandates the reversal of the treatment, that can be accomplished. The treatment is providing a wonderful teaching tool for the course we at the Center offer to the Graduate Art History students. The Pollock provides the basis for many a debate, and certainly elicits an opinion to the often asked question of what makes art art, and that relative implication on historians, curators and conservators.

AN APPROACH TO THE RECONSTRUCTION OF ANDY WARHOL'S <u>PORTRAIT OF ROY LICHTENSTEIN</u>

Daisy Craddock*

Andy Warhol's <u>Portrait of Roy Lichtenstein</u> is one of a series of portraits of the artist Roy Lichtenstein, and was carried out in 1976. There were possibly six portraits in the series (1). The work is synthetic polymer paint brushed onto linen which has been primed first with acrylic gesso. A layer of silkscreen ink has been applied over the synthetic polymer paint layer.

The painting suffered extensive damage in the 1992 Hurricane Andrew. Emergency treatment had already been carried out at Rustin Levenson's Miami studio, Florida Conservation Associates. The first phase of treatment included removal of grime and hurricane debris from the painting's surface and reverse, treatment for active mold, consolidation of paint and ground layers, and flattening of deformations in the canvas (2).

This paper will focus on treatment which was carried out after emergency stabilization (Figure 1). Almost every stage of the reconstruction from this point on has involved the use of unconventional methods and materials. Considerations as to approach and choice of materials will be addressed.

Flaking paint in areas of damage had been previously consolidated with Beva D8 (ethylene vinyl acetate dispersion) and remained secure. There was fairly extensive loss of paint and ground layers. Most disturbing was an arcing damage in the neck and chin area, an irregular loss of paint and ground approximately 3" x 17" wide (Figure 2). Circular canvas distortions radiated out from a small tear near the top center of the large loss. Vertical fibers in the tear area were stretched and misaligned. There were stretcher bar creases in the canvas, and the original stretcher was warped. There were draws in all four corners of the painting. Two small punctures had occurred in the blue background at upper right. The sitter's right cheek was marred by a cluster of paint losses. The surrounding paint, which had been previously consolidated with Beva D8, remained stretched and distorted around losses. Small paint losses were visible along all four sides, extending into the painted tacking margins and reverse on all four sides. The artist's signature and date remained intact and were inscribed at top right on the reverse.

* Rustin Levenson Art Conservation Assoc., 544 W. 27 St., New York, NY, 10001



Figure 1. Andy Warhol, <u>Portrait of Roy Lichtenstein</u>, During treatment, (after emergency treatment)



Figure 2. Andy Warhol, <u>Portrait of Roy Lichtenstein</u>, During treatment, detail

The extent of damage suffered by the painting raised a number of issues. Given it's extensive paint loss, could we justify reconstruction of the painting? One factor which seemed to make reconstruction feasible was the fact that paint loss and damages were confined to discrete areas; there was no significant abrasion of the original paint surface. The filling and toning of losses could be carried out in a fairly straight forward manner. We were fortunate to be working with a client with whom we could discuss these issues. The client was well aware that damages would more than likely remain clearly visible after treatment. It was his feeling that there could still be an audience for the painting. It was understood that treatment and condition reports would accompany the painting. The damage incurred in Hurricane Andrew had become an inextricable part of the painting's history. And so it was agreed that treatment should proceed through filling and toning of losses. At that point we would discuss the feasiblity of reconstructing silkscreened areas.

This phase of treatment included consolidation of further paint flaking; areas consolidated previously remained secure, however there were deformations in the paint layer surrounding areas of loss, particularly in cheek and chin. A shiny residue remained around some areas previously consolidated. This was removed with xylene. Two small blue paint flakes were found in the shipping crate. They appeared to have come from an area of flaking on the reverse tacking margin in the upper right corner; active flaking was then noted on all four sides of the painted tacking margins and reverse. Consolidation of active flaking was carried out with Beva D-8 diluted 1:1 in water, followed by application of a hot air blower.

Weights and slight moisture were used to flatten canvas distortions in so far as possible. From the reverse, torn fibers in the small tear in the chin area were realigned; two missing horizontal fibers were replaced using a fiber taken from the edge of a tacking margin. A small area of vertical fibers remained stretched and distorted; these were trimmed mechanically and rewoven; the fibers were attached with Jade adhesive 1:1 in water, followed by local application of heat.

The painting was removed from its original stretcher, which had become warped. Debris was vacuumed from reverse behind stretcher bars. The tacking margins were reinforced with a strip lining of polyester fabric which was attached with Beva film and heat. The painting was then mounted on a new stretcher, sealed first with mycrocrystalline wax.

Small paint losses around the edges were filled with "DAP" vinyl spackling paste. This material was chosen because of its resistance to cracking and its workability. It soon became obvious that a fairly specific surface texture would be needed, particularly in areas of large paint loss. A mold was made from the paint surface using "Sculpey" modeling compound, a material which has been used in the restoration of picture frames (3). After testing first whether "Sculpey" could be safely removed from the paint surface, the material was rolled out to approximately 3/8" thick with a rolling pin and pressed into an area of heavy impasto brushwork at the top right corner of the painting (the painting was first placed face up and supported "Sculpey" residue was removed from the paint from below). surface with benzine. The mold was then baked in a conventional Caution: This material has been found to contain oven. carcinogens which offgas during baking; it should be handled with gloves and heated only in the lab with proper ventilation (4). After the "Sculpey" cooled, small sections were broken off as needed and used to texture fills. The fills were built up in multiple layers, and the "Sculpey" mold pressed into the final layer as it dried. A stiff, flat bristle brush was used to apply additional fill material in areas where a heavier impasto brushwork texture was needed. (Figure 3) Fills were sealed with Winton retouching varnish. Stretched and elevated paint surrounding the losses had already been relaxed in so far as possible with local applications of heat and adhesive. At this point a decision was made to thin two tiny ridges of severely stretched and deformed paint surrounding an area of paint loss in the cheek. This was carried out under magnification using a scalpel.

Vincent Fremont writes that Warhol's portrait commissions from the early to mid 70's are more "painterly" than later ones. The paintings had "bold brushstrokes with thick acrylic paint and finger painting... Andy would elegantly extend his middle fingers and deftly squiggle lines around the subject's head" (5). Stylistically, the portrait of Roy Lichtenstein seems to fall into this category of early portraits. The painting's background consists of two layers painted wet into wet. A red underlayer is clearly visible, and has been pulled up into the blue-green in some areas. Wide brush marks are evident, and thick swirls of impasto follow the sitter's contours.

It has been noted that "After choosing a motif, a photograph taken from a magazine or newspaper, Warhol would send the original image to the silkscreen works, giving instructions about the size of screen and the number of colors to be used. The printers would then bring the finished screen to Warhol's factory (6). In a telephone interview, Vincent Fremont of the Warhol Foundation was very generous in sharing additional details about Warhol's working methods during the 1970's: Andy, when commissioned to paint a portrait, would usually take a series of Polaroids. From these he would choose one or two he liked best and have silkscreens prepared from them. His screenprinter at the time was Rupert Smith. Unfortunately, Rupert died four years ago. Vincent recalled that Warhol would have an acetate made from the This was blown up to a 40" x 40" format. Warhol Polaroids. worked on the acetate to get the look he wanted, burning in the image or cropping it as desired. He would do the acrylic painting himself, then direct the silkscreener where he wanted

the silkscreen image, which was the final stage. From 1976 on, the silkscreens were prepared off premises. Warhol painted in series, typically eight at a time, changing colors from one painting to the next. There is a great deal of variation in brushwork and color, as well as in silkscreen application, from one to the next. Vincent remembers that Warhol was quite specific about colors. He or an assistant would mix them; colors were rarely straight from the jar. Even when an assistant mixed the color, Warhol would adjust it if it was not what he wanted (7).

Toning of paint losses in the background was begun with an underlayer of Winsor Newton gouache. This was glazed using Lefranc and Bourgeois restoration colors mixed with benzine. Flesh toned areas in the face proved more difficult. A wide range of the pigments conventionally used to inpaint were tested. The broad expanse of pink in the cheek was particularly unforgiving. None of our conventional pigments came anywhere near the characteristic "acrylic emulsion appearance." Preliminary inpainting test areas with Liquitex acrylic polymer were successful. The retouches were readily soluble in acetone, while the surrounding original paint layer was not. But how would the Liquitex inpainting age? Use of the artist's pigments for retouching raised questions about reversibility over time. Clearly the Liquitex shouldn't be used over original paint, but could it be justified in areas of total loss where the original support remained? After much discussion in the studio, it was felt that the aesthetic continuity gained by using Liquitex outweighed doubts about its reversibility. The retouches could always be removed mechanically from the thick, multiple layered fill. At best the inpainting would still be readily apparent in large areas of loss.

The Liquitex proved difficult to work with in large areas. The size of losses necessitated working in relatively small sections at a time, but inpainting dried lighter or darker depending on a number of variables - thickness of application, overlapping and dilution with water. The first attempt at inpainting in the cheek area was unsuccessful, and had to be removed with acetone. Vestiges of pink toned pigment remained in the fill material and affected subsequent inpainting; the inpainting was removed once again and the fill coated with a layer of Liquitex white. The final version of inpainting consisted of two layers of pink. The "Sculpey" mold and dry brushing were employed as needed to add surface texture in the wet paint as needed. After losses had been toned to the flesh color, our client was asked to view the painting and discuss whether to proceed with reconstruction.

During this time there was a great deal of discussion about whether reconstruction of silkscreen losses should be attempted. Probably no other artist of his time so blurred the boundaries between printmaking and painting. Henry Geldzahler states that Andy was "the first artist for whom there was literally no difference between his work in painting and printmaking, except the material used to support the image; Andy used the same screens on canvas as he used on paper" (8). Robert Rosenblum writes that "Andy manipulated the look of commercial photography as a new vocabulary to be explored as an aesthetic language in itself. The blurrings of printer's ink, the misalignment of contours, the flat graininess of shadows, the brusque and arbitrary change from one filtered color to another..." (9).

While the treatment was being carried out, we were fortunate to be sharing our studio with Paper Conservator Daria Keynan. Daria had recently completed a survey of works on paper for the Andy Warhol Museum in Pittsburg, and was treating many of the early drawings destined for the museum's collection. Surrounded by Warhols, we argued the question: Daria maintained that from the paper conservator's standpoint, it would not be ethical to reconstruct silkscreen losses using the same method ie. silkscreening. They would be virtually indistinguishable from the original, even if a protective interleaf could be fashioned (10). From the paintings point of view I felt justified, given the discreet layer of fill material separating support from silkscreen, and the fact that inpainting would be readily visible. Were the paper and paintings approaches intrinsically different?

Vincent Freemont talks about how important lighting was for Warhol; that he liked "what shadows did to the contours of the face or body..." (11). Given this insight into the artist's intent, and the fact that reproductions of at least two other paintings from this series were available for reference of missing information (12), it seemed important to try to restore the missing chin. Our client was pleased with the first phase and wanted to continue.

Warhol's own attitude toward damages varied. In conversation with Vincent Freemont I had learned that collectors would bring damaged paintings in from time to time (with scratches or paint losses, not tears) and Warhol "repaired them" (13). On the other hand, there is the painting of Marilyn Monroe that suffered a bullet hole surrounded by concentric stress cracking when Warhol was shot by Valerie Solanis. The painting, which came up recently for auction, was left alone and retitled <u>Shot Marilyn</u>. If Andy were still alive would he call this one <u>Hurricane Roy</u>?

I looked to the Warhol Museum for input. Rustin Levenson's New York studio had worked for the Andy Warhol Museum on a preliminary survey of paintings destined for the museum's collection. After the survey, RLACA carried out emergency treatments of paintings before they traveled to Pittsburg. As it happened, my associate Harriet Irgang flew to Pittsburg for the Warhol Museum's inaugural exhibition. While there she discussed conservation approach with Paintings Conservator Will Real. Having seen paintings at the Warhol Foundation before treatment, it was apparent that significant treatments had been carried out prior to the exhibition. Will noted that a curatorial decision had been made that the work should look "complete"; major paint losses, regardless of where they were located, were not thought to be in keeping with original intent. Will noted that there are examples within the collection of previous retouches, presumably carried out by Warhol. On the other hand, certain "intractable fingermarks, footprints, and some abrasions were considered acceptable, evidence of their melieu." While he had never had to reconstruct extensive areas of silkscreen loss, Will had no problem with the proposed treatment (14). The search for a silkscreener began. Meanwhile, inpainting of the purple brushstroke in the chin area was carried out with Liquitex, using the two versions of Lichtenstein reproduced in the book <u>Andy</u> Warhol Portraits (15) for reference.

The initial idea was to find or make a silkscreen of dots through which a conventional inpainting pigment, such as gouache or Maimeri could be applied. This would be carried out in sections over the toned fills. Mark Epstein of "Izmo Screenprinting," New York City was consulted. A note of caution... the rest of this treatment is very dependent upon the skills and expertise of the silkscreener. Mark came well recommended and has been in the business for 25 years. He has worked with a number of artists and architects, and showed us some of his collaborations.

In conversation with Mark, it became obvious that the initial approach would not work. Warhol's photo derived image, while filled with all sorts of painterly skips and gliches, was essentially a mechanical and seamless application. The sectional approach would end up looking like a patchwork quilt, and was absurdly at odds with the artist's intent. Mark developed a plan which seemed to fit our concerns for safety. The method would be reversible; the actual silkscreening could be carried out in the conservation studio; a transparent film (the one used to make the silkscreen) would confirm proper registry before printing took place; the silkscreen would not cover any original material (16).

The first step was to make a tracing of the silkscreen losses. A conte crayon drawing of the missing chin information was made on vellum, simulating values of the original photo image. The two Lichtenstein paintings reproduced in <u>Andy Warhol Portraits</u> were again used for reference. Tiny paint fragments saved during consolidation were used by Mark to measure the angle of lines of the dots in the original, which was determined to be 45 degrees. The original number of silkscreen dots was found to be 15 dots per inch (17).

On site at IZMO a photograph was made of the conte crayon drawing. The photo could not be made at 15 lines per inch (the image would have been too course) and so it was reduced to 1/4 size. A Velox (which is a photo converted to half tone dots) was shot at 1/4 size at 60 dots per inch. The resulting half tone image was then blown up to the original size needed (15 dots per inch). From the resulting film a photo stencil was made on silkscreen (18).


Figure 3. Andy Warhol, <u>Portrait of Roy Lichtenstein</u>, During treatment, detail



Figure 4. Warhol, Portrait of Roy Lichtenstein, After treatment

Back in the conservation studio the painting was laid face up on a table and supported from below. The film was placed on the canvas to check for accuracy and registered with tape. There were no areas overlapping the surrounding original paint layer. The painting's surface was protected. Then the silkscreen was matched and the film removed. A fast drying enamel, soluble in mineral spirits, was squeegeed through the silkscreen (19). After the ink dried, small areas of missing dots around the edges of the reconstruction were filled in with "Sanford Expo Finepoint" Dry Erase Marker. Once again, this material would have to be considered reversible only from the fill layer.

As noted before, almost every phase of this reconstruction involved the use of unconventional methods and materials. The final result (Figure 4) was heavily dependent upon the expertise of a professional screenprinter. The treatment of this painting raised many issues. Reconstruction of extensively damaged contemporary paintings is a complex and challenging area of conservation which, by definition, continually presents new problems.

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LASER APPLICATIONS IN PAINTING CONSERVATION

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1. Introduction

Lasers have multiple applications in medicine and in industry. They have revolutionized the surgical approach to many diseases and have facilitated the development of complex miniature microcircuitry. Recently we have applied specialized laser technology to art conservation using primarily an excimer laser. This device emits a powerful ultraviolet beam which can remove material in microscopic increments. This facilitates the surface cleaning of soiled or dirty paintings with limited effects on the underlying material. We believe that painted works of art can also be examined and their surface and structural composition analyzed in a nondestructive manner using a variety of laser based spectroscopic techniques.

The application of laser technology for art restoration is necessarily a collaborative effort involving physicists, conservators, engineers and museum personnel. Our work has been centered in Europe at the Foundation for Research and Technology in Heraklion Crete, Greece (F.O.R.T.H.) and the National Gallery of Athens. A collaboration has also begun with the University of Pittsburgh in the United States.

Traditional methods of conservation of paintings rely on mechanical or chemical techniques chosen by a conservator. Because the processes are difficult to control, extensive experience is necessary to achieve an optimal result. However, if solvents are used incorrectly, these may penetrate the painting and damage the pigments and other media. Even under controlled conditions, some solvent penetration may occur Mechanical cleaning methods have similar shortcomings and may damage or destroy the texture of the painting or artwork.

In contrast to these more traditional techniques, a laser can be configured to remove unwanted surface layers in tiny increments of just a few microns. With proper laser selection, debris can be removed with minimal thermal or photochemical influence on the underlying material. Furthermore, optical techniques can be applied to evaluate the cleaning process and carefully monitor its progress minimizing damage [1,2]. We present herein our early collaborative work

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in cleaning absorbed particles, fungi, organic and inorganic compounds from paint-protecting varnishes as well as removal of these unwanted materials from the supporting structure.

2. Basic principles of laser restoration

When a laser beam interacts with a solid target, a variety of events may take place including thermal and photochemical ablation of surface molecules, shock wave formation with mechanical disruption of the surface layers, vaporization of organic debris, as well as other less well known phenomena. Each of these interactions can be produced more or less selectively by proper choice of the laser wavelength, as well as the other appropriate selection of the laser parameters including peak power, pulse duration, pulse shape, repetition rate, irradiance geometry and laser spot size. The characteristics of the material to be ablated are also quite important. These include the absorption coefficient of the material, its reflectivity, thermal diffusivity, enthalpy of evaporation and heat capacity. When gross cleaning effects are desired, large amounts of material must be removed. Neodymium-YAG lasers are useful in this setting because they create shock waves which result in the rapid removal of large amounts of surface materials. On the other hand, if the desired effect is microscopic rather than macroscopic, excimer lasers are typically employed. The photo-ablation of materials using an excimer laser is a complex interaction which is only partially understood. Photophysical, thermal, mechanical and chemical properties of the materials influence the ablation. In addition, the plasma which is created can influence the laser performance by filtering or altering the incident excimer laser beam.

Our early work shows that layers of varnish of 0.5 to 1 micron thickness can be removed per laser pulse when a krypton fluoride KrF excimer laser is used, emitting pulses of 15 ns duration and fluences of 10 to 200 mJ/cm² (unfocused) are selected. Paintings created with egg yolk media (tempera) have been restored in this manner using repetitive pulses. A typical varnish or paint stroke applies approximately 15 to 20 microns of material to the surface. The excimer laser can be set up to remove 0.5-1 microns of material per pulse, leaving the underlying layers unaffected.

3. Laser strategies for painting conservation

There are three conservation tasks for which the laser is well suited. These include the cleaning of **surface layers** of varnish or contaminated regions of the painting, cleaning of the **painting's support material**, usually canvas, wood or paper, and the removal of **overpaintings**. Each of these tasks must be approached using a separate strategy. For example, the laser surface cleaning of paintings ideally removes the unwanted debris in the top layers without any contamination or exposure of the underlying layers. Conservation of support material, as in the cleaning of canvas, requires the more gross removal of adhesives and synthetic glues from the back surface of the artwork. Finally, the removal of overpaintings which have been applied by ignorance or by vandalism can be done in microscopic increments, avoiding laborious more risky procedures employing organic and inorganic solvents and cleaning compounds.

To conserve a painting using laser technology, we developed a workstation comprised of a



Figure 1b

Figure 1a



EUFIHANS

Figure 2a

Figure 2b

computer controlled XYZ (3 directional) mechanical translator on which the painting is mounted. Appropriate optics are incorporated in the laser path and image processing techniques with a module for broad band reflectography is used for on-line process control. As the dirt or debris disappears, a clean thin layer of overcoating is exposed which can be detected by the reflectography data. Furthermore, during and after laser treatment, various diagnostic methods such as optical and scanning electron microscopy and profilometry are used to assess the quality of the cleaning process.

An example of surface cleaning by excimer laser is shown in Figure 1: Figure 1a shows a 17th century icon on the verge of disintegration. Application of any mechanical or chemical cleaning techniques would have destroyed this fragile piece. Using a laser however, the icon was restored after first stabilizing it with an epoxy binder. In our experience, laser irradiation can itself remove surface contamination directly, or it can be used to loosen dirt sufficiently to allow the effective use of mild rather than corrosive cleaning chemicals.

An example of the conservation of support material is depicted in Figure 2. Black fungi has been removed by KrF laser irradiation.

An example of overpainting removal is depicted in Figure 3, where a 14th century painting was restored by removing a 19th century overpainting. Figure 3a shows the region of the overpainting before irradiation. Figure 3b shows the underlying original painting recovered after laser treatment. A section of the white plaster preparation made by the 19th century painter, as it appears during the laser processing, is also shown in Figure 3b. Because the laser acts on a microscopic level, the texture of the original painting has been preserved, as has been shown by detailed profilometric assessments.

4. Structural and analytical applications of laser technology

The degree of success of any conservation technique applied relies on the availability of nondestructive diagnostic techniques including **imaging** techniques to document macroscopic color and structural information and **analytical** techniques to provide information on the chemical composition of the art object. Macroscopic observations are made by reflectography and can aid in on-line monitoring of the cleaning process to safeguard against potential damage. Depending on the choice of wavelengths used in the reflectography, information of many of the layers of the painting can be obtained. For example, reflectographic observations in the ultraviolet (200 to 350 nm) provide information for the superficial varnished layers, while imaging in the near infrared (1.0 to 2.5 μ m) reveals underlying structure characteristics, particularly in the case of overpaintings. Illumination by tunable lasers also aids in the layer-by-layer observation of the pigment strata.

Recently we have utilized Laser Induced Fluorescence Spectroscopy (LIF) in situations demanding careful diagnostics. Originally this method was used for medical applications [5]. A similar setup, developed by Theo Papazoglou at F.O.R.T.H. has been used to perform a nondestructive pigment analysis and to identify the presence of photochemical oxidation. Other laser based spectroscopic techniques, such as the Laser Induced Breakdown Spectroscopy have



Figure 3b

Figure 3a

shown promise in pigment and contamination identification and as an adjunct in the control of the laser cleaning process.

5. Conclusion

Our initial work has demonstrated that laser beams, when carefully chosen and applied, are useful in painting cleaning and diagnostics applications. The techniques must be carefully monitored, and considerable experience is required to optimize their use and minimize any danger to the artwork.

We envisage the ultimate development of safe, portable workstations incorporating both cleaning and diagnostic modules to allow works of art to be restored on site. This would help eliminate expensive and possible dangerous transportation of fragile works of art to off site locations. To achieve this goal, however, extensive work must be done, including the scientific categorization of pigment, varnish, and substrate data so the correct laser conservation strategies can be selected for the task at hand.

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Figure Captions

Figure 1. Surface cleaning by excimer laser: A 17th century icon before (Figure 2a) and after (Figure 2b) laser cleaning.

Figure 2. Paper cleaning from black fungi by excimer laser.

Figure 3. Removal of overpainting by excimer laser: A 19th century overpainting (Figure 3a) is removed from a 14th century icon (Figure 3b).

LESS IS MORE; OR IS IT? THE CONSERVATION OF THE TUNIS PONSEN EXHIBIT Kenneth B. Katz

> TUNIS PONSEN WAS BORN IN WAGENINGEN, THE NETHERLANDS IN 1891. HIS FATHER, A HOUSE PAINTER, ENCOURAGED HIS SON TO PAINT AND DRAW. BY 1912, HE HAD RECEIVED HIS CERTIFICATE TO TEACH DRAWING AT THE ELEMENTARY SCHOOL LEVEL AND TWO YEARS LATER LEFT FOR AMERICA, LEAVING HIS CHILDHOOD SWEETHEART CATO AT HOME. SHE WAS TO COME LATER AFTER TUNIS HAD SETTLED AND MADE ENOUGH MONEY FOR HER PASSAGE. PONSEN SETTLED IN MUSKEGON, MI WHERE HE EARNED A LIVING AS A HOUSE PAINTER. HIS SISTER ALSO CAME OVER AND SETTLED IN WESTERN MICHIGAN. BY 1916, TUNIS HAD SAVED ENOUGH MONEY FOR CATO TO MAKE PASSAGE. ONE CAN ONLY ASSUME THAT HE SUFFERED A PROFOUND DISAPPOINTMENT WHEN CATO ARRIVED, MARRIED TO A MAN SHE HAD MET ON THE BOAT. TUNIS PONSEN REMAINED A BACHELOR THE REST OF HIS LIFE.

TUNIS SERVED IN WORLD WAR I AND UPON HIS RETURN, CONTINUED HOUSE PAINTING TO SUPPORT HIM WHILE HE PAINTED. THE DIRECTOR OF THE HACKLEY ART GALLERY, WHICH EVENTUALLY BECAME THE MUSKEGON MUSEUM OF ART ARRANGED TWO, ONE MAN EXHIBITIONS DURING THIS TIME. ENCOURAGED BY HER AND POSITIVE REVIEWS IN LOCAL NEWSPAPERS, HE ENROLLED IN THE SCHOOL OF THE ART INSTITUTE OF CHICAGO, WHERE HE WAS AWARDED ADVANCED STANDING BASED UPON HIS PREVIOUS EXPERIENCE. HE SPENT SUMMERS AT THE PROVINCETOWN ART COLONY IN MASSACHUSETTS OR IN GLOUCESTER, MAINE. HE ESTABLISHED A STUDIO AT 4422 OAKEN WALD STREET IN CHICAGO. THE LATE 20'S SAW PONSEN SUMMERING AND PAINTING OUT EAST, AS WELL AS SPENDING A LOT OF HIS TIME WITH HIS SISTER AND ANGINITA, HIS NIECE, WHO HE OFTEN REFERRED TO AS HIS ADOPTIVE DAUGHTER. IT WAS AT THIS TIME THAT HE FORSOOK HIS ON SITE PAINTING FORMAT, DUE TO THE HASSLES OF TRANSPORT, AND DECIDED TO DO WATERCOLORS ON SITE; COMPLETING HIS OIL PAINTINGS IN HIS STUDIO FROM THESE PRELIMINARY DESIGNS.

IN 1928, HE LEFT FOR EUROPE ON A SCHOLARSHIP AND RECEIVED A PRIZE FOR HIS OIL PAINTING, <u>MORNING ON THE RIVER SEINE</u>, FIG 1., UPON HIS RETURN. BECOMING MODERATELY SUCCESSFUL, HE WAS ASKED BY THE "CHRISTIAN MONITOR" ABOUT HIS THEORY OF PAINTING. "NONE" HE SAID, SHYLY. "I JUST PAINT THE THING I SEE, THE WAY I FEEL IT. I JUST TRY TO PAINT WELL." THE THIRTIES AND FORTIES SAW A MORE MATURE STYLE, A TIGHTER VISUAL IMAGE. IN 1945 HE BEGAN TEACHING AT THE CHICAGO ACADEMY OF FINE ARTS WHERE REMAINED FOR THE NEXT TWENTY YEARS. IN 1952 HE MOVED TO ANOTHER STUDIO WHOSE BACK WINDOWS OPENED TO THE TRAIN YARDS. HE CONTINUED TO PAINT AND TEACH, AND BEGAN USING ACRYLICS ALTHOUGH HE SAID IT WAS ONLY BECAUSE HE HAD TO TEACH ITS USE.

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Detroit, MI 48226

HE PASSED AWAY AT THE AGE OF 77. HIS OBITUARY INCLUDED THAT MR. PONSEN WAS A LANDSCAPE ARTIST AND HAD TAUGHT AT THE CHICAGO ACADEMY OF FINE ARTS. HE LEFT A NIECE.

THE DISCOVERY OF THE LOST PAINTINGS OF TUNIS PONSEN BEGAN WITH A LETTER WRITTEN TO CITIZENS INSURANCE CO, WESTERN MICHIGAN DISTRICT, EXPLAINING THAT A RIDER TO COVER MORE THAN 100 PAINTINGS AND WATER COLORS WAS NEEDED. AS AN APPRAISER AND VICE PRESIDENT OF THE COMPANY, MR. PATRICK COFFEY WAS INTERESTED IN THIS REQUEST AND OF COURSE BEING AN INSURANCE MAN, SKEPTICAL. WHEN HE CAME TO VISIT ANGENITA, HE WAS A BIT SURPRISED TO SEE ALL ONE HUNDRED PAINTINGS AND WATERCOLORS ON HER WALLS. AFTER ABOUT THREE HOURS OF CONVERSATION, IN WHICH HE LEARNED THE HISTORY OF TUNIS, ANGENITA ASKED HIM IF HE WANTED TO SEE MORE. IF PAT WAS SURPRISED TO SEE 100 PAINTINGS ON ANGINITA'S WALLS, HE ALMOST FELL OVER WHEN HE WENT DOWNSTAIRS AND SAW THREE HUNDRED MORE PAINTINGS, AND 100 WATER COLORS ALL CATALOGUED AND STACKED IN STORAGE. THE SCOPE AND ACCOMPLISHMENT OF THE ART INSPIRED A MARKETING IDEA TO EXHIBIT THESE WORKS AS PART OF A CITIZEN'S INSURANCE SHOW. HE APPROACHED HENRY MATTHEWS, DIRECTOR OF THE MUSKEGON MUSEUM OF ART WHO QUICKLY AGREED AFTER SEEING THE WORKS AND, THE PROCESS BEGAN.

THE EXHIBITION WAS TO BE UNDERWRITTEN BY CITIZEN'S INSURANCE COMPANY OF AMERICA WHICH WAS REPRESENTED BY MR. PATRICK COFFEY, VICE PRESIDENT FOR MARKETING AND A CERTIFIED ART APPRAISER. THE ORGANIZER OF THE EXHIBITION WAS THE MUSKEGON MUSEUM OF ART, HENRY MATTHEWS, DIRECTOR, AND ANGINITA WOULD LEND THE BULK OF HER COLLECTION FOR THE TWO YEAR SHOW. EACH OF THE ABOVE HAD STRONG OPINIONS CONCERNING TUNIS, HIS PAINTINGS, AND THE PRESENTATION OF HIS WORKS. THEY ALL AGREED THAT SOMETHING HAD TO BE DONE TO HIS PAINTINGS, BUT THEIR ALTRUISTIC DESIRES WERE ALL TEMPERED WITH THEIR OWN CONCERNS. ANGENITA WAS CONCERNED WITH CONSERVATION AND LONG TERM EFFECTS OF TREATMENT. PATRICK COFFEY WAS CONCERNED WITH COSTS AND INTERVENTION FROM A VALUE POINT OF VIEW, HENRY WAS CONCERNED WITH ALL OF THE ABOVE AND MOST CONCERNED WITH PONSEN 'S INTENT AND HOW TO EXHIBIT HIS WORKS IN THE BEST POSSIBLE WAY. AFTER MANY MEETINGS BETWEEN THE THREE, I WAS ASKED TO SURVEY THE 48 CHOSEN PAINTINGS FOR THE EXHIBITION TO BE ENTITLED THE LOST PAINTINGS OF TUNIS PONSEN.

I MET WITH ANGENITA AND LOOKED AT THE PAINTINGS IN HER HOUSE. I SAW TUNIS'S ATTEMPTS AT RESTORATION, STRIP LININGS AND BACKING BOARDS. I WAS ALSO SHOWN THE BOOK THAT TUNIS USED TO HELP HIM IN HIS RESTORATIONS AND CLEANING. RALPH MEYERS "THE ARTIST'S HANDBOOK". O YES SAID ANGENITA, TUNIS LIKED TO CLEAN ALL OF HIS PAINTINGS . HE WOULD USE IVORY SNOWFLAKES IN WATER AND RING OUT THE CLOTH AND GENTLY WIPE OFF THE GRIME FOLLOWED BY A RINSING WITH PURE WATER. I NOTED ONLY ONE BLANCHED PAINTING, DUE IN PART TO THE LACK OF VARNISH.

THE COLLECTED WORKS OF TUNIS PONSEN EXHIBITED CERTAIN GENERAL CHARACTERISTICS PARTICULAR TO THE TIME IN WHICH THEY WERE PAINTED. HIS EARLY CHICAGO PERIOD AS SEEN IN THE YOUNG MAN WITH VIOLIN, FIG. 2, AND MALE MODEL, FIG. 3, REFLECTED THE USE OF THICK PAINT, REWORKING AND WET INTO WET GLAZING. THESE EARLY PAINTINGS EXHIBITED LOCAL CLEAVAGE AND MUCH MORE INTERVENTION THAN HIS LATER PAINTINGS. SOME HAD BEEN LINED, AND MOST EXHIBITED DAMAGE ASSOCIATED WITH CLEAVAGE OF PAINT. IN SOME PAINTINGS, UNFILLED LOSSES HAD BEEN RETOUCHED, PROBABLY BY PONSEN. VERY YELLOWED VARNISHES WITH EMBEDDED GRIME WERE PRESENT ON ALL OF THESE WORKS. THE PAINTINGS OF THE THIRTIES WERE THINNER AND USED A LIGHTER PALATE . NEVERTHELESS, THESE PAINTINGS ALSO APPEARED TO BE VARNISHED BY THE ARTIST. THE FORTIES SAW A MATURE STYLE AND BETTER CONDITIONED WORKS. MANY HAD BEEN STRIPPED LINED BY PONSEN WITH SURGICAL TAPE, OR THE CORNERS HAD BEEN REINFORCED, AND CARDBOARD BACKING BOARDS PLACED BETWEEN THE PAINTING AND STRETCHER. AGAIN THEY HAD A VARNISH COAT. ALL THE VARNISHES HAD TURNED SIGNIFICANTLY YELLOW AND THE GRIME LAYER CAUSED DISFIGUREMENT, AS WELL. IN GENERAL, THOUGH, THE CANVASES THAT HAD NOT BEEN LINED OR STRIPPED LINED BY PONSEN WERE RELATIVELY STRONG EXCEPT FOR TEARS ALONG THE TACKING MARGINS AND CORNERS WHICH HAD CAUSED DRAWS AND DEFORMATIONS IN PLANE. TREATMENTS INCLUDED: GRIME REMOVAL WITH THE DIAMMONIUM SALT OF CITRIC ACID NEUTRALIZED TO A pH OF 7 -7.5 WITH AMMONIA. VARNISHES WERE REMOVED USE MIXTURES OF ACETONE AND MINERAL SPIRITS. A FEW PIGMENTS TENDED TO BE SENSITIVE AND THE VARNISH WAS THINNED IN THOSE AREAS; THIS WAS CONFINED TO THE VERY DARK PURPLES AND BLUES. STRUCTURALLY, TORN TACKING EDGES WERE MENDED WITH LASCAUX POLYAMIDE TEXTILE WELDING POWDER 5060 AND THEN STRIP LINED WITH PECAP 7 60 HD AND ADAM EVA SHEET FILM OR WOVEN POLYESTER AND SHEET FILM, OR LINEN AND SHEET FILM. THE CHOICE OF FABRIC WAS DETERMINED AS MUCH BY MATERIALS ON HAND, AS WELL AS THINNESS OR THICKNESS OF CANVAS AND PAINT, THE THINNER CANVASES GETTING PECAP. TACKING MARGINS WERE ALL SIZED WITH BEVA GEL PRIOR TO STRIP LINING. ALL ORIGINAL STRETCHERS WERE USED AND KEYS WERE SECURED WITH BRADS. BACKING BOARDS WERE THEN ATTACHED WITH SCREWS.

THERE WERE TWO MAJOR EXCEPTIONS TO THE ABOVE: YOUNG MAN WITH VIOLIN EXHIBITED OVERZEALOUS RESTORATIONS IN THE BACKGROUND, FIG. 4, THIS WAS DETERMINED BY EXAMINATION AND BY ARCHIVAL DOCUMENTATION. ANGENITA HAD TOLD ME THAT THIS PAINTING HAD BEEN REFRAMED IN THE EARLY SEVENTIES AND WHEN QUESTIONED, THE FRAMER INFORMED ME THAT THEY HAD ALSO RESTORED IT. IN FACT, THE BACKGROUND HAD BEEN TOTALLY OVERPAINTED. IT HAD BEEN LINED TOO, APPARENTLY TO ALLEVIATE THE FLAKING, OVER WHICH MUCH HAD BEEN OVERPAINTED AND NOT FILLED. THE SURFACE COATINGS AND RESTORATIONS WERE REMOVED WITH ACETONE MIXTURES THEN INPAINTED WITH PVA AYAA/AYAC. A VARNISH OF ACRYLOID B72 IN CYCLOSOLVE 53 WAS BRUSHED ON, FOLLOWED BY A BRUSH COAT OF WINTON RETOUCH VARNISH. A FINAL SPRAY OF B72 IN XYLENE WAS APPLIED TO GET THE APPROPRIATE SHEEN. THE QUESTION OF VARNISHING AND THE FINAL APPEARANCE WAS DICTATED BY ANGENITA'S COMMENTS THAT HE ALWAYS VARNISHED HIS PAINTINGS. AND THE CONDITION AND TECHNIQUES NOTED ON THE WHOLE RANGE OF PAINTINGS THAT I WAS ALLOWED TO VIEW. IT APPEARED, AT LEAST TO ME, THAT AS HE GOT OLDER AND HIS STYLE BECAME MORE SPARSE, HIS VARNISHES BECAME LESS THICK AND GLOSSY, BUT ULTIMATELY IT APPEARED THAT HE PREFERRED A SATURATED APPEARANCE. I MIGHT ADD THAT ANGENITA REMARKED THAT HIS VARNISHING WAS DONE IN THE UPPER AREA OF HIS STUDIO OVERLOOKING THE TRAIN YARDS WITH WINDOW OPEN. NEEDLESS TO SAY, SHE CORRECTLY ASSUMED THAT, THAT MAY HAVE BEEN THE SOURCE OF SO MUCH EMBEDDED GRIME FOUND ON HIS PAINTINGS. PENTIMENTO WAS NOT FOUND ON MANY PAINTINGS, BUT WAS FOUND IN A FEW. OFTEN, THESE AREAS EXHIBITED CLEAVAGE AND INSECURITY.

THE SECOND MAJOR EXCEPTION WAS THE PAINTING STONE QUARRY, FIG. 5, EXAMINATION REVEALED AN UNLINED PAINTING WITH MANY AREAS OF LOSS THAT APPARENTLY HAD BEEN OVERPAINTED . IT APPEARED TO HAVE BEEN AN ONGOING PROBLEM. FURTHERMORE, MANY OF THESE AREAS HAD DISCOLORED OR HAD NOT MATCHED IN THE FIRST PLACE. THE TEXTURE AND APPEARANCE OF THE OVERPAINT INDICATED THAT IT MAY HAVE BEEN APPLIED BY PONSEN. TREATMENT INCLUDED: CONSOLIDATION WITH BEVA GEL, FOLLOWED BY THE REMOVAL OF THE VARNISH AND RESTORATIONS THAT WERE DISFIGURING. THE PAINTING WAS LINED ON A VACUUM HOT TABLE TO WOVEN POLYESTER. THE POLYESTER HAD BEEN STIFFENED FIRST WITH A COAT OF 15 % B72 IN XYLENE. A 3 ML MYLAR SHEET, CUT TO THE SAME DIMENSIONS OF THE PAINTING LESS TACKING MARGINS WAS ADHERED WITH ADAM EVA ADHESIVE FILM TO THE HOT TABLE SIDE OF THE WOVEN POLYESTER. LASCAUX 360 HV WAS SCREENED OVER THE SIDE FACING UP AND ALLOWED TO DRY OVERNIGHT. THE PAINTING WAS PLACED ON THE DRIED LASCAUX AND LINED AT A TEMP OF 150 F AND VACUUM OF 3" OF MERCURY. DARTEK WAS THE MEMBRANE. LOSSES WERE FILLED WITH A VINYL SPACKLE AND INPAINTING WAS DONE WITH WATER COLORS AND EGG TEMPERA COLORS FOLLOWED BY A BRUSH COAT OF B 72 IN CYCLOSOL 53. PVA AND DRY PIGMENT GLAZES WERE THEN USED FOLLOWED BY SPRAY COATS OF B 72 AND LOCAL VARNISHING WITH THE SAME.

OVER THE TWO YEARS THAT THE TREATMENTS WERE UNDERTAKEN, I TRIED TO MAINTAIN SOME INTANGIBLE, YET FELT CONNECTION WITH THE ARTIST. AS NOTED, MANY WERE IN VERY GOOD CONDITION AND IT WAS ALL OF OUR INTENTIONS TO DO LESS RATHER THAN MORE. PAINTINGS WERE LEFT WITH PONSENS SURGICAL TAPE STRIP LININGS AND MANY WITH HIS RESTORATIONS SINCE THEY WERE NOT TERRIBLY

DISFIGURING. WE ALSO ACCEPTED SLIGHT DEFORMATION IN PLANE WHEN LOCAL FLATTENING PROCEDURES WERE NOT SUCCESSFUL. I HAD BEEN TRAINED IN THE MID TO LATE 70'S WHEN THE PROPHYLACTIC APPROACH TO STRUCTURAL CONDITION WAS DISCUSSED AND TAUGHT. I WAS A BIT ANXIOUS AND UNEASY ABOUT THE RESULTS OF MY TREATMENTS. WHEN THE SHOW FINALLY OPENED, MY INFORMAL SURVEY OF DISCREETLY TAPPING PAINTINGS AND SUBTLY LOOKING FOR DEFORMATIONS AND SUCH REVEALED NO CONCERNS. HOWEVER, TWO MONTHS LATER MY WORST FEARS WERE REALIZED. AT LEAST 22 OF THE 48 PAINTINGS THAT I HAD TREATED WERE LOOSE AND OUT OF PLANE. USING A RATING OF 1 -5, 1 BEING TAUT, 2 BEING ACCEPTABLE, 3 HMPH SHOULD WE OR SHOULDN'T WE, 4 YES , AND 5 OH NO WILL KEYING EVER WORK? MOST WERE 3 AND 4. ALL THESE PAINTINGS WERE SOUND ON OPENING NIGHT, 2 1/2 MONTH PREVIOUS. CHECKING MY RECORDS, I NOTED THE ONES THAT HAD BEEN STRIPPED LINED, AND THE ONES THAT WE HAD DONE NOTHING, BUT KEY OUT. IN ALL CASES, THE MINIMALLY TREATED ONES HAD NOT SUFFERED DEFORMATIONS IN PLANE. THE SLACK PAINTINGS WERE SPLIT BETWEEN MY STRIP LININGS AND TUNIS'S. FURTHERMORE, IT DIDN'T SEEM TO HAVE MADE A DIFFERENCE AMONG THE MATERIAL USED AS A STRIP LINING MATERIAL, PeCAP 7-60 HD, WOVEN POLYESTER, OR LINEN. ANSWERS WERE NEEDED AND FAST. THE REGISTRAR AND I BEGAN REMOVING THE BACKING BOARDS AND UNFRAMING THE PAINTINGS. WHILE REMOVING THE PAINTINGS, I NOTED THAT ALL OF THEM WERE A BIT TIGHT IN THE FRAME AND ALL HAD FOME CORE SPACERS. I HAD NOT USED THESE SPACERS. WHERE DID THEY COME FROM? ALTHOUGH I TREATED ALL THE PAINTINGS, PERIOD FRAMES, BASED ON THE FRAMES NOTED IN HIS PICTURES AND EXISTING ONES, WERE FABRICATED FOR THE EXHIBITION, IF THE ORIGINAL ONES DID NOT EXIST. IT TURNED OUT THAT THE PAINTINGS HAD BEEN FRAMED ON SITE IN MUSKEGON PRIOR TO OPENING. IT WAS CLEAR, I HOPED, THAT THIS WAS THE PROBLEM. THE SPACERS HAD RESTRICTED THE NATURAL MOVEMENT OF THE WOODEN STRETCHERS OR IN FACT COMPRESSED THEM EVER SO SLOWLY OVER THE PERIOD OF TWO AND A HALF MONTHS. I REFRAMED THE PAINTINGS WITHOUT THE SPACERS, AND WHERE THE PAINTINGS WERE LOOSE, SECURED THE STRETCHER TO THE MENDING PLATES WITH SCREWS. THE NEXT OPENING WAS FOUR MONTHS AWAY.

I AM RELIEVED TO REPORT THAT SINCE THE FIRST SURVEY, ALL THE PAINTINGS HAVE RETAINED GOOD TENSION AND ARE SECURE. UP TO THIS WRITING, (11/30/95), THERE HAVE BEEN FOUR VENUES OVER THE LAST 3 YEARS AND EXCEPT FOR SOME MINOR MAT AREAS OF INPAINT, THERE HAVE NOT BEEN ANY DETECTABLE CHANGE IN CONDITION. I ALSO NOTED SOME METAMERISM OF INPAINTING DUE TO THE HALOGEN LIGHTING THAT APPEARS TO HAVE BECOME COMMON IN MUSEUM GALLERY LIGHTING.

IN CONCLUSION, IT WAS MY GOAL TO PREPARE THE PAINTINGS FOR EXHIBITION IN A WAY THAT WOULD REFLECT THE ARTIST'S INTENT WITH AS LITTLE INTERVENTION AS POSSIBLE. UP TO THIS POINT, THE PAINTINGS APPEAR TO HAVE EXHIBITED WELL. NEVERTHELESS, UNTIL THE PAINTINGS ARE BACK TO THEIR POINT OF ORIGIN, IT IS TOO SOON TO TELL IF LESS WAS INDEED, MORE.



Figure 1. Morning on the River Sine during varnish removal.



Figure 2. The Young Man with Violin.

Figure 3. Male Model.



Figure 4. Detail of overpaint removal.



Figure 5. Stone Quarry.

NON-INSTRUMENTAL METHODS FOR THE IDENTIFICATION AND CHARACTERIZATION OF ARTISTS' ACRYLIC PAINTS

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Abstract

Methods for art conservators to differentiate among acrylic resin and acrylic emulsion, oil and alkyd artists' paint media were developed that use hot-stage softening and solubility tests. Adapted from procedures outlined in ASTM, NIST and forensic science publications, the tests require only a microscope and a few simple tools. Standard paint samples were analyzed by Fourier transform infrared spectroscopy (FTIR) and pyrolysis gas-chromatography-mass spectroscopy (PY-GC-MS) to monitor the new test methods. Further analysis of the samples was undertaken using thin layer chromatography linked to GC-MS and PY-GC-MS. The tests were applied to unknown samples of works by Andy Warhol and Josef Albers.

Introduction

Problems in the identification of materials from works of art include the limited amount of sample available and its complexity. The latter is especially true for analysis of binding media of artists' paints due to the presence of plasticizers, emulsifiers, preservatives, thickeners, pigments, dyes, etc. plus items added by the artist to further "improve" their paints, as for example beeswax or resins. Techniques such as FTIR¹ spectroscopy and PY-GC² have been successful for this type of analysis. The cost of these techniques and the limited access conservators have to them puts them out of reach for most museums and art conservation laboratories.

Often in the case of art conservation, a general characterization of the binding media, as protein, oil or synthetic resin, is sufficient. The selection of solvents, adhesives, varnishes and retouching media for an art work's conservation is dependent upon the materials employed in that work of art. Likewise, the amount of heat and pressure that can be used in operations to consolidate, flatten or line a painting are controlled by the materials present.

Inexpensive techniques to supplement high tech methodologies have been developed for the characterization of traditional binders like oils, proteins, starches and sugars using methods such as fluorescence staining, paper chromatography and thin layer chromatography (TLC). 3,4,5,6,7,8 . This report discusses non-instrumental techniques for the characterization of acrylic paints and their application to actual works of art. The techniques, hot-stage softening and solubility tests, require only a microscope and a few simple tools. In addition to detecting acrylic paint, these tests will help conservators establish which solvents are safe for use and how much heat a paint film can tolerate during a conservation treatment.

Results of the instrumental techniques and supporting analyses for this study by FTIR and PYGC are reviewed. The sensitivity and accuracy of these techniques allowed identification of some minor constituents of the artists' paints used in this study. The results indicate that the different brands of acrylic paints used as standards in this study could be distinguished from each other based on the type and quantity of UV absorbers, stabilizers, surfactants and plasticizers detected by PYGC.

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Experimental Methods

Sample Collection

A set of standards was assembled to represent new and aged paints; these were characterized by the methods listed below. The results of the characterization were used for comparison with those of unknown samples.

<u>Standards</u> Several brands of acrylic emulsion, acrylic resin, oil and alkyd paints were used for testing. Paint samples were aged by either natural or artificial means to various degrees to improve the accuracy of results. Naturally aged samples range from 5 months, 1 year to 5 years in age. Conditions for natural aging were 21°C and 50% RH under normal indoor lighting. Artificial aging was conducted in an Atlas weather-ometer using a xenon arc light source for 150 hours at 1.11 watts/m² followed by 150 hours of thermal aging in an oven set at 90°C and 50% RH.

<u>Unknowns</u> Samples of the paintings listed below were taken to serve as unknowns. Sample size was approximately 1mg.

<u>Elvis</u>, Andy Warhol, 1964. Private collection <u>Self Portrait</u>, Andy Warhol, 1986. Hirshorn Museum <u>Homage to the Square, Elected II</u>, Josef Albers, 1961. Hirshorn Museum <u>Untitled (Variant)</u>, Josef Albers, 1973. Hirshorn Museum

Equipment

FTIR data was obtained using a Mattson Cygnus 100 spectrophotometer and a Spectratech IR-PLAN microscope. Chromatography was performed using a Perkin Elmer 8420 GC, with a $30 \,\mu\text{m}$ SPB-5 column, 0.25 mm ID, with a CDS 120 Pyroprobe for PY-GC and a Finnegen MS. All GC work was performed by the Materials Analysis Unit of the Federal Bureau of Investigation in Washington, D.C.

Hot-stage Softening Range

Samples were placed on a Kofler Hot-stage and examined under a low power stereoscopic binocular microscope. Observations on the effect of heating were recorded at a wide range of temperatures.

Solubility

Tests were conducted as outlined in National Institute of Standards and Testing (NIST) special publication 480-40, "Paint Solubility Testing." Solubility was established in the following reagents: concentrated sulfuric, hydrochloric, nitric and glacial acetic acids, solutions of potassium hydroxide at 1% and 30% concentrations, solutions of sodium hydroxide at concentrations of 30% an 50% and concentrated ammonium hydroxide. Reaction to organic solvents was evaluated using: acetone, carbon tetrachloride, chloroform, dichloroethane, DMSO, ethyl acetate, methylene chloride, toluene and xylene. Observations were made under stereoscopic binocular microscope and recorded after five-minute exposures.

The criteria for characterizing paint solubility was taken from NIST Report 480-40 which describes: a sample as *soluble* if after 5 minutes the paint was completely disintegrated; *partially soluble* if after 5 minutes more than half of the pigment was leached from the paint with some disintegration of the binder; *swelling* indicates uniform expansion with no noticeable solubility or pigment leaching; *softening* describes when the paint film could be pierced with a needle with no other visible effect and *discoloration* when a paint film turned black or brown.

Instrumental Analysis: FTIR and PY-GC

The non-instrumental techniques discussed in this study were compared to FTIR and PY-GC-MS analysis. The feasibility of using TLC as a technique to separate the complex acrylic paint into major polymeric subgroups for instrumental analysis was explored. Standard samples of the paints used in this study were analyzed by PY-GC-MS to provide data for comparison with other test results. Three brands of paint (Golden, Utrecht and Liquitex) were studied along with Rhom and Haas' Rhoplex AC33, the common base for artists' acrylic emulsion paints.

Results and Discussion

Hot-stage Softening

<u>Standards</u> Results from the hot-stage experiments (Table I) show the paints to react in increasing order of sensitivity to heat as follows: oil and alkyd, acrylic emulsion, acrylic resin. In general, by 60°C both acrylic emulsion and resin paints had become *soft and pliable*. At 90°C the acrylic resin paints had melted (*liquid*) and the emulsion paints had become sticky, with the consistency of rubber cement (*viscous fluid*). This behavior remained unchanged up to 200°C, when all other media types became brittle and charred.

Inert fill materials and pigments in the paint had a tendency to obscure observation on reaction temperatures and cause variation within each media type between different colored paints. Dyes and/or earth pigments decreased the temperature at which physical changes were observed while lead white, which is known to induce drying, raised the temperature at which the paint was effected.

The overall reproducibility of the hot stage test results support their use for generalized characterization of paint media as well as providing information for conservation treatments. Temperatures above 60°C are shown to be unsafe for paintings done in synthetic media. This has particular relevance for lining treatments for acrylic paintings because the most common thermoplastic adhesives used have melting points at or above 60°C. Cold lining methods, which avoid using heatset adhesives, may provide safer and more suitable alternatives.

<u>Unknowns</u> The softening range results of the unknowns (Table II) characterize the paint layer in both Andy Warhol's, <u>Elvis</u> and <u>Self Portrait</u> as acrylic resin media. The ground layer results show <u>Self Portrait</u> was painted on an acrylic gesso and the earlier work, <u>Elvis</u>, on an oil ground.

Hot-stage results for the Albers' works show the paint layer in <u>Homage</u> to be characteristic of acrylic and that from <u>Untitled</u> similar to oils.

Solubility

<u>Standards</u> Results from the artists' paints' solubility in acids and bases concurred for each medium with those obtained in the NIST report on household and automotive lacquers (Table III). Of the reagents tested, glacial acetic acid, 30% potassium hydroxide and 30% sodium hydroxide were the most useful for differentiating between media types. The oils and alkyds were readily saponified in the alkali solutions whereas the acrylics remained unaffected. Conversely, the acrylics dissolved in acetic acid and the oil and alkyds did not.

Dissolution in organic solvents proved less successful a means to differentiate between the various media and more useful for providing information for choosing conservation approaches (Table IV). Toluene, xylene, chloroform, and dichloroethane all visibly effected the acrylic paints but caused no observable reaction with the oils or alkyds. In all instances the acrylic resin paint was more greatly effected than the emulsion paints. This allowed a distinction between these media to

be made. Chloroform and dichloroethane were most successful for this purpose; they dissolved the acrylic resin paint completely, but caused the acrylic emulsion paints to swell, curl and soften.

Aged acrylic samples swelled, curled and, in the case of the resin based paints, partially dissolved, in toluene and xylene in less than five minutes time. These results highlight the limitations for solvent selection for consolidation and application and removal of varnish from synthetic paint films. Problems surrounding varnish on acrylic paintings are further compounded by the current recommendation and marketing of ketone resin and acrylic resin varnishes for synthetic media paintings.

<u>Unknowns</u> The solubility results for the unknowns (Table V) show the paint layer in Andy Warhol's <u>Elvis</u> and both paint and ground layers from <u>Self Portrait</u> to be identical to that of the acrylics. The ground layer in <u>Elvis</u> exhibited the solubility of the oils.

The solubility results for the paint layer in Josef Albers', <u>Untitled</u>, agree with acrylic media characterization. The solubility results from <u>Homage</u> were unclear as the sample fragmented in both alkali and acidic solutions. Disintegration may occur with poorly bound samples if the surface tension overpowers the sample's cohesive strength. In addition, when there is a low ratio of binder to pigment in the paint, solubility results may be influenced by the pigment's sensitivity to acidic or alkaline reagents.

Instrumental Analysis: FTIR and PY-GC-MS

<u>Standards</u> The FTIR spectra of the standards compared well with published spectra of their components: for example, a spectrum of Rhoplex AC33 matched a combination of spectra of poly(methyl methacrylate) and poly(ethyl acrylate).

In all standard samples, mixtures of methyl methacrylate, ethyl acrylate and n-butyl acrylate were present in the pyrograms from PY-GC-MS. The amount of n-butyl acrylate present varied with pigment and with the manufacturer; Rhoplex AC33 appears to have only trace amounts, while some artists' paints had large percentages of it (Fig. 1-3). Other additives identified by PY-GC-MS analysis are surfactants (Fig. 4-5), plasticizers, light stabilizers (including Tinuvin) and other UV absorbers (Fig. 6-7).

The large quantity of additives identified by PY-GC-MS illustrates the extent to which the acrylic polymers are manipulated in the manufacturing of artists' acrylic emulsion paints. It is impossible to identify which additives were added by the resin manufacturer and which were added later by the paint manufacturers. It is encouraging however, that light stabilizers and UV absorbers are present in both the raw resin and the final paint formulation. Differences in both the type and quantity of specific additives in the paints indicate that analysis of minor components might enable classification of acrylic emulsion paints.

What implications the inclusion of these additives will have on the long term aging of contemporary paintings is still relatively unknown. Conservators of modern art already acknowledge the problems they present for the preservation of these works once damage has occurred. For example, the large amount of plasticizers in emulsion paint formulatons reduces the melting point of the acrylic polymer and therefore restricts the suitable temperature range for relaxation, flattening, and lining treatments.

The much higher percentages of butyl acrylate in the paint than in the raw resin suggest that artist's paint manufacturers are adding poly(butyl acrylate) resin as part of their formulation. Adding poly (butyl acrylate) to the emulsion paints improves wetability and pigment saturation. Problems presented by the solubility of acrylic paint films are exacerbated by the presence of n-butyl acrylate in the medium. While the inclusion of this monomer might have little to no effect on aging

properties of acrylic paintings, its presence in the paint formulation limits solvent selection for surface cleaning, consolidation and varnishing almost exclusively to aqueous reagents. Issues surrounding varnishing and varnish removal from acrylic paint films are compounded by the previous recommendation of manufacturers of artists' materials for artists to use iso-butyl methacrylate, then n-butyl methacrylate varnishes and more recently, ketone resin varnishes on their synthetic media paintings.

<u>Unknowns</u> The FTIR spectrum of the ground for Andy Warhol's <u>Elvis</u> compared well with that of an oil (Fig. 8). The paint layer spectrum matched those of acrylics, especially poly(methyl methacrylate), Acryloid B44 (Fig.9). The FTIR spectra of the ground and paint layers for <u>Self</u> <u>Portrait</u> matched similar acrylic resins.

Conclusion

The non-instrumental methods tested in this research were designed to be simple and practical to use. Hot-stage softening and solubility tests are extremely useful in acquiring the information necessary to safely treat modern paintings. They give an accurate characterization of medium type, and often indicate the specific chemical composition of the binder. In addition, they can be used to determine the safe limits of heat and solvent exposure for individual works of art. It should be noted, however that results should always be compared to standards.

Instrumental methods can be used to obtain more information about modern media, often even identifying brands. They are not available to most conservators, except through commercial laboratories, and many of them should not be used as a first characterization step. When the cost of instrumental methods is warranted, the information from the low-tech methods can be used to choose the best instrumental methods.

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- ³ Masschelein-Kleiner, L. 1974. An Improved Method for the Thin-Layer Chromatography of Media in Tempera Paintings. *Studies in Conservation*. 19: 207-211.
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Table I: Softening Range Results for Standards

Sample	< 60°C	>180°C	
Acrylic Emulsion	soft & elastic	viscous fluid	
Acrylic Resin	soft	drying out*	
Oil	firm	charred	
Alkyd	hard	charred	

* By 90°C, the acrylic resins melt to a liquid

Table II: Softening Range Results for Unknown Samples

Sample	< 60°C	80°C	85°C	130°C	260°C	Characterization
Warhol, <u>Elvis</u> paint: silver	soft	elastic	liquid			acrylic resin
Warhol, <u>Elvis</u> ground: white	NR	NR	NR			oil/alkyd
Warhol, <u>Self Portrait</u> paint: blue	soft	soft	liquid	liquid		acrylic resin
Warhol, <u>Self Portrait</u> ground: white	rubbery	rubbery	rubbery	rubbery		acrylic emulsion
Albers, <u>Homage</u> paint: black	NR	NR	NR	darker	charred	oil/alkyd
Albers, <u>Untitled</u> paint: yellow	soft	soft	soft	liquid	dried	acrylic resin

Table III: Solubility in Acids & Bases

Sample	Acetic Acid (Glacial)	30% Potessium Hydroxide	30% Sodium Hydroxide
Acrylic Emulsion	partially soluble	NR	NR
Acrylic Resin	partially soluble	NR	NR
Oil	NR	patially soluble	partially soluble
Alkyd	NR	partially soluble	solable

Table IV: Solubility in Organic Solvents

Sample	Toluene	Xylene	Dichloroethane	Chloroform
Acrylic Emulsion	curis & softens	curls & softens	curls & softens	curls & softens
Acrylic Resin	partially soluble	partially soluble	soluble	soluble
Oil	NR	NR	NR	NR
Alkyd	NR	NR	NR	NR

Sample	Acetic Acid (Glacial)	30% Sodium Hydroxide	Characterization
Warhol, <u>Elvis</u> paint: silver	partially soluble	NR	acrylic
Warbol, <u>Elvis</u> ground: white	NR	partially soluble	oil/ alky d
Warhol, <u>Self Portrait</u> paint: blue	partially soluble	NR	acrylic
Warhol, <u>Self Portrait</u> ground: white	partially soluble	NR	acrylic
Albers, <u>Homage</u> paint: black	NR	NR	
Albers, <u>Untitled</u> paint: yellow	partially soluble	NR	acrylic

Table V: Solubility Results for Unknown Samples



Fig I Region of GC-Pyrogram of Rhoplex AC 33 Wherein Binding Modia Components Ethyi Acrylate(Scan No. 271), Methyl Methacrylate (Scan No. 284), Bihyl Methacrylate (Scan No. 352), Beta-Methacrylic Acid (Scan No. 396), Iso-Butyl Acrylate (Scan No. 458), N-Butyl Acrylate(Scan No. 489), and Butyl Methacrylate(Scan No. 572) Were Detected.

Scan No.



Fig 2 Region of GC-Pyrogram of an Artists' Acrylic Emulsion Paint "Golden" Brand Wherein Ethyl Acrylate (Scan No. 274), Methyl Methacrylate (Scan No. 286), Ethyl Methacrylate (Scan No. 355), Iso-Butyl Acrylate(Scan No. 462), N-Butyl Acrylate (Scan No. 488), and Butyl Methacrylate(Scan No. 572) Were Detected.



. Fig 3 Region of GC-Pyrogram of an Artists' Acrylic Emulsion Paint "Uretch" Brand Wherein Methyl Methacrylate (Scan No. 285) and N-Butyl Acrylate (Scan No. 488) Were Detected. Scan No.



Fig 4 Region of GC-Pyrogram of Rhopiex AC 33 Wherein Surfactants (Scar No. 1516, 1539, 1585, 1603, 1623, and Anti-Fourn Agent (Scan No. 1681) Were Detected.



Fig 5 Region of GC-Pyrogram of an Artists' Acryfic Emulsion Paint "Golden" Brand Wherein Surfactants (Scan No's. 1519, 1541, 1586, and 1605) and Anti-Foam Agent (Scan No. 1684) Were Detected



Fig 6 Region of GC-Pyrogram of Rhopiax AC 33 Wherein of UV Absorber (Tinuvin-Scan No. 1057) and Plasticizers (Scan No. 951 and 994) Were Detected.



Fig 7 Region of GC-Pyrogram of an Artists' Acrylic Emulsion Paint "Golden Artist" Brand Wherein Ultra Violet Absorbers (Scan No's . 916, 955, 998, and 1061) Were Detected.







Fig 9 Infrared Spectrum of Xylene Extract of Paint from Elvis by Warhol

ANOXIC TREATMENT FOR INSECT CONTROL IN PANEL PAINTINGS AND FRAMES WITH ARGON GAS

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Abstract

The only technique for eradication of insects in fine art currently used at the Metropolitan Museum of Art is a low-oxygen, or anoxic, treatment, using argon gas. The reason for using argon rather than nitrogen, currently the most widely publicized gas in controlled-atmosphere treatments, is four-fold: Argon is totally inert; it gives faster "kill rates" than nitrogen (25-50% faster); argon will not encourage anaerobic microorganisms; and, being heavier than oxygen, it will preferentially sink to the bottom of an enclosure, thus displacing the oxygen and producing lower-oxygen environments over time where the art usually rests.

More than 1000 fine art objects, including dozens of panel paintings and frames, have been treated with argon over the past five years, with no deleterious effects to the art.

Outlined herein is a brief review of the suffocation procedure, including determination of length-of-treatment time based on detection of actual insect presence in art, using a prototype Fourier transform infrared spectroscopy respiration detection system.

Introduction

The choice of an appropriate treatment for control of insect infestation in art objects, especially panel and easel paintings,

is naturally restricted to one that will minimize any potential alteration to the object. The choice of treatments until about 1990 for our paintings collection was restricted to a fumigant.

A fumigant is defined as a volatile material that forms vapors that destroy insect pathogens and other pests. All fumigants are therefore reactive. They actively interfere with some aspect of the pests' life processes. The interference may be specific to one life process, e.g., respiration or digestion, or nonspecific (affecting many aspects of the insect). The reactive ability of the fumigant to kill the pest has a detrimental side to it, which is that it can also react with the art object, and if they are not careful, with personnel handling the art. Fumigants are harmful to the environment and harmful or even lethal to humans in the dosages used to control insects. Also, residues from them may pose a problem if they become absorbed into the art.

The most recently used fumigant for our collection was sulfuryl fluoride (Vikane^R). Testing undertaken in 1990 at the MMA (Koestler et al., 1993) clearly showed the danger of this insecticide to some kinds of artwork. The poor performance of sulfuryl fluoride on tests of our painting material caused us to discontinue the use of this fumigant on any artwork within our collection.

The choice of an alternative process is limited by the desire to reduce the risk of collateral damage as much as possible. For art collections this means selecting a treatment that will not be reactive with the art or significantly alter its temperature, humidity, or pH, but that will still be effective at killing any stage of any of the insect pests that might infest the object. Such a treatment is found in the use of a low-oxygen or anoxic environment. An anoxic gas is one that is essentially inert, e.g., helium, argon, or, for most purposes, nitrogen. It is nontoxic, nonflammable, and nonreactive. The anoxic gas

serves to replace the oxygen-rich environment with one that insects cannot use. Many studies have shown that the use of anoxic gases is effective in eradicating insect infestations in museum objects (see for example Daniels et al., 1993; Gilberg, 1989, 1990, 1991, 1992; Koestler, 1991, 1992, 1993, 1994; Koestler and Mathews, 1994; Koestler et al., 1993; Valentin, 1990; Valentin and Preusser, 1990a,b). Koestler et al., (1993) has shown that nitrogen does not visually alter test samples of easel painting materials (unpublished work in our laboratory has shown a similar lack of effect for argon).

Nitrogen gas has been used by agricultural services and governmental agencies around the world to control insects in granary silos for decades. Helium gas has been used for some 40 years to protect one of the most important historical documents in U.S., the Declaration of Independence. Argon gas has been employed in museums around the world to control insect attack in fine art with no damage to the art.

The anoxic procedure

The procedure for anoxic treatment is at first glance very simple, as noted below (this procedure is the same regardless of the anoxic gas used):

1) Isolate the object from the oxygen-rich environment;

replace the oxygen-rich air with an anoxic (oxygen-less) air;
and

3) wait until the insects die, and then remove the object from its anoxic environment.

While simple in concept, each step requires an understanding of environmental, physical, and biological factors that may affect the procedure (Koestler, 1992).

Isolating an object from the oxygen-rich environment

There are two ways to isolate art from the environment: either in a hard-walled chamber or a soft-walled bag system.

A chamber offers the advantage of being able to treat a large number of objects at one time, month after month, year after year. It has the disadvantages of requiring that the objects be brought to the treatment site, and restricting treatment to the specific commencement times (i.e., no object can be added during the chamber treatment cycle.) Chambers are expensive to build, so if they are to be cost-effective large numbers of objects per year must be treated. In addition, the chamber must be able to maintain, actively or passively, a verylow-oxygen environment (at the MMA we currently recommend on the order of 0.05%, or 500 ppm).

A soft-walled, or bag system, on the other hand, enables one to build an enclosure around any infested object(s), at the collection location or at the conservation facility, thus reducing the risks of damage or spreading of infestation by transporting the art to a chamber location. Heat-sealable plastics materials with suitably low oxygen leakage rates can be obtained readily from plastic suppliers.

Replacing the oxygen-rich air with an anoxic (oxygen-less) air

Replacing the oxygen-rich air with an anoxic gas can be accomplished by a gas-flushing and replacement process or by scavenging the oxygen out of existing air.

The gas-flushing and replacement process uses simple gas displacement to gradually flush the oxygen-rich air out of the

container. This procedure permits selection of any of a number of different gases or gas combinations as the replacement choice, depending on the delicacy of the material to be treated.

The scavenging process using a chemical reaction to actively remove oxygen from air, leaving a high-nitrogen environment. Use of a nitrogen generator would fall under this category.

The active scavenging process used by the product Ageless^R, is an exothermic reaction. This product, when used without flushing with anoxic gas, results in a rapid reaction that can produce surface temperatures, on the scavenger packets, in excess of 110°F. If a packet is placed on or near a painted surface, melting or flowing could result.

Nitrogen generators have been recommended by some for use with hard-walled chamber systems. This has at least two drawbacks: the necessity of a hard-walled chamber system--an expensive proposition, and the fact that nitrogen must be used as the suffocation gas.

Flushing systems based upon hard- or soft-walled enclosure systems provide the greatest flexibility and the least amount of cost. A soft-walled enclosure system permits a capsule to be built around any size infested object or group of objects. This permits reducing the volume of treated space to a minimum and uses less gas than a hard-walled system would. In addition, a flushing system is easily transported to the site of treatment, reducing the risk of spread of infestations, and reducing handling and movement of the art. With this type of system, any anoxic gas or combination of gases may be used. The pressure and flow rate within a closed system can be easily monitored and regulated, with consideration given to the delicacy of the object within the environment.

Choice of anoxic gas

Much literature has been published about nitrogen gas. It is effective in suffocating insects, it is relatively inexpensive, and it is believed to be safe for the objects. What is generally overlooked in nitrogen use, though, is the ability of humidified nitrogen to support growth of anaerobic microorganisms. The microbiological literature is replete with studies about the ability of anaerobic microorganisms to "fix" nitrogen. What this means is that some microbes, when oxygen is absent, can convert the normally inert nitrogen gas to other nitrogen-containing compounds that are far more reactive and available for further use by organisms. Work performed at the Getty Conservation Institute clearly demonstrates the ability of anaerobic bacteria to grow in humidified nitrogen gas (Valentin and Preusser, 1990). This study reports that even at humidities as low as 33%, in 99.99% nitrogen, microbial activity was still present. The higher the humidity, the higher the activity of the microbes.

Microbes are often associated with insect presence. These can be protozoa or bacteria living in the guts of termites and wood borers, or fungi feeding on wood or the waste products of insects. Microbial deterioration affects virtually any material (c.f. the bibliography by Koestler and Vedral, 1991). What this means for art objects stored in or treated with nitrogen, especially in high-humidity environments and for long-term storage, is that there is a real risk of deterioration of the art caused by the actions of anaerobic microbes.

To eliminate the potential risk associated with the use of nitrogen, another anoxic gas should be used. Other choices are helium and argon. Helium was the gas of choice for storing the Declaration of Independence, some 40 years age. Argon is another possibility and is easier to retain in a bag enclosure than is helium.

Argon has other advantages over nitrogen besides discouraging anaerobic growth: It is faster at killing insects than nitrogen (25-50% faster, Valentin et al., 1992); it is inert; and, since it is heavier than air, it will displace any residual oxygen from the bottom of the bag where the painting usually resides.

Length of Treatment

After inertness of the gas, length of treatment (LOT) is the most important factor in anoxic treatments. It has also been the most difficult factor to determine precisely, until recently.

Laboratory studies give an approximate idea as to how long it takes different insect species to resist a low-oxygen environment. The LOT will vary considerably, not only from species to species, but also within one species, from one lifecycle stage--egg, larval, pupal, or adult--to another and age within each cycle to another, among other factors (Jay, 1984; Navarro, 1991; Navarro and Jay, 1987). In addition, the nutritional and ecological state of the insect in the object will affect the LOT, as will the ability of the gas to penetrate the object, and the ability of the insect to trap oxygen around it.

In the absence of <u>in vivo</u> data, the conservative approach is to pattern LOT after the most difficult insect life stage we are likely to encounter: For example, the LOT suggested by Navarro (1991) for <u>Trogoderma granarium</u>, the khapra or grain storage beetle, in 99.5% nitrogen (0.1% O₂), 20°C, and about 60% RH, is 20 days. Gilberg (1991) gives a LOT of 21 days for <u>Tineola</u> <u>bisselliella</u> (Hummel), webbing clothes moth; <u>Lasioderma</u> <u>serricorne</u> (Frabicus), cigarette beetle; <u>Stegobium paniceum</u> (Linnaeus), drugstore beetle; and <u>Anthrenus vorax</u> (Linnaeus), carpet beetle, in 99.5% nitrogen, 30°C, and 60% RH. Since higher
temperatures generally produce higher mortality rates, lowering the temperature in Gilberg's studies should increase the LOT. This would imply a treatment time in excess of 20 days for nitrogen, for common museum pests. Rust and Kennedy (1993) suggest that shorter treatments are effective for all stages of the common museum pests (although they lump instars together as one lifestage when they may in fact be composed of up to 12 instars.) A reasoned assumption for length of treatment would be 2-3 weeks. We have found that this LOT is too short for wood borers in some kinds of art.

Is there life in art?

How effective are the LOT values derived from laboratory studies in practice?

There are two methods of assessing the effectiveness of any treatment: Wait to see if the infestation continues, or devise a measurement system to determine the presence or absence of insect activity. Both the empirical and the instrumental testing methods have been employed in our studies.

Empirical testing is not satisfactory for a number of reasons: It is not always apparent that an object is infested, let alone still infested; the object may become re-infested if put back into an unaltered infested environment; and if still infested the object then is still undergoing damage and perhaps infesting other pieces.

There are a number of approaches one can take in using an instrumental technique to detect life in art. Some that have been attempted (Street and Bruce, 1976) include sound, temperature, and gas.

The most successful approach we have employed is detection of gas byproducts from infestation. A prototype system for

measurement of insect respiration byproducts was constructed using a Fourier transform infrared spectrometer (FTIR) system to measure the CO_2 produced by insects (Koestler, 1993). The system has proven capable of measuring a 10-ppm change per day as insect-derived respiration byproducts. Using this system, measurements have been collected from insects: <u>in vitro</u> and <u>in</u> <u>vivo</u> and before and after treatment of infested paintings and panels.

Using this system, it is possible to prove that the selected LOT times have infact killed all the insects within the art. To reliably eradicate all wood borers, a LOT of 4 weeks, in argon $(O_2 \leq 700 \text{ ppm})$ at 70°F and 58%RH is necessary. If nitrogen is used, Valentin's (1990, 1992) data suggests an increase of 25-50% in the LOT, that is 6-8 weeks, not the 2-3 weeks given in the literature for insects in test tubes.

Insects living on the surface of an object are more readily suffocated then those living within--here the <u>in vitro</u> data will probably match the <u>in vivo</u> results.

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TINTORETTO AND THE DREAMS OF MEN AT THE DETROIT INSTITUTE OF ARTS

by Julie C. Moreno*

The objective of this study is to provide an overview of the research and conservation treatment of *The Dreams of Men*, a large ceiling painting by Jacopo Tintoretto at the Detroit Institute of Arts. The artist's use of materials and painting techniques is the predominant focus of the paper. Additional information is presented on the condition and treatment of the painting, and a brief description of the conservation related exhibition that occurred in 1994.

INTRODUCTION

In 1648, Carlo Ridolfi described *The Dreams of Men* by Jacopo Tintoretto in his "Le Maraviglie dell'Arte":

"... In the Palazzo Barbo at San Pantaleone one sees in the paneling of one room a capriccio of dreams, with some gods in heaven and various symbols of the things that come into the minds of men while they are dreaming..."¹

The painting has an estimated date of 1547, and is thought to have been painted for the Casa Barbo, a private residence in Venice, Italy. The two Barbo brothers, the probable patrons of this commission, were poets and historians, which may have motivated the painting's complicated iconography.² *The Dreams of Men* embodies an intricate network of mythological and astrological symbols which portray the interaction of human dreams, fortune, and the great cycles governing heaven and earth.³ (fig. 1) Although influenced by the work of Michelangelo and Titian, it is thought that Tintoretto was largely self taught, as evidenced by the artist's sometimes unorthodox painting technique.

Little information exists on the provenance of *The Dreams of Men.*⁴ The work of art was first exhibited at the Detroit Institute of Arts in 1927 in a gallery with a specially designed ceiling for the painting. The painting hung on the thirty foot high ceiling of the gallery until the early 1970s, when construction of the museum's south wing and the deteriorating physical condition of the painting necessitated its removal. It then remained in storage until a comprehensive conservation treatment began in 1991.

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ARTIST'S MATERIALS AND TECHNIQUE

During this project, I had the opportunity to work with Art Historian Robert Echols who is a specialist in the early career of Tintoretto. Together, we were fortunate to be able to study some of the artist's early paintings in Venice with Joyce Plesters, formerly with the Scientific Department at the National Gallery of Art. When viewing Tintoretto's oeuvre, the artist's intensity and practicality are obvious in the vast number of commissions that he completed, and in his efficient use of materials and techniques when creating a painting.

AUXILIARY AND PRIMARY SUPPORT OF PAINTING

The elongated octagon shaped *Dreams of Men* measures 149 1/2" by 85 1/2". This appears to be the original format, but x-radiography and microscopic examination revealed that 1 to 4" of the painted image has been lost on all eight sides.

The auxiliary support of the painting is a ten-membered wooden stretcher with mortise and tenon joints. There is no documented evidence of when the present stretcher began to be used with this painting, but its construction and hardware indicate that it is not original.

The canvas support consists of two pieces of closely woven twill linen fabric of medium coarseness. A horizontal whip stitched seam runs through the center of the painting.

GROUND LAYERING

The ground layering in *Dreams* proved to be interesting and also assisted in the dating of the painting. Initially, the artist applied a thin calcium sulfate containing ground layer to fill the interstices of the canvas weave. The ground layer was unevenly covered with a thin, oil based, dark toned layer containing a large amount of charcoal black, earth pigments, and colored pigment particles.

Joyce Plesters has observed a dark toned layer in other paintings by Tintoretto and refers to it as a "palette scraping" ground, suggesting that the artist may have created this layer by mixing charcoal black, brown ochre, palette scrapings, and oil. The use of a dark toned layer has several advantages, but also some disadvantages. A major advantage is that the dark tone allowed Tintoretto to execute the underdrawing by painting with lines of white lead paint. A disadvantage is that with time and the increasing transparency of the paint layers, the underlying dark tone becomes more apparent and alters the original value relationships within a painting.⁵

Discussions with Robert Echols and Joyce Plesters, about the ground layering of *The Dreams of Men* as compared to other works by the artist led to some hypotheses on how his priming layers changed during his career. Several of the analyzed works from the artist's early period have only gesso grounds.⁶ *The Dreams of Men* represents an early work of his middle period. The gesso ground in this period, is covered by a dark "palette scraping" layer, which in turn is entirely covered by the subsequent paint layers. In some of his later paintings, the artist used the "palette scraping" as a priming layer without an underlying gesso ground. At

this point, Tintoretto also did not cover the entire dark toned ground with paint, but allowed it to show through thereby creating shadowed areas.⁷

UNDERPAINTING

The lead white underpainting in *The Dreams of Men* enabled Tintoretto's underdrawing technique and many compositional changes to be revealed by x-radiography. The compositional changes suggest that the original iconography of *The Dreams of Men* may have changed slightly during its creation. For instance, the underpainting beneath the lion's head portrays a wheel-like object that was apparently in the artist's original design. Additionally, the x-radiographs reveal that the main male figure was not originally balancing on the transparent orb, but was standing behind the figure of Kronos. Lines in the underpainting also suggest that the main figure was initially holding an unidentified object in his outstretched arms.

PAINT LAYERS

The examination of the colorants and painting techniques of *The Dreams of Men* was aided by the observation of cross sections using both polarizing and ultraviolet fluorescence microscopy. The identity of the materials in these multi-layer specimens was probed using a scanning electron microscope to obtain backscattered electron images of the sections followed by energy dispersive x-ray analysis. Dot maps indicating the distribution of individual elements within the different layers of a sample were also generated. X-ray diffraction analysis was used to conclusively identify the pigments from each layer.⁸

Tintoretto's palette for *Dreams* include pigments that are commonly associated with sixteenth century Venetian painting. As expected, lead white, charcoal black, and the earth colors are used throughout. The blues of the sky consist of azurite and ultramarine, while the final glaze in the darker clouds contain indigo. The greens in the main female figure's drapery are mixtures of azurite and lead-tin yellow. The shadows in the green drapery contains a copper based glaze. The varying shades of reds found in the fleshtones are combinations of red lakes and vermillion. The yellows and oranges of some of the draperies consist of pararealgar, a light induced polymorph of realgar.

Magnification and visual examination indicate that the initial paint layers were executed with a wet into wet technique followed by the application of thin tonal glazes. Characteristic of Tintoretto, most of the brushstrokes were expressive; only in the fleshtones were they well blended.

Certain innovative techniques reflect the quickness in which the painting was completed. The circular forms of the tambourine held by the putti, the star on the astrolabe, and the transparent orb were all scribed into the wet paint layers with a compass. X-radiographs and magnification reveal that the registration points and resulting circles penetrate through most of the paint layers, and sometimes to the ground layers. Tintoretto also used a type of incising technique with the back end of his brush to create a hatching texture in the damp paint of the sleeping female figure's drapery.

SKETCHES ON REVERSE OF CANVAS

Another interesting technique of Tintoretto's was discovered during the treatment of *The Dreams of Men.* In a previous restoration, a lining fabric was attached to the original canvas with a traditional Italian paste adhesive. Due to the extreme desiccation of the aged lining fabric and adhesive, and its delamination from the painting, it was decided to remove the lining. Upon its removal, sketches of two full-size figures were found on the reverse of the original canvas. The linear drawings, painted in dark washes, were brushed directly onto the bare canvas. Microscopic examination of several small samples of the "drawing" material indicates that the paint is probably of a bituminous nature.

The use of canvas for full scale sketching seems to have been a common procedure for Tintoretto. Sketches have also been discovered on the reverse of other paintings, including *The Miraculous Rescue of a Shipwrecked Saracen by St. Mark* in the Accademia, Venice.⁹ Due to the limited size of paper available at the time, and the amount of time saved by sketching in full scale, Tintoretto may have had a large roll of canvas that he sketched on, then re-used to execute the painting.

The sketches on the reverse of *The Dreams of Men* were obscured by fading, staining, and damages to the canvas. In order to clarify the images, slides of the sketches were scanned at a high resolution into a Power Macintosh 8100. The digitized images were then manipulated using Adobe Photoshop 3.0. The images were enhanced by minimizing the disfiguring staining and repairs of the canvas and increasing the contrast of the faded sketching lines.

One of the sketches appears to relate to the main male figure (fig. 2 & 3). The figure was drawn holding a book in his outstretched arms. Although the book is not present in the finished painting, the suggestion of a held object was noticed in the underpainting of this area through x-radiography. It is not certain if the other figure relates to this painting.

CONDITION AND TREATMENT

CONDITION OF PAINTING

The major condition problems in *The Dreams of Men* were caused by water damage, past treatments, and of course, time. The stretcher had developed splits in some of the joints, and was not adequately supporting the painting. Two sizable portions of the original canvas had suffered severe water damage, resulting in tears and losses of the fabric.

The discoloration of certain glazes permanently altered color relationships within the painting. Notably, the darkening of the main female's drapery is due to the degradation of a copper based glaze. A yet unidentified glaze used to create shadows in the fleshtones, drapery of the main male figure, and the surrounding clouds had also discolored.

The paint layers are secure, with the exception of a few localized areas of interlayer cleavage. This stability is partly due to the glue adhesive that had impregnated the underlying

paint layers during the prior lining process. Small losses of paint are scattered throughout the image. Three larger areas of paint loss, caused by water damage, are located in the main male figure's drapery, the astrolabe, and the clouds surrounding the main female figure. Harsh methods used in past cleanings apparently have abraded some of the more sensitive glazes, particularly in the shirt and drapery of the main male figure.

Old "restoration" materials used in the large paint losses consist of oil based overpaint on top of a brown toned aqueous fill. This restoration often unnecessarily covered areas of pristine original paint. Other areas of retouching were done with a resinous based paint. The dark tonality of the overpaint suggests that it was applied to match an extremely discolored varnish. A few layers of aged, natural resin varnish were found only on top of the darker passages of the painting, as a selective varnish removal in the lighter passages of the painting had been carried out in the past.

TREATMENT OF PAINTING

The present treatment was begun by performing solubility tests for the removal of the layers of varnish and overpaint. The varnish was removed with a 2:1 mixture of isopropanol and Stoddard solvent. The majority of the overpaint was removed by applying isopropanol gel¹⁰ and then mechanically removing the swelled overpaint with a scalpel. The area was then cleared with benzine and water.

The areas of oil overpaint in the drapery of the main figure and the astrolabe proved to be very tenacious. Solvent gels, resin soaps, enzymatic solutions, and strong solvent mixtures had no effect on this retouching. However, the awkwardness of its application and darkened tone necessitated its removal in order to reveal the existing islands of original paint, as revealed in the x-radiographs. Following literature and analytical research, it was decided to test the dibasic ester based "Safest Stripper" commercially prepared by 3M.¹¹ The paste was applied to small areas of the oil overpaint and covered with mylar. It was found that an exposure of between twenty minutes to one hour sufficiently swelled the overpaint such that it could be mechanically removed with a scalpel. The remaining "Safest Stripper" paste was removed with water and cleared with benzine. The paste had no visible swelling effect on the underlying filling material. This resistance of the gesso filler enabled it to function as an isolating layer between the paste and the few remaining islands of original paint. The filling material was then removed with water.

A system was designed to hold the painting in a vertical position to facilitate the repair of some of the major tears and canvas losses. A clamp-like device was constructed that permitted the application of even pressure on both sides of the painting during the repairs to the canvas. The lining fabric was released in the damaged sites, and the surrounding lining adhesive was removed. Pre-sized inserts of a similar weight linen fabric were adhered to the canvas losses using linen threads and diluted Lascaux 498 adhesive.¹²

Prior to removal of the old lining adhesive and fabric, a 15 % solution of hydrocarbon resin varnish in TS-28 was brushed onto portions of the painting's surface before attaching a facing material. Japanese tissue facing was adhered with wheat starch paste to susceptible

areas of the painted image. The painting was removed from its stretcher and strips of linen fabric were attached to the edges of the painting with Beva 371 adhesive.¹³ It was then stretched onto a working strainer and placed face down onto a flat, padded surface. Due to its embrittled condition, the lining fabric easily sheared away from the adhesive and original fabric. The lining adhesive was mechanically removed following light moisture treatments using Gore-tex, blotters, and weights.

Following this procedure, it was noted that the original canvas became remarkably supple. With the exception of the water damaged areas, the canvas was in surprisingly good condition. This factor, coupled with the discovery of the sketches on the canvas' verso, caused us to be understandably reluctant to attach a new secondary support to the painting. It was decided to repair the remainder of the tears locally and attach a strip lining with Beva 371 adhered polyester fabric. The possibility of a future lining is still being considered.

Upon completion of the tear repairs, the strip lined painting was stretched onto a new, Lebron expandable joint stretcher. Following extensive testing of various filling materials, the paint losses were filled with a polyvinyl acetate/polyvinyl alcohol based material.¹⁴

Next, in order to evenly saturate the surface of the painting, an isolating layer of 20% Dammar varnish in turpentine with 2% Tinuvin was brushed onto the entire surface of the painting. Inpainting was done with pigments in Lascaux retouching medium.¹⁵ Following inpainting, a second coat of a 15 % dammar solution was brushed onto the painting's surface.

CONSERVATION RELATED EXHIBITION

A special exhibition took place in November and December of 1994 in order to commemorate the 400th anniversary of Tintoretto's death. The purpose of the exhibition was to provide the public with an insight into an extensive conservation treatment while understanding the art historical importance of *The Dreams of Men*. The month and a half long exhibition also enabled us to gain an idea of how the horizontally hung, strip lined painting would respond to environmental changes.

Upon entering the exhibition visitors received a pamphlet containing information on the history, iconography, conservation of the painting, and a glossary of relevant terms. A video illustrating the conservation treatment occupied the first gallery. The second gallery contained the actual x-radiographs of the painting with an accompanying explanation. The opposite wall displayed large images of two exemplary cross sections with basic interpretations of their layered structure.

The Dreams of Men was hung from a specially constructed ceiling in the third gallery. Its proposed companion paintings, *Summer* from the National Gallery of Art in Washington, DC, and *Spring* from the Chrysler Museum in Norfolk, Virginia, flanked the tops of the adjacent walls.¹⁶ Art historical information was presented on text panels.

A wall in the fourth and final gallery showed images of the sketches found on the

painting's verso before and after digital enhancement. Another wall displayed comparative materials used in the research for this project. Illustrated were works by Tintoretto and other 16th century artists that relate to the *Dreams of Men*.

In conclusion, the research and treatment of Tintoretto's *Dreams of Men* was a fulfilling and successful project. We observed the unlined painting during the exhibition. It remained structurally stable with very little planar distortion. The painting is now in storage until the renovation of the Italian gallery is complete, and a more stable environment can be ensured.

ACKNOWLEDGEMENTS

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NOTES

- 1. Carlo Ridolfi, *Le Maraviglie dell'Arte*, vol. 2, (Roma: Societa multigrafica editrice SOMU, 1965), 55, 330.
- 2. Detroit Institute of Arts. "Tintoretto and *The Dreams of Men.*" Exh. pamphlet and text panels by Robert Echols. 1994.
- 3. Ibid., n.p.
- 4. Jacopo Tintoretto, <u>The Dreams of Men</u>, ca.1547; oil on canvas, The Detroit Institute of Arts, City of Detroit Purchase, (23.11).
- 5: Joyce Plesters, "Preliminary Observations on the Technique and Materials of Tintoretto," *Conservation and Restoration of Pictorial Art*, IIC, (London: Butterworths, 1976), 15.
- 6. Joyce Plesters, "Tintoretto's Paintings in the National Gallery," in *National Gallery Technical Bulletin* 4, (1980): 36.
- 7. Research travel in Venice with Joyce Plesters and Robert Echols, April 1993.
- 8. The results will be thoroughly discussed in an upcoming paper.
- 9. Marconi Moschini, "Rivisione di Due Tintoretto," Bolletino d'Arte, (1959): 69-81.

- 10. Isopropanol gel: 200 ml isopropanol
 50 ml benzyl alcohol
 25 ml distilled water
 8 ml Ethomeen C-25
 1.5 g Carbopol 940
- 11. Safest stripper, 3M: Water, dimethyl adipate, dimethyl glutarate, hydrated magnesium aluminum, Silicate, (formulation is 95% volatile).
- 12. Lascaux 498 adhesive: acrylic dispersion, based on acryl-butyl-ester, thickened with polymethacrylate.
- 13. Beva 371 adhesive: ethylene-vinylacetate copolymer, ketone resin N, paraffin dissolved in toluene/solvent naptha.
- 14. Fill material: 20% Beva D-8 (polyvinyl acetate based adhesive) 10% Hoechst Mowiol resin (polyvinyl alcohol) 25% water 1% ethanol 44% CaCO₃
- 15. Lascaux retouching medium: polyvinyl acetate, Mowilith 20 (AYAB), 50% in ethanol.
- <u>Allegorical Figure of Summer</u>, ca. 1546-47, oil on canvas, 41 1/2 x 76 in., National Gallery of Art, Washington, DC., Samuel H. Kress Collection. <u>Allegorical Figure of Spring</u>, ca. 1546-47, oil on canvas, 41 1/2 x 87 in., The Chrysler Museum, Norfolk, VA., Gift of Walter P. Chrysler, Jr.



FIG. 1: The Dreams of Men Jacopo Tintoretto, ca.1547, after treatment.



FIG 2: Digitally enhanced sketch of main figure, found on reverse of original canvas.



FIG. 3: Digitally enhanced sketch of unidentified figure, found on reverse of original canvas.

THE CONSERVATION OF PIERRE PUVIS DE CHAVANNES' ALLEGORICAL MURALS IN THE BOSTON PUBLIC LIBRARY

Gianfranco Pocobene, Teri Hensick, Kate Olivier

Introduction

Pierre Puvis de Chavannes' murals in the Boston Public Library were completed in 1896, just two years before his death. They are the only commission by the artist for a building outside of France. Apart from three fairly recent exhibitions ¹ Puvis' art has, during the last 100 years, been somewhat neglected, and today comparatively few people are aware of his significance and influence. At the end of the last century, however, he was considered by artists and critics alike to be one of France's most important artists. He was held in high esteem by both the official academic establishment and by a younger generation of artists.

Puvis was born in 1824 in the city of Lyon. His father, an eminent engineer, enrolled him in technical schools from boyhood. His intention was that his son would also become an engineer.² By the age of nineteen, however, both his parents had died and Puvis was left of independent means. He traveled twice to Italy in the late 1840's where he spent time painting and studying. He was deeply affected by the art he saw - particularly by the frescoes, of artists such as Giotto and Piero della Francesca.³ From 1847 to 1849 Puvis trained briefly with Scheffer, Delacroix and Couture. He left Couture's after finding his manner of instruction too restrictive, and soon after set up his own studio.

In 1850 the official Salon accepted one of Puvis's paintings, but for the next nine years his works were repeatedly rejected. At the end of this period Puvis painted his first murals - for the dining room of the family chateau, Le Brouchy. An enlarged version of one of those murals, *Return from the Hunt*, was accepted by the Salon in 1859 and from then on his fame as a muralist gradually increased, resulting in numerous commissions throughout France. These included projects for the Pantheon, the Hotel de Ville and the Sorbonne in Paris, as well as for museums in Lyon, Rouen and Amiens and other public buildings. In addition to his monumental murals, Puvis also painted a number of easel paintings that captured public attention and influenced a generation of artists including, Seurat, Denis, Gauguin, Vuillard, Picasso and others.⁴ In 1881 Puvis painted *The Poor Fisherman*, a poignant and starkly simplified image executed with areas of flat color with a limited tonal range. A number of artists paid homage to it in their works and its influence on Picasso's Blue Period paintings, such as *The Tragedy* of 1903, cannot be underestimated.

History of the Commission

Given his fame and reputation as France's greatest mural painter, it is not surprising that in 1893 the trustees of the Boston Public Library chose Puvis to paint an allegorical mural cycle for their yet to be completed building (Figure 1). Built between 1888-1895, it remains one of America's outstanding architectural works. Charles Folen McKim, principal partner of the famed architectural firm, McKim, Mead and White drew upon a number of classical architectural sources, combined them with modern building techniques and embellished the structure with the finest works of art by the most important artists of the period.

The murals, which decorate the most prominent and magnificent space in the Library were completed by Puvis at the age of seventy-two. Getting him to agree to take on the project, however, had been a difficult task for the Library Commission. In the summer of 1891, McKim went to Paris to meet the artist in his studio. Although he offered Puvis an exorbitant sum of money, the artist was reluctant. His reply to McKim was: "The offer is princely but the undertaking staggering. Boston is far, and I am old. I guess I'm afraid."⁵ Puvis did, however, accept that first offer, but shortly thereafter was awarded a mural commission for the Paris City Hall. He wrote to McKim asking to be released from his commitment.

McKim persisted and an emissary was sent the following year to convince Puvis to reconsider. As further enticement, a plaster scale model of the building interior was also sent to Paris. Puvis finally signed the contract on 7 July 1893, at age sixty nine, for 250,000 francs,⁶ which at that time was some \$50,000; the most he had been awarded for a decorative series. After completing the Paris City Hall project Puvis began

Straus Center for Conservation, Harvard University Art Museums, Cambridge, MA 02138



Figure 1. The Boston Public Library shortly after completion (photo courtesy of the Boston Public Libary).



Figure 2. View of the Inspiring Muses from the grand staircase.

to work in earnest on the Boston murals. At the end of July, 1894 he asked for more detailed measurements and, because he was concerned about harmonizing his murals with the surrounding architecture, he also asked for a sample of the marble used on the staircase.

Narrative of the Murals

The areas to be decorated consisted of eight, arched spaces around the grand staircase and a large, complex shaped wall in the loggia at the top of the staircase (Figure 2). It appears that Puvis was given nothing short of complete artistic freedom to create a narrative for the cycle. The theme for the mural program is best described in his own words:

"I have sought to represent under a symbolic form and in a single view the intellectual treasures collected in this beautiful building. The whole seems to me summed up in the composition entitled, *The Inspiring Muses Acclaim Geniuss, Messenger of Light.*"⁷

The Inspiring Muses is the largest of the nine murals and covers 660 sq. ft.. It is 16 feet high and almost 52 feet wide. Apart from its size, the shape of the wall presented Puvis with some dilemmas. The wall is broken in the lower half by the centrally placed door and along the top, capitals and vault supports project downward, dividing the field into five tympana. Puvis expressed concern about the compositional problems and at the possibility of having to paint separate paintings to fill the space. He made numerous drawings and sketches and finally chose to unify the space with one harmonizing and continuous scene. Above the door, a winged boy representing the Genius of Enlightenment, stands on a cloud with lights blazing in his hands. The pale yellow sky behind Genius extends across all five arches. Below the sky there is an expanse of deep blue water and below that, oak and laurel trees are scattered over a green, grass field. The nine Muses of inspiration, representing the various divisions of literature and the arts,⁸ are draped in white and hold lyres and wreathes as they float above the landscape. On either side of the door are seated allegorical figures of Study and Meditation, painted as stone statues.

For the eight panels, Puvis chose subjects "which generally suggest the diverse fields of human knowledge".⁹ On the south wall he painted *Philosophy*, *Astronomy*, and *History*. On the north wall he painted *Virgil*, *Aeschylus* and *Homer*. On the west wall, on either side of the windows that open out onto the courtyard he painted *Chemistry* on the left and *Physics* on the right. These panels are over 14 ft high and 7 ft. wide. Each has a surface area just under 100 sq. ft. Puvis is best known for painting Arcadian landscapes rich in classical themes and at the BPL these themes are used extensively. In the mural titled *Physics*, however, he has included telegraph wires, a 19th century technical invention. He would later describe the mural as follows, "By the wondrous agency of Electricity, Speech flashes through Space and swift as lightning bears tidings of good and evil."¹⁰

Technique & Materials

Puvis executed the paintings on coarse, heavy, linen canvas in his studio at Neuilly (Figure 3). Each of the eight panels consists of one piece of canvas while The Inspiring Muses is made up of only two pieces of canvas that come together in a vertical join above the door, to the right of Genius. The canvasses were primed with a fairly thin ground layer of white chalk in animal glue.¹¹ Because of their unsaturated colors and matte appearance many have mistakenly referred to the murals as "frescoes".¹² They are, however, painted in oil. By underbinding the pigments, that is, by mixing in as little oil as possible, Puvis achieved the matte, somewhat chalky appearance of fresco. According to one of his contemporaries (Hamerton), he deadened his oils by the addition of spirits of turpentine.¹³ One of his students, Paul Baudouin, states that Puvis drained his oils by placing them on blotting paper and never added anything to his paints (no siccatives, copal, varnish or any other ingredient).¹⁴ It has also been suggested by some authors that Puvis achieved a matte appearance by the addition of wax to his painting medium. A number of artists in the 19th century experimented with wax and it is known that Delacroix added wax to the oil medium for his wall paintings at the Palais Bourbon and at Saint-Sulpice.¹⁵ During our recent conservation treatment of Puvis' murals, hydrocarbon solvents were used extensively, but solubility problems were not encountered. Wax was not detected with gas chromatography¹⁶ suggesting that either none was used or, so little was used, that its presence is insignificant. It would seem then, that Puvis achieved a matter appearance on the surface of these murals by means of applying a somewhat lean paint layer over an absorbent ground.

The paint was applied in a direct manner using just one, two or occasionally three layers. In the light colored passages the paint, though lean, is fairly thick and textured, while in some of the darker passages the canvas is barely covered. The colors were chosen to harmonize with the tone of the staircase's yellow marble stonework and are generally pale and limited in range. All have a large component of lead white.¹⁷ His student Baudouin describes



Figure 3. Puvis' Studio at Neuilly. (from The Art Journal, 1896, 192.)

him mixing large amounts of "mother tones" ("tons meres") in bowls ("assiettes creuses") which he kept submerged in water so they would not dry out.¹⁷ This was done to ensure consistent tones across the large surfaces of his murals.

Throughout his career, Puvis was deeply concerned about how his murals would accord with the architectural space they were to decorate. He believed that his murals should not dominate the architecture they embellished. To that end, the figures and other elements in the murals were flattened to emphasize the two dimensional nature of the wall, and painterly devices to create illusionistic depth were avoided. Over time, his paint layers became more and more opaque and his glazes gradually non existent. The surface of the wall was further enhanced by selectively scraping the paint with a spatula or other pointed instrument. In certain passages, such as the laurel leaves in *The Inspiring Muses*, Puvis brought objects to the surface plane by reinforcing the contours. Here, charcoal appears to have been drawn over the partially dried paint, leaving a dark impression along the edges of the leaves.

Although Puvis may have varnished some of his early works to saturate and enhance their depth, it appears that he did not apply surface coatings to paintings from his middle and later period. As with many other questions of technique, he appears to have written nothing at all about varnishing his paintings. Clearly, the application of a saturating and glossy film on his paintings would have greatly altered the appearance of images that were meant to be flat and opaque. One can safely assume then that these murals were not varnished by the artist.

Installation

Upon its completion, *The Inspiring Muses*, was exhibited at the Salon du Champs-de-Mars and then rolled and transported to America in October of 1895. The following month one of Puvis's collaborators, Victor Koos, supervised its attachment to the wall. During the course of the following year, the other eight panels were completed and installed. When the last of the murals were installed, their arrival in Boston was met with much fanfare and celebration. On the other hand, the sentiments of the French was best summed up by Gustave Geffroy who, in 1897, wrote,

"It is a great shame to see these works go to the Boston Public Library, to far away America. It is certain that many among us will never see them again. But, on reflection their going is to be admired: art crossing the globe, braving the waves of the ocean, to a new people, is a confirmation of one of its roles.... And America, having asked of us the paintings of our artists, will someday give us in return miraculous airships and sea-going vessels that in a matter of hours will take us across the seas to rediscover our achievements, if we happen to forget them".¹⁸

Puvis did not come to Boston to install the murals nor did he ever see them again in the space for which they were intended.

The method by which Puvis' canvas paintings are attached to the walls of the Library is known as marouflage. The verb maroufler is defined as the attachment of a painted canvas to a wall with a strong adhesive. In French, maroufle means a sticky mixture of the remains of paint left in artists' pots. The technique has its origins in the 17th century where French tastes for illusionism and artists' preferences for transportable pictures led to the development of "mural painting techniques using methods common to easel painting".¹⁹ From this, the technique of affixing oil paintings on canvas to a wall or ceiling was developed. For the artist it meant that he could work in the comfort and privacy of his studio, surrounded by his own paraphernalia. When the painting was finished it was usually rolled and delivered to the site for installation by a mural hanger. Although Puvis was not involved in the B.P.L. installation, he did personally supervise the marouflaging of many of his murals in France.

Mural canvasses have been attached to walls with a variety of adhesives over the centuries. In the 17th century the adhesive used was a combination of burgundian pitch, wax, resin and red ochre. Often Venice turpentine was added to the paste to increase its adhesiveness and working properties; sometimes dammar varnish was preferred. At the beginning of the 19th century, ceruse (lead carbonate) was added to the oil paint adhesive to speed up the drying process.²⁰ This was used for the mounting of the Puvis murals at the Library. Paintings marouflaged with lead white paste are extremely durable and often show no signs of cracking.

The traditional method of attachment was to coat the wall and the back of the canvas with a thin layer of the paste using large spatulas and wall scrapers. The canvas was then attached either from a roll or flat. Hand rollers were then used to force it into contact with the wall and to work out wrinkles, air pockets and excess paste.²¹ The task of mounting an immense canvas like *The Inspiring Muses* was not without its problems. The huge canvas did not quite register properly, especially in the vaults where retouching after the installation masks portions of the old tacking margin. Often it was not possible to completely push out the air trapped between the canvas and wall. In these air pockets the canvas was slit open (Figure 4), more glue applied and the canvas pressed back against the wall. Along some of the canvas edges metal tacks were also driven through the painting to ensure contact while the glue dried.

Conservation History

Documentary evidence indicates that Puvis' murals were restored on at least three previous occasions. They were cleaned and coated by Durham in 1930. Commenting on that early restoration, Edward Forbes wrote that, "the protective surface that was put on ... was a mixture of the white of egg combined with some other ingredients, which makes a sort of varnish and has given the paintings a slight gloss".²² In 1940, the restorer R. Arcadius Lyon cleaned the murals with a weak solution of Castille soap and water (sodium carbonate and olive oil). At that time he found that the previously applied egg white coating was tough, well adhered and that it did not respond well to his cleaning efforts. Fearing possible damage to the paint layers he decided to leave it on the surface.²³ Finlayson Brothers restored the murals in 1953, but do not appear to have left any documentation.

Accidental Steam Release

In March of 1993 the Center for Conservation completed a major conservation project of Puvis' murals. The murals were scheduled for conservation in 1994 as part of a major renovation program at the Boston Public Library. However, an unfortunate event in 1992 necessitated the immediate treatment of the mural titled, *The Inspiring Muses*. The mural suffered damage as a result of an accidental, steam valve release in the early morning hours of February 3, 1992. Fortunately, the other eight murals in the cycle, which decorate the walls of the staircase, were not damaged. They had been covered with multi-layer barriers to protect them from work in the area, which included the repainting of the coffered ceiling and the cleaning of the marble walls. Water vapor condensed on the exposed mural and on the protective coverings of the other eight murals. The general contractor, instructed by the architects, installed fans in the windows to ventilate the damp air out of the staircase. Kate Olivier, who was the first conservator from the Center to arrive at the scene, found the area still full of hot, white steam and described it as "like being in a Turkish bath." The first RH. reading taken that morning. By mid afternoon the RH. had dropped to 77% and by the next morning it had dropped to 55%. Our immediate recommendations included the installation of protective polyethylene barriers around scaffolding in front of the mural and the placing of humidifiers in the enclosure to condition the dry winter air.



Figure 4. Detail of detached canvas.

Condition

It became evident that the steam had caused three specific types of damage. The most serious damage was extensive lifting and tenting of the paint layers which affected approximately 40% of the painting. The majority of the damage occurred on the right half of the mural with fewer, smaller sections affected on the left half. Why this occurred is not entirely clear but it appeared that variations in air currents may have increased the amount of water condensation on the right side. The canvas did not undergo excessive shrinkage because it was glued to the wall. The areas of lifting varied in severity over the surface of the painting. The most severe damage occurred along the bottom edge where most of the water collected and in the blue areas on the right side of the mural. This was followed by moderate and minor amounts of flaking in the middle and top sections. Generally, the white paint layers exhibited less damage than the blue and green paint layers, probably because lead white absorbs water at a slower rate. In spite of their critical condition, the paint layers remained surprisingly intact with very few visible losses.

A second serious consequence of the water condensation was overall blanching and the formation of dark vertical stains across much of the paint surface. As the warm water ran down the mural it dissolved the grime layers, soluble salts and surface coatings. The dissolved material was then re-deposited and dried in the form of disfiguring drip marks. Even prior to the steam damage, the surface grime was known to be difficult to remove. Further complicating the cleaning problem was the question of surface coatings that were applied in the past. Coating samples were analyzed with FTIR and distinct, amide groups for protein were found.²⁴ The source of the amide

groups is probably the egg white coating that was mentioned earlier, but could perhaps be a component of animal glue extracted by the steam from the canvas support.

The third problem we encountered was localized detachment of the canvas from the wall (Figure 4). This problem was noted as small pockets near the bottom of the mural where the water collected, but was especially dramatic in six of the numerous cuts made by the mural installation crew in 1895 to release air trapped between the canvas and wall.

Consolidation of Flaking and Tented Paint Layers

Under emergency conditions, tests for the consolidation of the mural were begun immediately. Access to the entire surface of the mural was provided by fixed scaffolding which had been installed in the loggia for other renovation activities. Of the many adhesives used in painting conservation two were chosen for actual testing on the mural; sturgeon glue and Beva® 371. Other consolidants were considered but rejected because of certain undesirable characteristics. Both consolidants tested were effective in re-adhering the paint layers. The Beva® 371, however, held the flaking paint more effectively during the rinsing procedure to remove excess adhesive. In addition, the Beva® 371 would not be affected by water based cleaning solutions that we knew would be required later to remove the surface grime and stains, it would not cause further canvas shrinkage during application, and it would be less affected by fluctuations in temperature and relative humidity.

Treatment of the mural began in the first week of March, 1992. The team of conservators who worked on this project were, Gianfranco Pocobene, Teri Hensick, Kate Olivier, Nancy Buschini, and painting conservation interns Catherine Rogers, Danica Stojkovikova, Lenora Rosenfield and Lydia Vagts. The Beva® 371 adhesive was applied to the affected areas with sable brushes. The adhesive was diluted in benzine at low concentrations and heated to increase its flow and penetration into the detached paint layers. Because the work had to be carried out on a vertical surface one could not always be entirely certain that the adhesive had penetrated and flowed under all the areas of flaking paint. In many areas, benzine was lightly sprayed on the paint surface prior to the application of the Beva® 371 to assist penetration. Two or three applications were required to consolidate the paint layers. The flaking paint was re-adhered using heated spatulas (Figure 5). Because more than one third of the mural required consolidation, the process was quite lengthy. After the flaking paint was re-adhered, a xylenes/water emulsion²⁵ was used to remove the excess Beva® 371 adhesive. This reduced the amount of solvent penetrating into the paint layers that might otherwise have loosened them. The emulsion also had the added advantage of removing some of the less tenacious grime layers.

Removal of Surface Grime, Stains and Blanching

After the consolidation procedure was completed the fixed staging was replaced in favor of rolling scaffolding which allowed more flexibility and the ability to view the work as a whole for the remainder of the project. As mentioned earlier, the steam had completely disrupted the grime and whatever coatings were present on the surface. Pre-treatment tests for the removal of the surface grime, and the stains and blanching that had formed on the mural indicated that they were extremely tenacious. Numerous cleaning solutions and solvents were tested, including a cleaning solution that had recently been devised by Richard Wolbers. This, unlike the others, gave very encouraging results. The solution was a diammonium citrate gel, buffered to pH 8.5, for the removal of intractable surface grime.²⁶ The solution was found to be effective on all paint layers tested but worked especially well in the blue and green areas. In the white drapery of the Muses the re-deposited accretions and streaks were also removed, but here the paint layers had been physically altered by the water. While the nature of this darkening effect is yet to be determined, possible causes include: (1) the conversion of lead carbonate into lead sulfide which is typically seen in fresco paintings, (2) the much rarer conversion of lead carbonate into lead dioxide,²⁷ and (3) the re-crystallization of the lead carbonate which would give it a darkened appearance.²⁸ Attempts were made to convert what was thought to be darkened lead sulfide into lead sulfide (white form) using hydrogen peroxide. The very limited success of this procedure suggested that lead sulfide was not present and this was later confirmed by analysis.

The cleaning of the mural was carried out as follows. The gel solution was brushed onto the mural and gently worked over the paint for approximately 10 to 15 seconds (Figure 6). A great deal of the surface grime and staining was dislodged during this first application. The bulk of the solution and dissolved grime was removed with large, dry wads of cotton. Several more applications of the diammonium citrate gel were required to completely free the grime from the paint layers. After the cleaning was completed, the area was then rinsed several times with water followed by a final benzine rinse.



Figure 5. Detail during consolidation.



Figure 6. Catherine Rogers applying the cleaning solution to the Inspiring Muses.

A number of conservators and conservation scientists have expressed concerns about the use of some of Wolbers' cleaning solutions. Among those concerns are the solubility effects of various components on the paint layers; the difficulties of clearing surface residues; and the long term effects of residues that might remain on the paint layers. These issues led us to spend a great deal of time repeatedly rinsing the surfaces of the murals. It is quite possible that, given the large quantities of cleaning solution used, some residues were left on the paint but, hopefully, they are few and insignificant.

Re-attachment of Detached Canvas Sections

The detached canvas areas were plasticized in the manner commonly used to eliminate canvas distortions in canvas paintings, namely by the application of local moisture and pressure. Here, however, the vertical surface and the lack of access from the back required a slight modification in technique. A pressure jig made from a veneer press was secured to the scaffolding (**Figure 7**). Dampened blotters, thick sections of foam (to allow the blotter to conform to the distortion) and a masonite board were placed against the de-laminated canvas and gentle pressure was exerted with the press. After some 40 minutes the moisture had sufficiently plasticized the paint layers and canvas. The dampened blotters and foam were removed and replaced with dry blotters, a 1/4" thick Ethafoam section and a masonite board. This was left in place overnight to allow the canvas to dry flat. The detached canvas was then adhered to the wall with PVA (Jade® 403). The adhesive was allowed to set under the pressure of the Mylar®, blotters and masonite board for 24 hours.



Figure 7. Re-attaching canvas.

Filling and Inpainting

The losses in the mural were small and relatively few in number. Several inpainting materials were tested, but Bocour Magna Colors® were found to have the appropriate opacity and degree of sheen. Where necessary the saturation of the retouchings was modified by glazing with Acryloid B-72.

Treatment of the Eight Panels

Once the treatment of the Inspiring Muses was completed, we proceeded to the other eight panels in the staircase. Small cleaning tests in the upper corners of these panels indicated how much dirt had accumulated on the paintings over the years (**Figure 8**). Here, the surface grime was also very tenacious but there were only a few areas of flaking that required consolidation. The consolidation, cleaning and retouching of these mural was executed using the same methods described for *The Muses*.



Figure 8. Detail of Aeschylus panel during cleaning.

The Decision Not to Apply a Protective Coating

Although we believe these paintings were not originally varnished, some consideration was given to the possibility of applying a protective coating to the murals because of their position around the grand staircase, close to the main entrance. Natural resins and most synthetics were considered but rejected because of their high saturating properties and poor aging characteristics. Acryloid® B-72, because of its stability and lower saturating properties, was applied in small test areas in various concentrations. The tests indicated that the varnish would impart too much saturation

and gloss on the mural surfaces. The unsatisfactory results of the varnishing tests combined with Puvis' clear desire for a matte surface convinced us that the murals should remain unvarnished.

Acknowledgements

In addition to the many colleagues and interns who worked on the project and are noted in the text and references, the authors would like to thank the Boston Public Library for its support.

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THE PURCHASE OF A LOW-PRESSURE SUCTION TABLE AT THE LOS ANGELES COUNTY MUSEUM OF ART Virginia Rasmussen, Associate Paintings Conservator¹

In 1993, the Paintings Section of the Conservation Center at the Los Angeles County Museum of Art purchased a low-pressure suction table from Willard Developments, with funds provided by the Ahmanson Foundation and the Shinji Shumakai Organization. Before acquiring the table, LACMA conservators researched low-pressure tables and consulted with other conservators and engineers in evaluating table designs and options.

CONSIDERATIONS IN SELECTING A LOW-PRESSURE TABLE

Low-pressure tables have been used by paintings conservators for over twenty years, and the field of research in design is extensive. A low-pressure system produces suction when air is drawn through the perforated surface of the table into the circulation system inside the plenum. Such a system can provide special advantages over a conventional vacuum hot table. Using the principle of low-pressure, the painting is restrained without being enclosed under a membrane. This avoids pressure to the face of a painting which could impart harmful effects, such as flattening of the paint film, but it also allows for direct manipulation of the paint film during treatment. Variable conditions of heat or moisture may be used with better control to carry out overall treatments, such as relaxation, as well as selective, local operations, such as consolidation. In addition, the high volume of air-flow produced in a low-pressure system is capable of evacuating moisture quickly from the reverse of a painting during aqueous treatments. Importantly, these procedures can be carried out using a minimum of pressure.

Bent Hacke designed one of the earliest low-pressure tables in the late 1970's and has contributed considerable practical knowledge in developing their use.¹ His table's basic functions include a heating source and an air circulation system. Hacke has also developed an internal humidification system for the table, which is generally used only to treat large paintings.² The table's simple design facilitates ease of control during treatments.

Bill Maxwell has also played a major role in the development of low-pressure tables. Working with Al Albano at the Museum of Modern Art in 1985, Maxwell designed a table suited to the needs of the modern collection, incorporating an effective heating source in a high air-flow system to treat large canvases.³ Humidity was generally introduced to the front of the painting by means of an enclosed humidification chamber.

A third table design was developed in 1984 for the National Gallery in London. Tony Reeve had worked with engineers at Willard Developments over a number of years to devise a low-pressure table which would have multi-purpose capabilities.⁴ The Willard table incorporated an internal humidification system, as well as heating and air circulation which could be engaged simultaneously. The capability of introducing variable amounts of humidified air to the reverse of a painting at the same time as using heat and suction was seen as the principle advantage of the Willard by conservators at LACMA.

The 1991 course "The Suction Table for Textile and Painting Conservation", sponsored by the Conservation Analytical Laboratory", provided a valuable opportunity to look at current progress in table research and design and to talk to other conservators about issues and concerns in using low-pressure tables.⁵ The course, coordinated by Timothy Vitale, focused on some of the basic functions of low-pressure tables and defined certain principles more clearly, such as downward vs. lateral air flow. Some limitations of low-pressure tables were also discussed, for example, effective heating in high air-flow systems and accurate monitoring of humidity levels.

In evaluating low-pressure tables, it was important to address practical considerations. Of basic importance were

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the needs of the collection. LACMA's paintings collection is diverse, ranging from old masters to contemporary paintings, and a variety of treatment approaches is called for.

In the past we have successfully adapted our conventional hot table to perform the types of treatments for which a low-pressure table would be ideally suited. For example, we have carried out treatments which require a source of humidity from below the painting, such as overall relaxation treatments to remove canvas deformations. A large altarpiece, "Holy Family with Saint Francis in a Landscape" by Giorgio Vasari was a candidate for such a treatment. After removal of the old glue lining, the painting required humidification to remove distortions in the canvas caused by deposits of glue adhesive, and to reduce a ridge created by the seam in the original canvas. The painting was placed face up on the hot table over dampened blotters and humidified under vacuum with heat. The procedure was successful in reducing the most serious distortions.

A similar humidification method was used to treat a large 19th C. family portrait by William Hamilton. When the painting came into the collection, the canvas was slack and detached from its stretcher along the top edge and there was pronounced cracking in the paint and ground layers. To treat the cracks, the painting was placed face up over dampened blotters on the hot table, and sealed in a membrane under vacuum pressure. The treatment was repeated twice, resulting in overall improvement.

We have also used humidification to regenerate old glue linings. A painting by Jean Lemaire, "Achilles Discovered among the Daughters of Lycomedes", had been previously glue lined and required humidification to correct buldges which had developed in the canvas. The painting was treated using weights and dampened sheets of Goretex_{TM} to regenerate the glue lining adhesive and relax and flatten the buldges.

A low-pressure table with internal humidification capabilites would be useful in treating such problems. With the direct application of moisture from below, treatments could be more easily controlled and conditions more easily adjusted. On a larger scale, a low-pressure table would offer more uniform conditions and require less movement of the artwork.

Major cleaning treatments have involved paintings with unusual or particularly delicate surfaces. One such example was a large 15th C. glue tempera on canvas, "The Last Supper", by Pedro Berruguete. The painting had survived unvarnished, but a dark substance had been rubbed over the central area around the figure of Christ. The painting was locally cleaned with a combination of mild solvents which improved its condition. A low-pressure table would be useful in providing additional means of treating such cleaning problems.

We have also used a small suction table in the paper lab to perform treatments on paintings, such as the removal of wax adhesive residues from a previously wax-lined painting. A small still-life by Paul Gaugin which had been wax-lined in the past was treated in this fashion. First the old lining was mechanically removed. Then the painting was placed on the suction table face up over blotters and using the aid of suction, the residues of wax adhesive were removed with small amounts of solvent. A low-pressure table, with the possibility of downward air flow, would be useful in treatments involving the reversal of wax-resing linings.

We have also carried out several starch-paste lining treatments by hand. The air circulation system of a lowpressure table would help facilitate these lining treatments by providing uniform and controlled conditions during the drying process.

A low-pressure table could fulfill these many treatment needs. With a low-pressure table, treatments would be more easily controlled and the conditions more closely monitored. The combination of heat, humidity and suction would offer more versatility in our methods and require less manipulation of the painting in the course of a treatment.

In view of the requirements, the Willard table was considered the best choice. Probably one of the most important factors was the internal humidification system, which only the Willard offers. The humidification system could be used for treatments such as overall humidification and relaxation, the regeneration of old glue linings, the relaxation and consolidation of cupped or lifting paint, as well as local structural repairs such as tear



mending.

In addition to treatments related to humidification, the Willard offered a number of other functions. The table could perform cold lining treatments, or it could function as a conventional hot table, and it could aid in the reversal of deteriorated wax-resin linings. Certain cleaning problems such as stain removal could be dealt with more effectively. For treatments related to textiles and works of art on paper, the Willard would also have potential for use.

Taking advantage of the favorable exchange rate in the spring of 1993, the table was purchased for £52,000, or about \$78,000.

THE WILLARD TABLE

The working surface of LACMA's table is 8'x12' in size. Because of its size, the table had to be shipped in two sections and assembled in the conservation lab. This required some modifications to the table so that it could be disassembled and also some logistical planning. The surface of the table is composed of two sheets of perforated aluminum which are joined along a center seam. The seam is smooth and no distortions have been observed with use of the table. However on delivery, a slight distortion along two sides of the table top was noticed. This may have been caused by a drop during shipping. To correct the problem, Willard sent an engineer to LACMA to make repairs. It is important to be aware that while the surface of the table is capable of bearing high loads, it can be easily dented or scratched and it is important to keep it covered and protected if it is to be used as an ordinary work surface.

The air circulation systems of the table consist of two variable speed fans, one which generates the suction airflow, the other which circulates the humidified air.⁶ The two systems can be engaged simultaneously. The humidification system uses a steam hot plate which is monitored by dry/wet bulb sensors located at the intake port. The table also has a refrigeration unit which can be engaged to control the drying process during treatment, and is always used in the routine drying out procedure for the table before it is turned off. The heat is produced by metal elements in open louvered panels inside the plenum and is controlled by electronic thermostat. There are also heating elements around the outer edges to compensate for heat loss and at the work surface to control the problem of condensation. The table also has a digital data logger which automatically controls the humidity setting for the table. The data logger records data which can be stored in the form of a graph for the file in necessary. It is important to note however, that the data logger controls only the humidity level inside the table, not at the work surface. It is always necessary to monitor the humidity level of the table's surface independently.

Although a common concern with the Willard table was that it was complicated to use, operation is actually quite straight forward. Recent modifications to the control panel may have helped solve this problem. Before these improvements, the monitors for humidity displayed values in terms of wet/dry bulb depression points, which meant that the actual RH had to be extrapolated from psychometric tables, which can take some getting used to. The data logger was introduced to improve this operation.⁷ The logger allows one to simply dial in the desired RH. In addition, the instrumentation of the control panel has been replaced with digital read-outs and certain uneccessary monitors have been eliminated.

TREATMENTS CONSIDERED

Treatments performed using the Willard table over the past two years have included humidification and consolidation treatments, the reversal of a wax-resin lining, as well as a traditional glue-paste lining treatment.

Humidification and relaxation treatments have been carried out on two paintings with effective results. One was on a small painting by Ben Berlin from 1939, "Untitled (Surreal Abstraction)". The painting had been slack on its stretcher for some time resulting in a dished-in planar deformation. The paint layer was generally thin and

there was no overall varnish. The painting needed to be cleaned of surface dirt, and required local consolidation. If possible, the deformations in the canvas needed to be improved.

The painting was initially surface cleaned and locally consolidated using a dilute solution of BEVA 371 adhesive. In order to reduce the deformations, the canvas was then prepared for treatment on the low-pressure table. The painting was taken off its stretcher and strip-lined with light-weight linen and BEVA 371. Next it was mounted to a working strainer. The painting was placed face up over polyester interleaf material on the table.⁸ Over a two-hour period the humidity was slowly raised to 85%, and the table surface heated to 29°C with the painting held under low suction. The elevated temperature helped the penetration of the moisture into the canvas as it gradually relaxed. The painting was covered with Dartek which could be removed for direct access to the paint film.

After the initial period of humidification, the suction was briefly turned up, drawing the painting into a more planar state. With the deformations relaxed, the humidification system was turned off and the painting was allowed to dry while remaining under suction. The treatment was successful in correcting the most pronounced irregularities while preserving the natural look of the canvas. After treatment the painting was loose-lined over its original stretcher.

During initial tests, it was found that while the table's temperature and humidification systems can be engaged simultaneously at elevated temperatures, the humidity is most effectively controlled when working at only slightly elevated temperatures. As temperature is increased, humidification takes time to adjust accordingly. But is should be noted that in general, when the variables of heat and pressure are combined with humidification at the same time, it is often possible to work within lower parameters.

A treatment was carried out on a painting by Adolph Gottlieb from 1946, "Expectation of Evil", to correct deformations in the canvas caused by age cracks in the paint. To consolidate and flatten the cracks the painting was prepared for treatment on the low-pressure table. The painting was removed from the stretcher and striplined using linen and BEVA 371, and mounted in a working strainer. It was placed face up on the table over an interleaf of polyester. The cracks were locally humidified on the front using moistened pieces of Goretex_{TM}, while the painting was held overall under slight suction at slightly elevated temperatures, about 30°C. The local humidification relaxed the paint and canvas into a more planar condition. Then the cracks were consolidated. A dilute solution of fish glue was locally applied to the cracks by brush. The suction system was effective in drawing the adhesive into the cracks while the combination of heat and the moisture present in the adhesive helped to reduce the distortions further. A heated spatula was used to set the adhesive. The treatment was successful in securing the cracks and reducing the deformations to a degree. The painting was loose-lined and attached to a new stretcher.

It should be noted that for any treatment it is important to use an interleaf material between the object and the table surface. An interleaf of fabric or blotting paper cushions the artwork and in treatments involving humidification, helps in the distribution of moisture to the artwork.⁹

A painting by John Graham, "Still Life", 1932, was recently treated using the Willard. Due to the thick paint layers and working technique of the artist, the painting was badly cracked and there were several losses. The canvas had been wax-lined in the past to correct the problem and was varnished with PVA. However, the cracks had remained unstable. In many areas there was lifting paint, and deposits of wax had resulted in misalignment of the paint along cracks. Visually, the painting was compromised by the lining and the varnish.

The treatment included removal of the varnish and the lining, and consolidation of the paint layer. First the painting was cleaned to remove the discolored synthetic coating. Then the painting was taken off its stretcher and the lining was removed. Excess adhesive was mechanically scraped away. Significant amounts of the wax-resin remained in the canvas, increasing the brittleness of the canvas.

In his 1984 article, "A New Multi-Purpose Low-Pressure Conservation Table for the Treatment of Paintings", Tony Reeve noted as an application for the low-pressure table, the use of mild solvents to draw wax out of impregnated paintings.¹⁰ Other conservators have carried out treatments on low-pressure tables to remove wax adhesive from paintings. In a 1994 article in <u>The Conservator</u>, Gunnar Heydenreich describes such a treatment performed at the Tate Gallery.¹¹ Another article by Bettina Landgrebe published in 1988 in <u>Kunsttechnologie</u> und Konservierung outlines a similar treatment.¹²

Extraction methods using the low-pressure table offered an effective way to remove the wax from the canvas. Guidelines from the manufacturer recommend that the proportion of the solvent to the volume of air must be kept low, well within the lower flammability limits of hazardous concentration.¹³ It is also necessary when using solvents to exhaust the air from the table to an appropriate outside source.

Treatment proceeded using a gel prepared with a solvent mixture which could be delivered on an interleaf to the back of the canvas. Tests indicated a hydroxypropylcellulose gel containing toluene and ethanol would be most effective in removing the wax-resin. First the painting was prepared with a strip-lining, using linen attached with BEVA 371 adhesive, and mounted to a working strainer. The gel was applied to a piece of polyester interleaf fabric, which was sandwiched between two more sheets of polyester and placed on the suction table. The painting was treated in sections to reduce the amount of solvent in use. The painting was placed over the polyester and left for several minutes with the table slightly heated to approximately 30°C. Then the suction was turned on. The air flow system drew adhesive residues out of the canvas and into the interleaf material beneath it. The treatment lasted for approximately fifteen minutes. Then the interleaf material was exchanged for dry sheets and the painting was left to dry under suction for approximately a half hour. The treatment was repeated twice in a period of a few days. The improvement to the canvas was noticeable. The cracks relaxed and flattened, and the canvas seemed more pliable and regained a more natural look.

Next, the painting was consolidated on the suction table. The painting was placed face up over an interleaf of polyester material. The suction air-flow was turned on and a dilute solution of BEVA 371 was applied to the cracks using a syringe. The suction system was effective in drawing the adhesive into the cracks. A heated spatula was used to set the adhesive. After the treatment, the painting was loose-lined and restretched.

Since the treatment of the Graham picture we no longer use solvents with the low-pressure table. The fans in the Willard are not explosion proof and they do not meet specifications for use with flammable solvents. Although the manufacturer has recommended that some use of solvents with the table is safe, until guidelines are more clearly defined we will continue to avoid any use of solvents with the table.

As an example of a traditional lining, a painting by Francois Boucher was recently treated using the Willard table. The painting, "Cupid Wounding Psyche", is one of a pair of Bouchers in the collection which were originally painted as overdoors for the Hotel du Mazarin in Paris, dated 1738 and 1741. At some point, both paintings were expanded into rectangular compositions and glue lined. The left and right sides were cropped. The paintings needed to be cleaned and if possible, returned to their proper format.

The painting was initially cleaned and the old additions were removed. The painting was then prepared with a thick varnish of damar containing a little wax to protect the surface. It was removed from the stretcher and the old glue lining was removed. Old glue residues were mechanically scraped away.

To replace the missing sections on the two sides, canvas additions were prepared and cut to the proper shape. Sketches of overdoors by Boucher for the Hotel du Mazarin provided examples of how the painting would have looked. The additions were attached to the canvas using japanese tissue and strands of B-72 ethyl methacrylate resin.

To prepare the lining canvas, linen was stretched and sized. The outline of the original canvas was marked. The starch-glue paste adhesive was slightly warmed, then applied to the back of the painting.¹⁴ The adhesive was evenly spread over the back. Then the painting was positioned on the lining canvas and placed on the suction table face up over polyester interleaf material. The surface of the painting was smoothed by lightly rubbing with cotton. Then the suction system and the dehumidifier were turned on. With the painting held under restraint, the air circulation system quickly evacuated the moisture. The vacuum was raised to about 10" of water and

maintained for the duration of the treatment, approximately 20 minutes and the work surface was heated to approximately 49°C to help drive off moisture and generate the adhesive. The painting dried quickly and the uniform conditions produced a good overall bond.

After this first stage, the painting was removed from the table. It was placed face down between sheets of newspaper and lightly ironed on the reverse. This made it possible to deal effectively with minor local surface problems such as old damages, and helped to improve the planar alignment of the additions.

After the lining was completed, the painting was left to dry under weights overnight. The painting will be mounted onto a stretcher which represents the original shape of the painting.

CONCLUSION

Treatments discussed in this paper represent a relatively brief hands-on experience with the Willard table. However, more than three years were spent investigating various possibilities and so far, conservators at LACMA are pleased with their choice. It is hoped that this explanation of our decision will help other conservators choose the best table for them.

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photo credit: Adam Avila

ENDNOTES

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Laboratory. Hacke still seems to favor more conventional methods for the introduction of humidification to canvas paintings, through a wet interleaf or humidification chamber.

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SPANISH COLONIAL PAINTINGS AT THE BROOKLYN MUSEUM SOME TECHNICAL OBSERVATIONS

Carolyn J. Tomkiewicz, Paintings Conservator

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Abstract

The Spanish colonial paintings from The Brooklyn Museum (TBM) collection were examined during preparation for the 1996 exhibition: "Converging Cultures: Art and Identity in Spanish America".¹ Results from analytical studies carried out at CAL in 1993 to identify materials used in two 19th c. Mexican paintings are reviewed. Instruments of scientific analysis include polarized light microscopy (PLM), Fourier transform infrared microspectroscopy (FTIR), scanning electron microscopy with energy dispersive spectroscopy (SEM-EDS), gas chromatography-mass spectrometry (GC-MS), and X-ray diffraction (XRD). This report includes observations made with the aid of stereomicroscopy, ultraviolet illumination, X-radiography, infrared reflectography and infrared Ektachrome photography² on selected paintings of the 60 examined and treated for exhibition. Further research on these New Mexican, Mexican and Peruvian paintings will continue in order to augment the limited information available on this unique group of paintings.

Introduction

The Brooklyn Museum's Spanish colonial collection is comprised of approximately 120 paintings produced in the viceroyalties of New Spain and Peru, today the southern United States, Central and South America (except for Brazil). The works date from the 17th to the 19th centuries. The paintings are part of the Museum's collection of Spanish colonial art consisting of textiles, furniture, ceramics, silver, polychrome sculpture and works of art on paper totaling over 1,000 objects. The first collecting expedition in Central and South America by the Museum's then Department of Ethnology was in the summer of 1941, which resulted in an exhibition in the same year entitled "America South of U.S.".³ The next acquisitions were in 1948 and 1952 of portraits, porcelain, lace, fans, silver, and textiles, including extensive holdings of an historically prominent and distinguished colonial Mexican family. These acquisitions form the core of one of the largest collections of Spanish colonial art in the United States.

Original Construction: Observations and Analyses

The following two 19th c. Mexican paintings were selected for more detailed study, since interference by more recent treatment materials could be excluded.

"Christ of Chalma", unknown Mexican, early 19th c. [#45.128.191] (Figure 1)

The strainer is a fixed double fork mortise construction with one horizontal crossbar.⁴ The wood has been identified as a Mexican species of the genus *Pinus*.⁵ A single rope believed to be original and most likely used for hanging purposes is threaded through a hole in the top of the strainer. Having no tacking margin, the fabric is cut to the approximate size of the strainer and attached with an aqueous adhesive to its outer members. Characteristics of construction typical to Andean paintings have been found to apply to the two

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Mexican paintings described here.⁶ The plain weave fabric support with a thread count of 23×21 per in. sq. is made from a very coarse fiber identified as a vegetable bast fiber other than flax.⁷ The yarns have a "Z" twist and are inconsistent in thickness.⁸ Original holes throughout the fabric appear to have been repaired by the artist, indicating that it was in poor condition and most likely not manufactured as a painting canvas.⁹ Both the lower aggregate red ground and the upper finer red ground were examined with SEM-EDS, XRD and FTIR.¹⁰ Results from these analyses suggest the presence of inorganic pigments such as: red ferrous oxide, red lead, and red bole or another red clay as well as the possible presence of organic pigments such as carmine, a lake of the cochineal extract. These pigments are mixed with fillers such as calcium carbonate, quartz and other mineral compounds. The medium was found to be a drying oil as the spectrum of the extraction matched that of a standard for oleic acid in FTIR and GC-MS analyses.¹¹ Infrared reflectography did not prove helpful in detecting an underdrawing, although one area of black outlining is visible in normal light around the proper right foot of St. John. The coarse canvas weave is generally visible through the paint layer, except for smooth, continuous areas associated with the slightly concave original repairs in the canvas. The red paint layer is rich in mercury suggesting the presence of vermilion, either synthetic or ground native cinnabar.¹² The spectra in FTIR and GC-MS analyses for the paint layer were found to match the standard for oleic acid, possibly with a pine resin fraction.¹³ X-radiography confirmed observations of pentimenti in normal light; the positioning of the proper right arm of the Christ figure was slightly altered as well as the style of the loincloth. The thinly applied surface coating was not isolated for analysis. However, it is most likely a natural resin due to the yellow/green fluorescence in ultraviolet illumination. The visible "gilding" along the border and in the form of ornamentation on the garments of both the Virgin and St. John was applied at a later date. Originally, orpiment was used to simulate "gilding", as evidenced by an area not overpainted along the border of St. John's robe. The later "gilding" was identified as brass powder primarily containing copper and zinc.¹⁴ The application of this brass paint over wax drips (possibly due to the proximity to burning candles) on the robes of both attending figures, implies a later embellishing. Black water-sensitive outlining is found to accentuate this later "gilding" on the crown of thorns of the central figure, the inscription "INRI", both "gilded" ends of the horizontal beam of the cross, and the sword piercing the Virgin's breast. The 1995 treatment considerations took into account that these embellishing features are an integral part of the painting's history. They were both respected and preserved during treatment to remove the discolored, disfiguring glue/grime layer sandwiched between the varnish coating and the embellishing.

"Virgin of Guadalupe", Unknown Mexican, 19th c. [#45.128.189] (Figure 2)

The painting is signed and dated bottom, center: "Ysidro Escamilla. 1824" (the underlined letters are poorly legible; an additional letter may follow the final "a"). The rectangular strainer¹⁵ is a fixed five-member single fork mortise construction; the canvas is adhered with glue to the outer members. The fabric is approximately 1/4" smaller than the outside dimension of the strainer. As confirmed by the X-radiograph, the difference in dimension was filled with ground directly onto the strainer and subsequently painted to the edge. The wood has been identified as a conifer in the Cuppressaecae Family, probably cypress.¹⁶ The plain weave, finely woven fabric was identified as cotton,¹⁷ having a thread count of 56 x 55 per in. sq. The yarns have an "S" twist which is unusual for Andean paintings.¹⁸ Cotton is native to Spanish America and its use more common than linen imported from Europe.¹⁹ The two layers of white ground have been identified as a chalk oil ground, possibly with a pine resin fraction.²⁰ A red priming was found to be rich in iron, indicating the possible presence of iron oxides, and/or red clay. Due to the identification of elements also found in organic carmine, this color could not be excluded. Elemental analysis indicates the possible use of chalk and quartz as fillers in the red priming, which does not appear to be a continuous layer throughout the composition. Some indication of a black sketchy underdrawing is visible. The media of the paint layer was identified as oil possibly with a pine resin fraction.²¹ Neither the media used in the red priming nor that used for applying the gilding was identified. When viewed under the stereomicroscope, the gilding, which was identified as gold with traces of silver, appears as leaf adhered with a mordant. Elemental analysis with SEM-EDS of a sample taken from the blue robe of the Virgin in the lower left rondel led to the conclusion that the blue coloration could only be due to indigo or Prussian blue.²² When examined with IR Ektachrome photography, the blue/black modified color of Prussian blue was confirmed.²³ Flowers painted to the right and left of the Virgin appear to have altered with age. The discoloration and fading of the pink flowers seem to be due to the component of altered red lake. The leaves attached to both the pink and blue flowers were once a brilliant green, residues of which were found in areas of low impasto and more strongly in areas once concealed by a frame. Although an unaltered orpiment was found mixed in with Prussian blue, an unidentified organic yellow that has mostly faded must have once primarily been responsible for this green color. Reference is made in the literature to

the scarcity of imported products and to the use of available materials such as "the juice of certain plants and suitable flowers...".²⁴ Both the preservation of the fugitive yellow in the green leaves along the edge and the application of a surface coating to within 1/2" of the edge imply a former framing. The thinly applied surface coating was not identified analytically.

Canvas, Wood, Hide, Paper, Glass, Stone, and Metal Supports: Further Observations

Canvas: The process of attaching a fabric directly to the strainer or stretcher with an aqueous adhesive was common practice in 18th c. Spanish colonial paintings. Only four paintings among those examined retain this original construction. In many cases and often in response to planar irregularities, canvas paintings were removed from their strainers for treatment, both prior to acquisition and thereafter.

Of those retaining an original construction, "Saint Philip of Jesus" by an unknown Mexican of the 18th c. [#44.47.2] is painted on a coarse, loosely woven, unidentified fabric attached with an aqueous adhesive to a finely woven fabric, determined under polarizing light microscopy to be cotton. These adhered fabrics were then glued to the outer members of a five member, single fork mortise, dovetailed, lap-joined strainer prior to the execution of the painting. The robe of Saint Philip is ornately gilded onto an underlying layer of ochre pigmented mordant. The surface coating was not analyzed at this time; under ultraviolet illumination, it fluoresces yellowish.

Another example of an original construction is the late 18th c. depiction of "St. John Nepomuk" by an unknown Mexican artist [#44.195.22]. The support is paper mounted to fabric, subsequently glued to the outer members of a five member, single fork mortise, dovetailed strainer prior to painting. The paper is approximately 1/2" smaller than the fabric support on all sides as confirmed by X-radiography. Infrared reflectography did not facilitate exposing an underdrawing or even the incorporation of a print into the construction (discussed in the section on paper supports). Stereomicroscopy reveals broad strokes of light gray underpainting from which the composition diverges slightly. The cross-sections examined under polarizing light microscopy indicate a pink ground layer which stained positively with FTIC suggesting a proteinaceous binder. Staining of the paint layers was not conclusive as a mild positive for FTIC, TTC and RHOB suggests an emulsion of oil with protein and gum.²⁵ Further testing is recommended with FTIR.

The most recent acquisition of portraits of fourteen Inca Kings [#1995.29.1-.14] will provide excellent study material for early 18th c. working methods and materials. Only four have been previously treated; they all retain their original construction. The coarsely woven fabrics are adhered to 5-member wood strainers, some retaining what appears to be an original cord threaded through a hole in the top member for hanging.

Of the 60 paintings examined, 44 are on fabric supports. The scarcity of fabric not only accounts for the manner of construction as previously discussed but also explains the re-use of fabric and the stitching together of pieces of fabric to provide larger formats. A pattern of double rows of holes on the reverse of the Peruvian (Cuzco School) painting, "Our Lady of Pomata", dated 1675 [#41.1275.177] bears no relation to damage on the image. The pattern was mapped out suggesting the former use of this fabric as a tarp or cargo cover. In the 18th c. Peruvian painting depicting "The Archangel Raphael" [#41.1275.187], a patch protrudes through the surface of the paint layer in the proper left leg and in the mantle of the angel. The patches were adhered to the front of the canvas over which the ground layer was applied. Photographic documentation of the reverse prior to lining in 1962 reveals holes and other irregularities, which do not correspond to damages in the paint layer and indicate the second-hand quality of the canvas. After removal of the lining canvas from the 18th c. Peruvian (Cuzco) "Triumph of Christ the King with the Four Continents" [#41.1254], three sections of fabric were found to have been stitched together to achieve a larger size. Previously extending in four directions, the original dimensions of this work can not be estimated. The 18th c. Peruvian (Cuzco) "Our Lady of Cocharcas under the Baldachin" [#57.144] and the 18th c. Peruvian (Cuzco) "Legend of St. Augustine" [#41.1275.192] are both larger paintings comprised of three and two pieces of canvas, respectively. A segment of coarsely woven and a more finely woven segment of canvas were stitched together in the support of the 18th c. Peruvian (Cuzco) "St. Isidore the Husbandman" [#41.1275.189]. In addition to identifying the stitching together of fabric for 18th c. Peruvian paintings, this practice was also found on the 19th c. Mexican painting depicting "Don Manuel Romero de Terreros y (Villar-) Villamil" [#52.166.15]. Prior to the execution of the painting, a sheet of laid paper was glued to a canvas support made of two different pieces of fabric stitched together.

An interesting method for repairing paintings that appeared to be native was found on the traveling scroll

painting of "Our Lady of Mount Carmel" dated late 18th c. by an unknown follower of Mauricio García (Cuzco) [#48.206.81] (*Figure 3*). Some of the patches used in the repair of this piece, worn and frayed along many horizontal lines from constant rolling and unrolling, were found to be covered with blue paint as though cut from the sky of another painting.

Wood Panel: Limited analysis was done on materials found on two of the seven New Mexican retablos, religious paintings on wood panel, prepared for this exhibition. Wood identification was not carried out at this time. However, macroscopic examination suggests hand hewn pine for the seven paintings.²⁶ The late 17th/early 18th c. depiction of "Our Lady of Mount Carmel" [#40.915] is painted on an irregularly shaped quarter sawn panel with slight convex warpage. A set of holes is located at the top through which a thin strip of animal skin is threaded with an additional piece of fabric attached to the skin. One additional hole in each of the upper corners enters along the top and exits through the reverse; a reason for these additional holes is unknown to the author. Analysis of the ground with FTIR 27 suggests a mixture of gypsum and chalk bound with a proteinaceous adhesive.²⁸ Infrared reflectography reveals a sketchy black underdrawing also visible in normal light over which the paint layer lies. Neither the resinous surface coating on this panel nor residues of a coating on other panels were analyzed at this time. The "Flight into Egypt" attributed to José Rafael Aragón (ca. 1795-1862) [#40.128] (Figure 4) shows three holes through the top of the panel with remnants of an animal skin found, probably for hanging purposes. The ground layer appears to be built up in two layers with an isolating adhesive over the first ground layer. FTIR analysis ²⁹ of the ground layer suggests the presence of gypsum and a proteinaceous binder. A sample of green paint also showed a peak in FTIR corresponding to protein.³⁰ A black linear underdrawing is reinforced with additional black paint after the colors have been blocked in. The paint layer is thinly applied with the white ground layer serving as the white color of part of the composition as well as background color. When comparing the X-radiograph of "Our Lady of Mount Carmel" [#40.915] to that of "Flight into Egypt [#40.128], an interesting difference was noted. Whereas the flesh tones and white shawl with red ornaments on "Our Lady of Mount Carmel" are X-ray dense, the white areas in "Flight into Egypt" are not.³¹ It appears that white lead may have been used in "Our Lady of Mount Carmel", while the gesso ground layer serves as the white color for the background, flesh tones and other white areas in "Flight into Egypt". The technique of implementing the uncovered ground for the whites was found in "The Holy Trinity" attributed to Pedro Antonio Fresquis (ca. 1780-1840) [#40.127] and "Our Lady of Sorrows" of the School of José Aragón (ca. 1821-1835) [#40.129]. Infrared Ektachrome photography used to study these two panels, "The Holy Trinity" [#40.127] and "Our Lady of Sorrows" [#40.129], showed the reddish/purple modified color typical of indigo where blue is found. This paint layer has a dye-like quality under magnification.

Hide: "St Francis Rescuing Souls from Purgatory " [#X594] attributed to the New Mexican artist Molleno (ca. 1805-1850) is the only water-based painting on buffalo hide in the collection.

Paper: Of the paintings examined, two are on paper adhered with an aqueous adhesive to fabric prior to painting: "St. John Nepomuk", late 18th c. [#44.195.22] and "Don Manuel Romero de Terreros y (Villar) Villamil", ca. 1865 [#52.166.15], both by unknown Mexican artists. Two Peruvian paintings on paper were adhered to copper supports prior to the execution of the paintings: "The Anunciation" [#41.1275.13] and "The Meeting of Joachim and Anna" [#41.1275.14]. Painted by an unknown artist in the 18th c., both pieces appear to be executed directly onto prints.³² Infrared reflectography shows closely placed hatch lines in the form of architectural structures beneath both pieces. The painted image estimated to be oil and resin seems to only partially follow the underlying image with no ground layer separating the two levels.

Glass: Two reverse painted rectangles of glass by an unknown Peruvian artist form a medallion depicting the "Madonna and Child" and "The Coronation of the Virgin" [#48.206.34] enclosed by a narrow silver frame. This complex structure uses an interesting technique to imitate "estofado", resembling the Italian "sgrafitto", the scratching of a design into a painted surface to expose an underlying gold leaf layer. In this piece, the paint film is scratched away to reveal both "gold" and "silver" metal foil sandwiched between the two sheets of glass. In addition, red pigmented paper functioning as a ground layer is laid behind the translucent white flesh tones.

Stone: "Our Lady of the Rosary with Saints", 18th c. Mexican [#52.8], is executed on alabaster in what appears to be an oil medium. This unusual painting support lent a translucency to the original composition in which more of the stone was visible. It was later more densely embellished or repainted, partially with watercolor. The original gilding on a pink colored mordant was later enhanced by "gold" powder.

Metal: One painting and two medallions from Peru and two paintings from Mexico are on metal supports. In all cases, the paint layer is not water sensitive and appears to have been executed in oil, perhaps with admixtures of resin. "The All-Powerful Hand" by an unknown Mexican artist of the 19th c. [#44.195.24] (*Figure 7*) appears to be oil on tin-coated iron, judging from the corrosion products formed. A hole punched through the top was probably used for hanging purposes. The "white" colored metal is visible through the faded red and the green glazes applied in the robes of the figures. The gilding appears in low relief on the garments of the figures due to the application of a pink-colored raised mordant, possibly comprised of oil/resin. In some areas the gilding is enhanced with colored glazes. The green paint in the landscape was analyzed with FTIR.³³ Although the paint medium could not be identified due to interference from the later applied surface coating, a peak corresponding to Prussian blue was noted. Infrared Ektachrome photography confirmed the modified blue/black color of Prussian blue.

"St Catherine of Siena" [#48.206.84] by an unknown Peruvian artist is dated to the 17th c. and is assessed to be oil on copper. This depiction is interesting for its use of an underlying "verdaccio" layer, reminiscent of early Italian Renaissance painting. It is known that European prints and books on theology were used by missionaries in New Spain as early as the 16th c.³⁴

Grounds, Pigments, Gilding Techniques, Compositional Changes

Colored Grounds: Of the paintings examined, some x-sections were taken and studied showing a common use of one or more layers of colored ground, which would coincide with a practice of 17th and 18th c. European painting.³⁵ In the Mexican paintings examined, applications of a red ground layer [#'s 45.128.191 (*Figure 1*), 52.166.3, 52.166.5 (*Figure 8*), 52.166.6, 52.166.7] were found in both religious images and secular portrait paintings. In the case of "Doña María de la Luz Padilla y (Gomez de) Cervantes", attributed to the Mexican artist Nicolás Enriquez, ca. 1735, [#52.166.3] the x-section shows a continuous ochre layer directly above the two red ground layers. The artist incorporates this ochre layer in the visible image by "sparing out" or by thinly glazing over. For example, a thin blue glaze over the underlying ochre creates areas of chartreuse in the dress of the sitter. A x-section taken from the 18th c. Peruvian painting "Triumph of Christ the King with the Four Continents" [#41.1254] reveals a lower gray/brown ground layer followed by an ochre layer containing large globular ochre particles. The tonality of these 18th c. Peruvian paintings is influenced by the application of colored grounds. As the transparency of the oil film increases with the aging of the media, the paint layer loses its covering quality and the image appears darker than originally intended. Examination under magnification discloses a variety of colored grounds used in these paintings. Those found include dark ochre [#41.1275.178], brown [#48.206.85, #41.1275.191], red [#41.1275.400], gray [#64.207, #41.1275.187] and black [#48.206.86, #41.1275.177, #48.206.88].

Pigments: Blues - The occurrence of pigments such as smalt, indigo, and Prussian blue, and the importance of the latter two in admixtures producing greens led to a preliminary study in order to identify the extent of their use on specific paintings. Polarizing light microscopy, infrared Ektachrome photography, microchemical testing and FTIR aided in the identification of the blue samples. Identified with polarizing light microscopy, smalt was found on "Christ Child with Symbols of the Passion" [#64.207], 17th c. Peruvian or Bolivian, and on "The Archangel Raphael", 18th c. Peruvian, [#41.1275.187].³⁶ This would account for the pale gray/blue color in both instances. IR Ektachrome photography shows the modified purple/pink color suggesting smalt as a possibility on these two paintings. Indigo is produced from the American plant Indigofera anil which yields an intense blue dyestuff. A lesser quality of indigo is also obtained from the American Cruciferae, Isatis tinctoria and "wild indigo".³⁷ The presence of indigo on the breastplate of the archangel Michael on a traveling scroll painting by an unknown Peruvian artist of the Cuzco School, dated around 1780 [#48.206.81] (Figure 3) was confirmed by FTIR.³⁸ A sample taken from the green foliage of the mid-18th c. "Virgin of Mercy with Three Saints" by an unknown Peruvian artist of the Cuzco School (Circle of Maurizio García) [#41.1275.181] (Figure 6) was analyzed with FTIR ³⁹ also confirming the presence of indigo. Preliminary examination with IR Ektachrome photography indicated the reddish/purple modified color for indigo.⁴⁰ Trade with Spain probably made Prussian blue accessible in the colonies in the early part of the 18th c. The presence of Prussian blue was confirmed by microchemical testing as well as suggested by IR Ektachrome photography in the early 18th c. "Virgin of Carmel Saving Souls in Purgatory" [#41.1275.178]. FTIR suggested the presence of Prussian blue on two Mexican 19th c. paintings: "The All-Powerful Hand" [#44.195.24] (Figure 7) and "Virgin of Guadalupe" [#45.128.189] (Figure 2), both of which showed the modified blue/black of Prussian blue in IR Ektachrome photography.⁴¹

Greens - The use of both Prussian blue and indigo in admixtures with orpiment and organic vellows was found in areas intended to be green as in landscapes and foliage. As mentioned in the report on the "Virgin of Guadalupe" by Ysidro Escamilla, 1824, [#45.128.189] (Figure 2) residues of bright green protected by previous framing were noticed. The pigment mixture is Prussian blue and orpiment and most probably an organic yellow which has faded on most of the painting. This phenomenon of fading was examined on three Peruvian paintings of the Cuzco School in which the foliage appears somewhat blue both in the foreground and in the middle ground: "St. Sophronia" (late 17th c.) [#48.206.88], "St. Isidore the Husbandman" (mid 18th c.) [#41.1275.189], and "The Flight into Egypt" (18th c.) [#48.206.85]. Appearing light blue, the distant backgrounds of these three paintings as well as that in the "Triumph of Christ the King with the Four Continents" (18th c., Peru) [#41.1254] were closely examined under the microscope. In the green foliage of the foreground and middle ground in these examples, orpiment is always found in combination with either indigo or Prussian blue and probably an organic yellow lake, which has faded to differing degrees. Only a few particles of orpiment were found in the distant background of these paintings suggesting the intentional light blue of aerial perspective.⁴² A further type of green was found to color jewels on the robe of the Virgin in "Virgin of Carmel Saving Souls in Purgatory" [#41.1275.178] (Bolivia, 18th c.). This transparent, "grass" green glaze may be of plant origin.43

Yellows - Orpiment is among the known yellow pigments in colonial paintings.⁴⁴ Identification of orpiment was made with the polarizing light microscope on samples taken from the green foliage of the "Virgin of Mercy with Three Saints" [#41.1275.181] (*Figure 6*) (Peru, mid-18th c.).⁴⁵ Orpiment was identified as the main contributing pigment in the imitation of gilding on the robe of "Our Lady of Pomata" [#41.1275.177] (Peru, 1675). It was found on a number of paintings including the "Virgin of Pomata" [#41.1275.400], (Peru, 18th c.) and "Don Ignacio María Leonel Gomez de Cervantes y Padilla" [#52.166.6], (Mexico, 18th c.). In both of these paintings the presence of orpiment seems to be diminished. The halo around the head of the "Virgin of Pomata" and the ornament on the jacket of "Don Ignacio" are areas where the orpiment is practically indiscernible in normal light. In ultraviolet light, these areas are more readily visible.⁴⁶ As mentioned in the report on the "Virgin of Guadalupe" [#45.128.189] (*Figure 2*), the foliage now appearing almost completely blue was previously a brilliant green color. Residues of green were detected in areas of foliage concealed by a former frame as well as in low peaks of impasto. In addition to orpiment in the admixture with Prussian blue the yellow component is proposed to have been a yellow lake or "plant juice" which has subsequently faded.

Reds - Red lake pigments are found to have been used on many of the New Mexican, Mexican and Peruvian or Bolivian paintings studied in this collection. Although no analysis of specific lakes was made at this time, it appears that the pigments were possibly obtained from different sources judging from their varying manner of color degradation. According to the literature, native vegetal red organic dyes of Mexico include the heartwood of *Poinciana spp.* and the heartwood of *Haematoxylon compechianum*.⁴⁷ Essays on the techniques of painting in New Spain refer to madder lake, *Rubia tinctorium* and its having possibly been imported from Spain.⁴⁸ The cochineal insect is indigenous to Mexico, Central America and South America and has been used in the manufacture of red colorants since ancient times.⁴⁹

Gilding techniques: One type of gilding commonly found on Cuzco School painting is a technique defined as "brocateado" 50 in which the patterns for gilding are drawn or stenciled with a *mordiente* (mordant of resinous oil) onto the image with no regard for following the folds in the garments. The folds are then reinforced with umber or dark brown transparent glazes above the gilding as in the "Virgin of Mercy with Three Saints" [#41.1275.181] (Peru, mid-18th c.)(Figure 6). Another commonly found application of "gold" is that of leaf onto a size of oil, resin and earth or bole in low relief, as in the "Virgin of Carmel Saving Souls from Purgatory" (Peru, 18th c.)[#41.1275.178] [also #41.1275.191 and #48.206.88]. This low relief gilding is enhanced in areas with red, blue and green glazing. Mordant application of silver was found on the "Triumph of Christ the King with the Four Continents" (Peru, 18th c.) [#41.1254] as well as mordant applied gilding, onto which brown glazing was selectively added to further define shapes such as in the scepter held by the central figure. An interesting hierarchical use of gilding was found in the depiction of "The Virgin Mary with Indian Donors" (Bolivia, 1752) [#41.1275.225] (Figure 5). In this panel gold was used in the decoration of the Virgin's robe, whereas orpiment was used to imitate gilding on the costumes and headdresses of the Indian worshippers. An interesting application of gilding was detected on the 18th c. painting of "The Carpenter's Shop in Nazareth" (Bolivia) [#43.112]. In addition to mordant applied gold, embossed rectangles of paper showing remnants of gilding were attached with an aqueous adhesive to the surface of the robes of both the Virgin and

the Christ figures. These appliqués are reminiscent of a technique used by 15th c. Flemish artists to depict brocade fabrics, a technique which is thought to have made its way from the Netherlands, its country of origin, to Spain in the mid-15th c.51

Compositional Changes and Re-use of Canvas: Examination with X-radiography was carried out initially on paintings with visible pentimenti. Interesting findings include the re-use of the same canvas for superimposed images. X-radiography of the portrait of "Doña María Joséfa de la Cotera y Calvo de la Puerta" (Mexico, 1816) [#52.166.5] (*Figure 8*) reveals three additional portraits beneath the visible one, including that of a young girl whose accompanying cartouche dates the painting to the 1770's. "The Legend of St. Augustine" (Peru, 18th c.) [#41.1275.192] with the depiction of several episodes in the life of this saint covers an earlier 3/4 portrait of St. Augustine in his library. The tradition of altering or "modernizing" an image is seen in "The Carpenter's Shop in Nazareth" (Bolivia, 18th c.) [#43.112]. The composition was changed by the painting out or around of figures with a similar red paint used in the original execution in order to change the position of certain figures or completely exchange some figures with others. For example, St. Joseph, originally the central figure in sawing planks in the right half of the painting. "Christ of the Earthquakes with Our Lady of Sorrows" (Peru, 18th c.) [#41.1276.7] is another example of changing the image by altering the robe of the Virgin, removing the draperies which formed a niche around her, adding the sword of sorrows, exchanging vases of flowers, eliminating flanking candles, etc. This practice of adjusting or completely changing a depiction is found to be a common occurrence in this collection of paintings.

Conclusion

This project has enabled the Conservation Department along with the Curatorial Department to reassess the collection of Spanish colonial paintings. Discussion on issues concerning the original construction, native repairs, embellishing and damages from the religious function of the paintings such as wax drips or candle burns were informative and helpful in subsequent treatment decisions. Continued research and analyses on the samples taken from the paintings during the examination phase of this project should aid in the understanding of these unique works. It is hoped that information found in this report and in the files at The Brooklyn Museum will be of use to colleagues.

Footnotes

¹ Fane, Diana, ed., *Converging Cultures: Art and Identity in Spanish America*, Brooklyn and New York: The Brooklyn Museum in association with Harry N. Abrams, Inc., 1996.

² Isacco, Enrico and Josephine Darrah, "The Ultraviolet-Infrared Method of Analysis - A Scientific Approach to the Study of Indian Miniatures", *Artibus Asiae*, Vol.LIII 3/4, 1993, published by the Museum Rietberg Zurich in Cooperation with the Arthur M. Sackler Gallery, Smithsonian Institution, Washington, D.C. Charts of known pigments were made and photographed under the same conditions as the paintings at TBM for comparison of modified colors in the IR spectrum. Daylight bulbs, Wratten #12 filter, 3', f 11, 1/8, 1/4 and 1/2 sec.

³ Spinden, Dr. Herbert J., America South of U.S. / As Revealed by Art, 1941, November 13 - January 4, revised edition exhibition catalogue, 1942.

⁴ Buck, Richard D., "Stretcher Design, A Brief Preliminary Survey", Intermuseum Laboratory, Oberlin, October 1972. (unpublished)

⁵ Wood Identification (Leitz Dialux microscope): CAL 1993, Mel Wachowiak and Marina Delaney.

⁶ Querejazu, Pedro, "Materials and Techniques of Andean Painting" in: *Gloria in Excelsio, the Virgin and Angels in Viceregal Painting of Peru and Bolivia*, New York: Center for Inter-America Relations, 1986, pp 78-86. In reference to the process of adhering canvases to strainers in Andean paintings, Pedro Querejazu states that the fabric was "glued to the face of a wooden stretcher and held in place with thorns or very small wooden dowels until the glue dried. The cloth was not wrapped around the sides of the stretcher because both cloth and iron nails were scarce and expensive." It is not clear whether this process was used in this painting as Xradiography examination showed no "dowel holes" along the edges of the canvas. ⁷ Fiber Identification (SEM analysis): CAL 1993, Roland Cunningham, Mary Ballard, Marina Delaney, Melanie Feather.

⁸ Querejazu, P., op. cit., p. 78. Querejazu states that in Andean painting, "the threads have a right hand twist or "Z" twist, and it is rare to find the left hand twist".

⁹ Querejazu, P., op. cit., p. 79. According to Querejazu, "Cuzco paintings are usually done on second-hand canvas, pieces of cloth previously used for packing or for covering and wrapping merchandise shipped from Spain to Peru."

¹⁰ Pigment and media identification (XRD, FTIR, SEM-EDS, GC-MS analyses): CAL, 1993, Camie Campbell, Walter Hopwood, Roland Cunningham, Melanie Feather and Marina Delaney.

¹¹ FTIR, GC-MS: Cal, 1993.

¹² Gettens, Rutherford J., and Evan H. Turner, "Materials and Methods of Some Religious Paintings of Early Nineteenth-Century New Mexico", in *El Palacio*, Vol 58, No. 1, January 1951, p. 11.

¹³ FTIR, GC-MS: CAL, 1993.

¹⁴ SEM-EDS: CAL, 1993.

¹⁵ Querejazu, P., op. cit., p. 79. According to this author, the strainers of Andean paintings are always rectangular.

¹⁶ Wood Identification (Leitz Dialux microscope): CAL, 1993, Mel Wachowiak and Marina Delaney.

¹⁷ Fiber Identification (SEM analysis): CAL, 1993, Roland Cunningham, Mary Ballard, Marina Delaney, Melanie Feather.

¹⁸ Querajazu, P., op. cit., pp. 78-79.

¹⁹ Kelemen, Pál, *Peruvian Colonial Painting*, exhibition catalogue, The Meriden Gravure Company, 1971, pp. 6-8.

²⁰ Pigment and media identification (XRD, FTIR, SEM-EDS, GC-MS analyses): CAL, 1993.

21 ibid.

²² SEM-EDS: CAL, 1993.

²³ Isacco, Enrico and Josephine Darrah, op. cit. pp. 470-491.

²⁴ Kelemen, P., op. cit., p. 8.

²⁵ Staining tests were carried out by Marina Delaney at TBM in 1991.

²⁶ Gettens, R. and E. Turner, op. cit., pp. 3-16. Of the thirteen *retablos* examined by Gettens and Turner in 1951, all were found to be painted on pine.

²⁷ FTIR: Winterthur Museum, 1992, Prof. Jan Carlson and Marina Delaney.

²⁸ Gettens R.J. and Evan H. Turner, op. cit., p. 9. Chalk was not detected on any of the panels studied by

Gettens and Turner in their 1951 study.

²⁹ FTIR: Winterthur Museum, 1992, Prof. Jan Carlson and Marina Delaney.

³⁰ ibid.

³¹ Gettens, R.J. and E. Turner, op. cit., p.15. The study by Gettens and Turner of 1951 reports the use of white lead in only two cases, while "... in many of the panels the white tones and the flesh areas are simply uncovered gesso background. It is possible with a tempera medium to produce a bright white with an inert of low refractive index like gypsum, but it would not have been possible to do it with an oil medium."

³² Kelemen, Pál, *Baroque and Rococo in Latin America*, New York: Dover, 1967, p. 200. According to Pál Kelemen, "Among the greater influences which shaped the iconography of painting in the New World were imported prints and illustrations from books."

³³ FTIR: Winterthur Museum, 1992, Prof. Jan Carlson and Marina Delaney.

³⁴ Lovera de Navarro, Norma, "Contributions of the Franciscan Brother Peter of Ghent to the Painting and Architecture of New Spain during the Sixteenth Century, in: *America / Bride of the Sun / 500 years Latin America an the Low Countries*, exhibition catalogue, 1.2-31.5.92, Royal Museum of Fine Arts, Antwerp, p. 71.

³⁵ Koller, Manfred, "Maltechniken im 17. und 18. Jh. - Grundierung", *Reclams Handbuch der Künstlerischen Techniken*, Band 1, Stuttgart: Reclam, 1984. pp. 345-354. Manfred Koller reviews the application of colored grounds in European paintings in the 17th and 18th centuries.

³⁶ Seldes, Alicia Marta, "A note on the pigments and media in some Spanish Colonial paintings from Argentina", *Studies in Conservation*, Vol. 39, No. 4, November 1994. pp. 272-276.

³⁷ Castedo, Leopoldo, *The Cuzco Circle*, The Center for Inter-American Relations / The American Federation of Arts, 1976, p. 42.

³⁸ FTIR: Williamstown Art Conservation Center, 1995, James Martin.

³⁹ ibid.

 40 Note: the modified colors for ultramarine and smalt are close to that of indigo so that one could not rely on identification with IR Ektachrome photography alone.

⁴¹ FTIR; Winterthur Museum, 1992 and CAL, 1993.

42 'Vandenbroeck, Paul, "Economic Conquest: Money Makes the Round World Go", essay in *America / Bride* of the Sun, op. cit., pp. 377-380. The technique of aerial perspective is used in early Flemish painting. Flemish paintings were exported to the colonies as early as the 16th c. and continued up to the 18th c.

⁴³ Kelemen, P., op. cit., p. 9.

44 Querejazu, P., op. cit., p. 81.

⁴⁵ Pigment identification (PLM): Williamstown Art Conservation Center, 1995, James Martin.

⁴⁶ Gettens, Rutherford J. and George L. Stout, *Painting Materials / A Short Encyclopedia*, New York: Dover, 1966 p. 135. Gettens and Stout mention the possible alteration of orpiment in the presence of lead and copper containing pigments, which may be the reason for a change in the orpiment used in these two paintings.

⁴⁷ Tierney, Gail, "Plants for the Dye Pot", *El Palacio*, Vol. 83, No. 3, Fall 1983, p. 33.

⁴⁸ Carrillo y Gariel, Abelardo, *Tecnica de la Pintura de Nueva Espana*, Mexico: Universidad Nacional de Mexico, 1983, p. 37.

⁴⁹ Schweppe, and Heinz Roosen-Runge "Carmine", in Feller, Robert L., ed. Artist's Pigments. A Handbook of their History and Characteristics, Washington, D.C.: National Gallery, 1986.

⁵⁰ Querejazu, P., op. cit., p. 81.

51 Frinta, Mojmir S., "The Use of Wax for Appliqué Relief Brocade on Wooden Statuary", in *Studies in Conservation*, Vol. 8, No. 4, pp. 136-147.



Figure 1. "Christ of Chalma" (#45.128.191)



Figure 2. "Virgin of Guadalupe" (#45.128.189)



Figure 3. "Our Lady of Mount Carmel" (#48.206.81)



Figure 4. "Flight into Egypt" (#40.915)



Figure 5. "The Virgin Mary with Indian Donors" (#41.1275.225)



Figure 6. "Virgin of Mercy with Three Saints" (#41.1275.181)



Figure 7. "The All-Powerful Hand" (#44.195.24)



Figure 8. "Doña María Josefa de la Cotera de la Puerta (#52.166.5)

ANALYSIS OF A MOISTURE-SENSITIVE PAINTING

Jia-sun Tsang, * Walter Hopwood, ** and Susan Lake***

Early in 1994, <u>Arundel Castle</u>, a painting by Frank Stella (b. 1936) in the collection of the Hirshhorn Museum and Sculpture Garden, developed a series of subtle but disfiguring glossy streaks throughout the lower half of the painting that appeared to be the result of handand fingerprints. As the treatment of monochromatic paintings is often problematic, the decision was made to thoroughly analyze this work before determining a treatment proposal. Analysis not only allowed the possibility of assessing the damage to this significant painting but also provided the opportunity to add to our knowledge of the techniques and materials of a major postwar artist. Additionally, analysis answered two long-standing questions concerning the condition of the painting: has it been repainted and are the black bands becoming less distinct with time?

Painted in 1959, <u>Arundel Castle</u> measures just over 10 by 6 feet. It is one of the earliest of Stella's groundbreaking series of twentythree paintings that have come to be known as the "Black Paintings." The Black Paintings are often cited as a cornerstone for important developments in the progressive painting of the 1960s, now known as Minimalism. In his work, Stella championed a more direct mode of geometric abstract painting, which he said is "based on the fact that only what can be seen there <u>is</u> there....What you see is what you see."¹ All the Black Paintings are reported to have been executed with commercial black enamel paint. Stella has said he mixed white enamel

*Paintings Conservator, Conservation Analytical Laboratory, Smithsonian Institution **Chemist, Conservation Analytical Laboratory ***Paintings Conservator, Hirshhorn Museum and Sculpture Garden, Smithsonian Institution into the black in the earliest of the series, producing a "no-color."² The artist's choice of paint was primarily an economic one. He stated, "It was like having a lot of oil paint; for thirty-five cents you could get a quart of it and you could do a lot of painting."³ Stella does not recall the brand of paint he used. Painter Walter Darby Bannard remembers, however, that Stella bought his paints on Canal Street in New York and that some were bituminous roofing paints.⁴

From photographs taken as the artist worked, we know that he began his painting having previously sketched out the basic design directly on the unprimed canvas. In the case of <u>Arundel Castle</u>, he probably began painting from the perimeter. Working toward the center, he would cover the painting field with black bands applied freehand using a 2-1/2 inch house-painting brush. Each band of black enamel was painted at a slight distance from the next, allowing a narrow strip of raw canvas to show in between. Each band was repainted three or four times to create a paint film that would detach the band somewhat from the canvas texture. The uneven absorption of the paint into the canvas support has created subtle gloss and matte modulations that serve to enliven the paint surface.

To answer the first of two long-standing questions about the condition of this painting, the initial step in the analytical process was to determine whether the paint surface was original or a later restoration. The catalogue for an exhibition of the Black Paintings, held in 1977 at the Baltimore Museum of Art, noted that the majority of the Black paintings had been repainted, not by the artist, but by professional conservators.⁵ The exhibition curator also stated that many of these paintings had been varnished, which permanently altered the original matte surfaces.

The cross-sections taken to study the painting's layer structure all showed that the painting has not been repainted, nor does it have a surface coating.⁶ There is no evidence of a distinct or disturbed upper paint layer. The cross-sections and dispersed paint samples also show that <u>Arundel Castle</u> is one of the works in which the artist added white paint to the black. In fact, in most of the samples there is as much or more white material as black. The samples also make it clear that the artist's blending of the two paints was cursory, resulting in an uneven distribution of the black and white paints. All the samples showed the presence of a dark amber-colored material, which presumably is the binding medium.

Once it was determined that the painting's surface was original, examination and analysis centered upon determining the source of the glossy streaks on the painting's surface. Initial examination indicated that the disfiguring streaks were not caused by the transfer of body oils from hands, as initially assumed. The paint surface is in fact not particularly vulnerable to the touch. It is, however, brittle (the paint tends to shatter under the sampling blade), soluble in virtually all organic solvents (including petroleum benzine), and extremely sensitive to water (directly applied by a damp swab) and even to moist air (when one blows on the painting).

Analysis initially focused upon identification of a watersusceptible, or soluble, component in the binding medium. An infrared spectrum (FTIR) of this material indicated the binder is an oil.⁷ However, solubility and heat stage tests were not consistent with that of a drying oil.⁸ When a paint flake was allowed to sit in hexane, a yellow substance leached from it. FTIR analysis of this material indicates that it is a hydrocarbon wax.

All these initial tests served to indicate that the binding material is not a straight oil, but a mixture. Gas chromatography-mass spectrometry was therefore used to separate the components of the mixture and analyze them individually.⁹ Figure 1 shows the total ion chromatogram obtained of a paint sample after saponification and methylation.¹⁰ The binding medium is clearly a mixture of drying oil, pine resin, and waxes. The left portion of the chromatogram is consistent with that of a drying oil. In addition to the saturated palmitic and stearic methyl esters (C 16:0 and C 18:0), it shows the presence of the unsaturated methyl oleate (C 18:1) and dimethyl azelate. The higher molecular weight region of the chromatogram shows a pattern that is the result of diterpenes as well as alkanes and long-chain fatty acids due to waxes.¹¹ All the larger peaks in this region are readily identified from their individual mass spectra as pimaradiene and abietadiene methyl esters, which strongly suggests a conifer source, probably a pine resin. The probability that the resin is a pine is underscored by the presence of the relatively stable diterpene, methyl dehydroabietate.¹²

The peak around scan 1196 is problematic. A mass scan indicates that there are in fact several compounds within the broad peak. In addition to an oxygenated pine resin, spectra of other components indicate the presence of asphaltic bitumen.¹³ The sample preparation was not ideal, however, for detection of bitumen. Additional analysis of solvent extracts may give better results. If bitumen is present, it may be due to the addition of the residues of low volatility from crude petroleum distillation. The presence of bitumen would not be particularly unusual in an industrial paint. A technical essay on Canadian Abstract Expressionist artists cited a number of painters during the 1950s and 1960s who used stove-pipe enamel.¹⁴ The article listed the contents of a stove-pipe enamel of that period as linseed oil, resin, asphaltum, turpentine, and carbon black--nearly identical components to those found in Stella's paint.

<u>Arundel Castle</u> appears to be executed with what in industry is called an oleoresinious paint. Early oleoresinious paints consisted of a drying oil such as tung or linseed, which is either mixed with, or more commonly heat-bodied, in the presence of rosin. These paints were advertised to dry within 24 hours. Predictably, they have relatively poor durability. They are brittle, sensitive to solvents, and have a tendency to discolor.

Identification of the binding medium in and of itself did not account for the paint's vulnerability to moisture. However, it did help answer the second question concerning the painting's condition, that is, whether the painting is changing with time. In a 1975 letter to the artist, a curator at the Hirshhorn Museum observed that the white spaces between the black bands seemed to be slowly disappearing over the years. He expressed concern that <u>Arundel Castle</u> would eventually look like an Ad Reinhardt painting if this process continued.¹⁵ The artist responded, but was unable to offer an explanation.

Examination of the painting in its current condition, reinforced by early photographs of the painting, has revealed that the painted bands of <u>Arundel Castle</u> have always been somewhat irregular and at points touch or nearly touch one another.¹⁶ Microscopical examination leaves little doubt, however, that the canvas fibers between the bands, once white, have darkened with exposure to a discolored medium and, therefore, offer less of a contrast with the surrounding black paint.

The cause for the painting's vulnerability to water is owed not solely to the medium but also to the white pigments present in the paint. Α paint flake allowed to sit in water for about 5 minutes leached a ring of white particles that formed a tide line around the flake. А microchemical test of these white particles was positive for calcium sulphate, giving characteristic needlelike sheaves.¹⁷ An infrared (FTIR) spectrum of this material and elemental analysis (SEM/EDS) of the white material in a paint cross-section confirmed the presence of sulphur as the main element, as well as silicon, calcium, and titanium. Calcium sulphate, titanium dioxide, and silicon dioxide commonly occur in modern paints as pigments and bulking materials. Their presence is not unusual and their identification alone does not explain the painting's sensitivity to water. X-ray diffraction, however, identified the calcium sulphate as an anhydrite, also known as anhydrous sulphate of lime and anhydrous gypsum.¹⁸

Most conservators are familiar with the anhydrite form of calcium sulphate, known as dead burnt gypsum, commonly used in the grounds of Italian Renaissance paintings.¹⁹ Dead burnt gypsum only slowly combines with water. In modern times, however, there are two forms of calcium sulphate anhydrite: soluble and insoluble. Insoluble calcium sulphate, the familiar dead burnt gypsum, is prepared by decomposition of the calcium sulphate dihydrate at high temperatures. The soluble form of calcium sulphate anhydrite is readily made from gypsum in an electric oven by dehydration at temperatures below 300°C. The soluble form of the anhydrite possesses a high affinity for water or free moisture in ambient air. It absorbs almost 7% of its weight of water, converting to the hemihydrate. Soluble anhydrite is in fact sold under the trade name Drierite and is widely used in industry as a desiccant because it is inert to most materials and inexpensive.²⁰

It is reasonable to assume that the vulnerability of the painting to moisture is due to the abundant presence of the soluble form of calcium sulphate anhydrite as one of the white pigments in the paint. The condition is undoubtedly exacerbated by the binding medium, which offers little protection to the pigments from water in the form of liquid or even high humidity.

In sum, analysis identified the damage to <u>Arundel Castle</u> as primarily due to the presence of calcium sulphate anhydrite in the paint film and to a poor quality binding medium. It also clarified long-standing questions about the painting's condition. <u>Arundel Castle</u> has not been repainted or varnished. The lack of a clear distinction between the black bands is due to the way the work was painted and to the progressive darkening of the canvas fibers. Analysis also indicated that there is no possibility of safely removing the fingerprints. Mechanical removal, organic solvents, water, or a combination of solvents and water would not reduce the damage, but only further jeopardize the painting.

1. Interview by Bruce Glaser with Stella and Donald Judd broadcast by WBAI-FM, New York, February 1964 as "New Nihilism or New Art?" In Lucy R. Lippard, ed., "Questions for Stella and Judd," <u>Art News</u> (September 1964): 58-59.

2. Brenda Richardson, <u>Frank Stella: The Black Paintings</u> (Baltimore: Baltimore Museum of Art, 1976), 15.

3. From the unpublished transcript of taped interviews made in 1966 for a program in the series "U.S.A. Artists" produced by Lane Slate for National Educational Television. In Rubin, William S., <u>Frank Stella</u> (New York: Museum of Modern Art, 1970), 15.

4. "Special Report on Acrylic and Other Synthetic Media Paintings. Part 1." <u>McKay Lodge Conservation Report</u> 3 (Spring 1991): 4.

5. Richardson, Frank Stella, 15.

6. A limited number of paint samples were taken from the edges of the painting and elsewhere near existing paint losses. Microscopic examination was done at the Hirshhorn Museum Conservation Laboratory.

7. Infrared spectroscopy (FTIR), scanning electron microscopy with energy dispersive x-ray spectroscopy (SEM/EDS), and x-ray diffraction were carried out at the Conservation Analytical Laboratory, Smithsonian Institution, Suitland, Maryland.

8. Elyse Klein, Jia-sun Tsang, and Mary Baker, "Noninstrumental Techniques for Characterization and Identification of Artist's Acrylic Paint," <u>Polymer Preprints</u> 33, no. 2 (paper delivered at the American Chemical Society Division of Polymer Chemistry, Washington, D.C., August 1992): 650-51.

9. Sample analysis was performed after methylation with a supelcowax 10 (30m, 0.32 mm ID) column. The initial oven temperature was 150°C, held for one minute, ramped 15°/min. to 200°C, and then 2°/min. to 250°C. Three runs were made of samples taken from the left, right, and bottom edges, with consistent results. Gas chromatography-mass spectroscopy was done at the University of Delaware Chemistry and Biochemistry Department. The authors are grateful to Gordon Nicol, Mass Spectrometrist, for his generous assistance in this analysis.

10. For the derivatization method, see David Erhardt et al., "A Systematic Approach to the Instrumental Analysis of Natural Finishes and Binding Media," <u>Preprints</u> (paper delivered at the American Institute for Conservation of Historic and Artistic Works, New Orleans, Louisiana, June 1-5, 1988): 82.

11. No attempt was made to identify the wax because the alkane peaks overlapped somewhat with the diterpene peaks.

12. As pine resin does not incorporate itself into the polymer network of the drying oil film, the proportion of dehydroabietic acid increases with age. The absence of retene and norabietatrienes suggests that neither softwood tar nor pitch is a component in this paint. John S. Mills and Raymond White, <u>The</u> <u>Organic Chemistry of Museum Objects</u> (London: Butterworths, 1987), 54-57, 144.

13. The possible presence of bitumen is based on a scan of the upper end of the chromatogram for mass 191, usually the base peak for hopanoid compounds, which are diagnostic of bitumens. Ibid., 152-58, and Erhardt, David, David von Endt, and Jia-sun Tsang, "Condition, Change, and Complexity: The Media of Albert, Pinkham Ryder," <u>The Paintings Specialty Group Annual</u> 3 (paper delivered at the American Institute for Conservation, Richmond, Virginia, 1990): 28-35.

14. Marion Barclay, "Materials Used in Certain Canadian Abstract Paintings of the 1950s," in LeClerc, Denise, <u>The Crisis of</u> <u>Abstraction in Canada: The 1950s</u> (Ottawa: National Gallery of Canada, 1992), 216.

15. Charles Millard to Frank Stella, 27 January 1975. The Hirshhorn Museum and Sculpture Garden Archives, Smithsonian Institution, Washington, D.C.

16. In all the the earlier paintings in the series, the bands are more irregular and the interstices are narrower than in the later paintings. The bands and the lines of raw canvas become more uniform in width in the later works in the series. Even later in his career, Stella used masking tape to give his painted bands a hard edge.

17. Rutherford J. Gettens and George Stout, "The Stage Microscope in the Routine Examination of Paintings," <u>Technical</u> <u>Studies in the Field of Fine Arts</u> 4, no. 4 (April 1936): 217-20.

18. Diffraction patterns of calcium sulfate dihydrate, hemihydrate, and anhydrite are all different because water of crystallization or the absence of it has a marked influence on the respective crystalline structures of the calcium sulfates. X-ray diffraction was carried out by Camie S. Campbell.

19. Rutherford J. Gettens and M. E. Mrose. "Calcium Sulphate Minerals in the Grounds of Italian Paintings," <u>Studies in Conservation</u> 1, no. 4 (October 1954): 174-89.

20. <u>Kirk-Othmer Encyclopedia of Chemical Technology</u>, 3d. ed., Herman F. Mark et al., ed., 1978, "calcium sulphate" (vol. 4) and "drying agents" (vol. 8).



LOW-MOLECULAR-WEIGHT RESINS FOR PICTURE VARNISHES

Jill Whitten, Mellon Fellow in Paintings Conservation

Materials for conservation have to fulfill a variety of criteria in order to be accepted by the conservation community. Not only are they judged by their reversibility, stability and resistance to visual changes over time, but by the aesthetic and more subjective factors of appearance and ease of application. Materials must also be versatile and in the case of varnishes, have the ability to be manipulated by the application method. These latter factors have made some conservators prefer natural resin varnishes in spite of their tendencies toward chemical change and physical degradation.

After artificially aging and testing new materials, Regalrez 1094, Arkon P90, and an experimental aldehyde made by BASF were introduced to conservation by René de la Rie as alternatives to the less stable natural resins [1]. Arkon P90 and the experimental aldehyde have been applied to mock-ups and artworks at the J. Paul Getty Museum [2] and the Metropolitan Museum of Art [1] and some of the results have been published. As a result, Arkon P90 has been in fairly wide use for several years, but some consider it too glossy and it is the least stable of the three resins discussed here. Regalrez 1094 has been used with cautious experimentation for many years and has proven to be stable in aging tests. Like Arkon P90, it is commercially available but has been disappointing to some people because the gloss and ready solubility have made it less versatile than natural resins. The aldehyde resin has performed extremely well in both aging tests and aesthetic evaluations but at this point has not been widely used because it is not commercially available [1]. Even so, each of these resins should still be considered because conservators are a tiny portion of the market, and we cannot influence which resins industry will continue to make.

Initial application tests and visual comparisons with these resins showed that they can imitate natural resins in terms of saturation but the working and handling properties have remained quite different. Feedback from early experiences led René de la Rie to his investigation of additives that might increase flexibility and mimic the behavior of the polymeric fractions that occur naturally in resins like dammar and mastic, and that give them their desirable handling properties [3]. Practical research was undertaken to determine if solvents as well as additives can be used to modify the working properties of these new resins. This paper will present the results of practical brush and spray application tests focusing on Regalrez 1094, and will discuss how polymeric additives and solvents can affect the application, appearance, and physical properties of the final film.

Two comments that are sometimes heard about the new low-molecular-weight (LMW) resins are that they are too glossy and dry too slowly. The LMW resins are hydrocarbons similar in structure to the hydrocarbon solvents they are dissolved in. Therefore they exhibit an affinity for the solvent, which may cause the resin to retain solvent and dry more slowly. In early tests with these resins, very slow evaporating solvents were used which would tend to increase the gloss and drying times further [2]. The low viscosity of LMW varnishes causes them to level well and therefore appear glossy, but the gloss can be controlled somewhat by the application method and choice of solvent.

Solvents produced by Shell Chemical were chosen for these varnish experiments because Shell manufactures a wide variety of hydrocarbon solvents in the U.S. and the ingredients in these Shell hydrocarbon mixtures remain constant throughout the year. (Industrial solvent formulations can change on a seasonal basis [4].) A great deal of technical information is available from the manufacturer. Shell solvents are more consistent in terms of aromaticity and evaporation rate than other solvent mixtures which often are made from industrial by-products. Be aware that manufacturers have the right to change the composition at any time and only by knowing the properties of the solvents can accurate comparisons be made. For example, by examining Shell solvent charts, you will find that terms like naphtha and mineral spirits do not accurately describe the specific properties of a named solvent. There are many types of naphthas, mineral spirits and stoddards solvents. Shell makes at least five kinds of mineral spirits with aromatic contents of 0.1 to 15%. They make at least four naphthas with aromatic contents of .02 to 12% and which have widely varying evaporation rates. There are 33 different characteristics listed in the margins of Shell

Jill Whitten The Art Institute of Chicago 111 South Michigan Avenue Chicago, Illinois 60603 hydrocarbon charts but only a few are important for mixing varnishes [5]. There are many ways to measure evaporation rate and two are listed in the charts, "seconds to 90% evaporation" and "n-butyl acetate value" (n-BuOAc or n-BuAc). Although n-butyl-acetate values are more frequently seen on Material Safety Data Sheets and European solvent charts, the "seconds to 90% evaporation" may present a clearer picture. The Hildebrand solubility parameter and aromatic content may also be useful for comparison. The Shell aromatics have virtually no toluene or xylene; they are all higher derivatives of benzene (listed as C-8 and higher) and so have slower evaporation rates and are less toxic.

In early application tests the new LMW resins were dissolved in slow evaporating solvents such as Sol 71 (0.1% aromatic) or Mineral Spirits 145 (approximately 7% aromatic), with evaporation times of 5100 and 3200 seconds to 90% evaporation. The use of these solvents makes for very long working and drying times. Solvents in the 1500-1700 seconds range, such as Sol 340 HT (0.1% aromatic), Sol 320 (7% aromatic), and naphtha EC (7% aromatic, not commercially available) [5] evaporate quickly enough that you can begin to manipulate the surface as the solvent evaporates. Brushing tests show that a more satiny or matte surface can be achieved when the varnish is brushed until tacky or buffed with a dry badger hair brush after the initial brush application.

In May 1995, Michael Palmer of the scientific research department at the National Gallery of Art in Washington prepared Scanning Electron Microscope (SEM) photographs from varnished mock-up surfaces that were prepared in January. The photos depict paint surfaces coated with Regalrez 1094 brush applied in different ways and at different concentrations. The purpose of the SEM examination was to determine how much the application method affected the final appearance. It was hoped that we would see actual brushstrokes on the surfaces which were buffed, but this was not the case. Instead, the differences that were visible as matte areas on the mock-up seem to relate to material being picked up and removed by the brush. The surfaces are affected by the brushing but maybe only because material is being removed. These are very preliminary results and none of these experiments have been repeated. We have not yet performed any comparisons to determine if natural resins are manipulated or simply removed by continued brushing or buffing. We plan to use SEM studies to examine more varnished surfaces so we may be able to correlate microscopic topography with visual appearance, in order to determine which factors affect appearance. Many more tests will have to be performed to draw accurate conclusions.

Regalrez 1094 has been used successfully at The Art Institute of Chicago for almost four years in instances where saturation is needed for canvas and panel paintings, to resaturate aged synthetic and natural resin varnishes, and to even areas of matte and gloss (applied in dilute concentrations in instances where it was deemed appropriate). The most common uses have been to resaturate PVA and Lucite varnishes applied in the 1960's and to resaturate natural resins that had become dull on paintings that were not slated to be fully treated.

Treatment Examples: (Only pertinent steps in the treatment process are included here.)

In a treatment at The Art Institute of Chicago, Regalrez 1094 was selected as a varnish for a small painting on an unprimed oak panel by Jean Louis Meissonier (1815-1891), <u>La Defense de Paris</u>. After reducing a discolored varnish with a mixture of petroleum benzine and ethanol, we chose Regalrez 1094 for the final varnish because of the delicate nature of the thinly painted image and unprimed panel, and because we wanted saturation without having to use polar solvents to remove the varnish in the future. Thirty grams (g) of Regalrez 1094 in 100 milliliters (ml) of Sol 340 HT was spray applied with a Chiron sprayer. The spray application was fairly wet and was brushed out with a dry badger hair brush until the surface felt dry.

On a little painting by Thomas Cole (1801-1848), <u>Landscape (New England Scenery)</u>, a label on the reverse stated that dammar had been applied in 1913. The natural resin had not appreciably yellowed but had lost some of its gloss and saturation. A light spray coat of 25 g of Regalrez 1094 in 100 ml 340 HT was spray applied over the existing dammar with a Chiron sprayer to resaturate the surface.

<u>The Cloisters, San Lorenzo Fuori le Mora</u> by Christoffer Eckersberg (1783-1853), had a finely cupped surface which was consolidated with gelatin applied through tissue. A discolored natural resin was removed and the picture revarnished with a 25% weight to volume solution of Regalrez 1094 dissolved in Shell TS 28 (75% aromatic). The varnish was spray applied with a Chiron sprayer and the picture was then inpainted with Maimeri and sprayed again with a very light spray of the same varnish. Regalrez 1094 was selected because saturation was appropriate and the

cleaning revealed delicate pinks and greens that would be obscured by a resin that might discolor.

A painting by Alberto Pasini, <u>Soldiers Outside a Mosque</u>, had a darkened or toned natural resin applied by a collector (while in the frame) that completely obscured the high contrast image which was visible in the unvarnished margins. Except for the application of this toned varnish, the painting appeared to have never been treated. Regalrez 1094 was selected to saturate the image and protect it from cleaning with polar solvents in the future. The image was very cool in tone after cleaning and it was interesting how the painting seemed to have a warmer tone after the varnish of 40 g in 100 ml 340 HT was brush applied. The varnish was brushed until tacky and then buffed with a badger hair brush until almost dry. With continued brushing, varnish could be picked up in the few areas that remained slightly glossier after cleaning.

Many conservators in other institutions and private practice have also been using Regalrez 1094. Patricia Garland at the Wadsworth Atheneum has spray applied Regalrez 1094 to several Barbizon school paintings in a 5% weight to volume petroleum benzine mixture. She has both brush and spray applied Regalrez 1094 in this concentration. Different inpainting techniques were used over the varnish with good results and final sprays of the same concentration were applied in some instances. Patricia said that she has not experienced any reticulation. She was looking for a very subtle effect from the varnish and was pleased because many of the surfaces do not look varnished but have regained the appearance of a healthy oil film. This solvent system may have worked well because petroleum benzine (Fisher petroleum benzine is 13% aromatic) has the same evaporation rate as toluene (n-BuOAc of 2.0) and would therefore evaporate quickly enough that it would produce a dry spray. (Note: if you are using a spray booth and brush varnishing a mixture in petroleum benzine, you may not have <u>any</u> time to manipulate the varnish before it dries.)

A point about percentages: 20% weight to volume is described by most U.S. conservators as 20 grams in 80 milliliters. In England and Canada 20 grams in 100 milliliters is often called 20%. A true percent can only be achieved when the solids and liquids are weighed [6], so I try and avoid the term because it is often impractical to weigh solvents in everyday practice. For my experiments, solutions are described by the gram weight dissolved in 100 ml of solvent. The 100 ml measurement has been used because it is helpful to keep one factor constant when making concentration comparisons.

Treatment Examples: (In the next two treatments, Robert Proctor was able to exploit differences in solubility parameters between the varnishes and the inpainting materials.)

In the <u>Portrait of Rhoda D. Selleck</u> by the Indiana artist Wayman Adams, the artist mixed large amounts of varnish with his oilpaints which resulted in a paint film sensitive to aromatic solvents. Because of the artist's technique, disturbing pentimenti from an underlying image became visible over time. Following the example outlined by Mark Leonard in the Brussels meeting IIC Preprints [2], Rob first applied a 25% weight to volume solution of Arkon P90 in a 1:1 mixture of Shell Sol 71 and Sol 340 HT by spray, followed by brushing with a soft brush. The pentimenti were retouched using a PVA palette diluted with ethanol. A final light spray application of the same solution of Arkon P90 was applied and brushed out for a glossy, appropriate final surface.

A vandalized painting entitled <u>Shrimpers of Yarmouth</u> by Harry Chase had been slashed numerous times with a knife. The discolored natural resin varnish was removed and the tears were repaired and then filled with pigmented wax. The fills were isolated with a light spray coat of Acryloid B-72, 10 g in 90 ml xylene, and inpainted with pigments mixed in Acryloid B-72. A final brush application of Regalrez 1094, 15 g in 85 ml in Mineral Spirits 135 (15% aromatic) did not disturb the inpainting and imparted the appropriate gloss and saturation.

In 1994 <u>The Titanic</u>, by Max Beckmann, was treated at the Saint Louis Art Museum. Due to the large size of the painting, 110" x 96", long brushing times were required for revarnishing. Slow solvents like Shell Sol 71 or Shell Sol 142 HT can be useful when brushing large canvases. A fairly thick layer of Soluvar varnish applied in 1986 was removed with a 20% xylene and 80% petroleum benzine mixture as it had become dull and yellow with age. An underlying layer of Acryloid B-72 and B-72 retouches were left intact. Regalrez 1094 was brushed over the older varnish to even areas of matte and gloss remaining after cleaning. Further inpainting was undertaken with Lefranc and Bourgeois Restoration Colors. Regalrez 1094 was brush applied 15% weight to volume in Shell Sol 142 HT which has an evaporation time of 9200 seconds to 90% evaporation. It was selected partly because a brush varnish

was required since the painting was too large to fit in the spray booth, and because Regalrez 1094 could be brushed over the numerous retouches of Lefranc and Bourgeois Restoration Colors without affecting the inpainting.

To modify the working properties and add flexibility to the resins, René de la Rie age tested various synthetic rubbers from the Kraton G series made by Shell Chemical. The Kraton Rubbers have been tested as an additive for Regalrez 1094 and have remained stable in aging tests in concentrations of up to 10% when combined with the Hindered Amine Light Stabilizer (HALS) Tinuvin 292 added at 2% to the weight of the combined resins [3].

The Kraton G series rubbers are interesting materials with complex behaviors and Shell has several good publications which are listed at the end of the article [7]. The Kraton G rubbers are formulated by industry to be the major component of coatings and hot melt adhesives.

The Kraton G rubbers will dissolve in most hydrocarbon solvents but the solvent you choose will affect the viscosity of the solution. Technically, the Kraton rubbers require a small amount of aromatics but in the small concentrations used for these experiments, they will dissolve in aliphatic hydrocarbons. Dissolving the Kraton rubbers in solvents with little or no aromatics will make more viscous solutions so you can actually use less of the additive.

Both the Kraton G 1650 and 1657 have been used on mock-ups and artworks and function to increase viscosity, add flexibility and improve brushability. The Kraton G 1657, in pellet form, is easier to handle and weigh, but the Kraton G 1650 (which is of higher molecular weight) goes into solution more quickly because it is in powder form. At concentrations of 1.5-3% to the weight of the resin, the working properties are substantially modified and brushability improved. The rubber adds a polymeric fraction which gives the same resistance to the brush that you feel as you apply a natural resin. The Kraton G rubbers do change the appearance of the varnish: the addition of more than 3% can give the varnish a "synthetic" appearance. Kraton is not an essential ingredient for these new varnishes but for our purposes it is strongly recommended that Tinuvin 292 be added at 2% to the combined weight of the resin and rubber. Tinuvin 292 increases the stability of Regalrez 1094 and should be added whether or not Kraton rubber is included.

Treatment Example: (The addition of the rubber can be useful for canvases that have a rough or cupped surface or in other circumstances when you may need a varnish with more body.)

Another painting from the Art Institute collection, <u>Pastoral Scene- St. John the Baptist as a Child</u>, by Giovanni Battista Piazetta (1682-1754), had a cupped surface and a gray, dull, Lucite and PVA varnish dating from the 1960's. The painting was not cleaned for a recent exhibition because of harsh past treatments but was resaturated with 45 g of Regalrez 1094 in 105 ml Shell 320 (7% aromatic) with the addition of 1.35 g of Kraton G 1657 (3% to weight of resin) and stabilized with Tinuvin 292 (2% added to the combined weight of the Regalrez 1094 and Kraton). A thin, 6" wide brush was used and the varnish brushed out very well with the Kraton rubber added; however, small air bubbles appeared. The bubbles were eliminated by brushing more slowly and through evaporation. The resulting glossy surface was beautifully saturated and appropriate. Losses and abrasions were inpainted with Maimeri restoration colors.

Although the new LMW resins were introduced as stable synthetics which could duplicate the optical and aesthetic properties of natural resins, many conservators have discovered that a wide range of effects can be achieved, which has broadened their use beyond those instances where maximum saturation and gloss is desired. These new LMW resins also have the advantage of dissolving in far less polar solvents than are necessary for natural, ketone, and methacrylate resins, which makes them appropriate for modern paintings. They can be applied locally in instances where a tiny bit of saturation or evening-out of matte and gloss is required. Examples include twentieth century paintings, or naive and folk paintings that might be sensitive to most other solvents or should not have the appearance of a distinct varnish layer.

Treatment Example:

For a Joseph Albers painting treated at the National Gallery of Art in Washington, D.C., Jay Krueger selected Regalrez 1094 to resaturate areas of uneven matte and gloss after a discolored synthetic varnish was removed. After

cleaning, the surface was slightly dry and because of the artist's technique, there was variation in the gloss of different bands of color. It is well documented that Albers intended for his paintings to be varnished and have even surfaces. Regalrez 1094 was spray applied in an approximately 12% weight to volume solution in naphtha for an even, non-glossy surface.

Numerous people have asked me how to matte down Regalrez varnishes, so in the Spring of '95 I spent a week preparing mock-ups and spraying varnishes at the Indiana University Art Museum in Bloomington, Indiana. The Art Institute of Chicago, where most of this work was performed, did not have a spray booth. Several different resins were examined to compare gloss. Gloss was affected by the choice of resin, with dammar, Arkon P90 and Regalrez 1094 being the glossiest followed by MS2A and the experimental aldehyde. A variety of matte spray surfaces were achieved during this week of experimentation. The factors which yielded matte varnishes were: low concentration of resin to solvent (10 g in 100 ml or less), the addition of wax or fumed silica, and the use of fast evaporating solvents. Fast evaporating solvents can greatly reduce the gloss of a varnish. The concentration of the varnish solution was the second most important factor in terms of gloss- the lower the concentration, the lower the gloss. Matting agents were effective in reducing gloss but wax can make a varnish look dull and fumed silica can leave the surface with a pebbly appearance. The varnishes that actually gave glossy paint a more matte appearance were: 10 g of Acryloid B-72 in 100 ml xylene, and 10 g Regalrez 1094 in 100ml of Shell Sol 340 HT with bleached beeswax added at 10% to the weight of the resin, and 10g Regalrez 1094 in 340 HT with fumed silica (it is almost impossible to weigh fumed silica but approximately one heaping teaspoon was required to matte down this small amount of varnish). Lower concentrations of wax also matted down a glossy varnish but were not effective in matting down glossy paint surfaces. Although the literature from Hercules states that Regalrez 1094 is compatible with both paraffin and microcrystalline waxes [8], the addition of 10% wax is not recommended until further tests are made. Regalrez 1094 is inherently glossy and may not be the best resin selection when trying to produce a matte varnish. (Note: In treatments performed since this presentation, it was discovered that the spray application technique may be the single most important factor when trying to create a matte surface using Regalrez 1094. A concentration of 20 g in 100 ml of Sol 340 HT can matte down an initial brush coat of the same concentration if it is applied in a dry spray.)

I have been fortunate to do some traveling and participating in workshops this year where I was able to learn about other people's varnishing practices. This has been truly interesting and informative and I have seen that there are as many ways to varnish as there are conservators. There are all types of brushing techniques from the union jack, to vertical and horizontal stripes, squares, and random "X" marks. Spray application varies from high pressure spray guns, to high volume low pressure units like the Chiron, to airbrush and the famous Frank Zuccari atomizer method. Brush preferences vary widely but for Regalrez 1094, I like stiff, thin China bristle brushes that do not hold much varnish because the LMW resins spread and brush out well with just a small amount of material. To resaturate unvarnished, leached paint films sensitive to aromatic solvents, Rob Proctor will gently rub in dilute concentrations of Regalrez using a cotton ball wrapped in silk.

The type of substrate you are varnishing will help determine which concentration to select. Regalrez 1094 looks much more like a natural resin when it is applied to a weathered or aged surface than it does on a newer, rich oil film. The Kraton rubber will change the appearance and working properties of the varnish but is not an essential ingredient. On the other hand, it is highly recommended that you add the Tinuvin 292 with or without the rubber. It is also important to discard varnish mixtures after three weeks because solutions degrade more quickly than dry materials. I make small batches for this reason.

There are both pros and cons to the new materials. The ready solubility can be a drawback sometimes when trying to inpaint or build up spray surfaces. These varnishes can be inpainted on with Lefranc and Bourgeois and even Maimeri if you use a fairly dry brush. Arkon P90 and Regalrez 1094 are insoluble in acetone and the lower alcohols so those conservators who use a PVA or Acryloid B-72 palette dissolved in these polar solvents will have no trouble inpainting on top of Regalrez 1094. I have heard two horror stories where big inpainting jobs on top of Arkon-P90 or Regalrez 1094 were ruined when the final spray varnish caused reticulation. The initial application may have been too thick or the solvent used for spraying may have been too strong or the spray too wet. Use a thin initial layer of Regalrez 1094 or an initial varnish of Acryloid B-72 or stabilized dammar before your inpainting, followed by a spray or brush coat of Regalrez 1094. I have found that airbrush and Chiron-type sprayers give more control and less chance of reticulation or overly glossy surfaces. One of the positive characteristics of Arkon P90 and Regalrez 1094

is that their solubility in mild solvents allows brush application of these varnishes over most any inpainting material (Maimeri, Lefranc & Bourgeois, watercolor, PVA, etc.). Regalrez 1094 cannot be brushed over an existing Regalrez layer because the first coat will redissolve and look uneven.

These new resins have already become indispensable to me because of their unique properties and the range of surfaces that can be achieved. The new LMW resins do not perfectly mimic the beauty and unique handling properties of dammar and mastic, but the natural resins are not always an appropriate choice, and it is very useful to finally have stable, aesthetically appropriate alternatives.

There are many people I would like to thank- René de la Rie for including me in this interesting research and not giving up on varnishes, Frank Zuccari and all of my colleagues at The Art Institute of Chicago, Bob and Martha Gamblin who supplied the oil paints for my mock-ups and whose insights I have enjoyed through our varnish collaboration, Margaret Contompasis and Danae Thimme at the Indiana University Art Museum for letting me share their space for a week to do spray varnishing, all of those colleagues whose experiences I have shared with you, and especially Robert Proctor, my collaborator and partner, whose good ideas I rely on so heavily. Thanks to you all.

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- 2 Leonard, M., "Some Observations on the Use and Appearance of Two New Synthetic Resins for Picture Varnishes," in *Cleaning, Retouching and Coatings*, eds. J.S. Mills and P. Smith (London: International Institute for Conservation of Historic and Artistic Works, 1990) 174-176.
- 3 de la Rie, E.R., "Polymer Additives for Synthetic Low-Molecular-Weight Varnishes," 10th Triennial Meeting Washington, DC, USA 22-27 August 1993 Preprints Vol. II, ICOM Committee for Conservation, 1993, 566-573.
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- 5 Shell Hydrocarbon Solvents, SC: 1056-93.
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- 7 Kraton Polymers for Coatings, Shell Chemical Company, SC: 1757-93.
- 8 Regalrez® 1018, 1085, 1094, 1126, Technical Informationation Sheet, Hercules, June 1994.

SUPPLIER

Arakawa Chemical Inc. (Arkon P90), Chicago, IL 60611, tel 312-642-1750.

Hercules Inc. (Regalrez 1094), Wilmington, DE 19894, tel 800-247-4372 (also available from several different U.S. vendors who supply products for conservation).

Shell Chemical Co. (solvents, Kraton G rubber, and solvent charts), Houston, TX 77251, tel 800-457-2866 (some solvents available from Conservation Materials).

Ciba-Geigy, Additives Division (Tinuvin 292), Hawthorne, NY 10532, tel 800-431-1900.

BASF Aktiengesellschaft, D-6700 Ludwigshafen, Germany (Experimental Aldehyde, not commercially available).

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