EXAMINATION AND TREATMENT OF A SET OF KLISMOS CHAIRS, ATTR. TO JOHN AND HUGH FINLAY

RIAN M. H. DEURENBERG

ABSTRACT—This paper describes the examination and treatment of a set of four klismos side chairs, attributed to John and Hugh Finlay of Baltimore, Maryland (1815–1825), in the collection of the Metropolitan Museum of Art, New York. X-radiographs, detailed drawings of the construction, and comparisons between the four chairs indicated an unusual coordination of work between chair makers, painters, and caners within the Finlay shop. Cross sectional stratification analysis aided in designing the treatment and understanding the decoration, including a puzzling blue ground layer and painted caned seats. Analysis with Fourier transform infrared spectroscopy, Raman spectroscopy, and energy dispersive x-ray spectrometry in the scanning electron microscope indicated the use of pigments such as chrome yellow, lead white, Prussian blue, and hematite. The treatment focused on the selective reduction of multiple later layers of varnish in a four-step process with solvent blends based on Keck #2, Pomerantz #3, #4, and Rabin #2, initially creating several levels of cleaning. Condition anomalies, such as a tenacious layer and dirt in a craquelure, were dealt with separately. Losses were filled and inpainted to a level that resulted in a legible decorated surface and a coherent set, without concealing the wear and age of the chairs.

TITRE—L'examen et le traitement d'un ensemble de chaises 'klismos' attribué à John et Hugh Finlay. RÉSUMÉ—Cet article décrit l'examen et le traitement d'un ensemble de quatre chaises 'klismos', attribué à John et à Hugh Finlay de Baltimore, au Maryland (1815–1825), qui font partie de la collection du *Metropolitan Museum of Art* (musée d'art métropolitain) à New York. Les radiographies, les schémas détaillés de la construction et les comparaisons entre les quatre chaises indiqueraient une organisation peu commune du travail entre les ébénistes, les peintres, et les vanniers dans les ateliers Finlay. L'analyse des couches de peintures a permis l'élaboration d'un traitement et la compréhension des couches décoratives, en particulier une préparation bleue énigmatique et la peinture sur la vannerie. L'analyse par spectrométrie IR à transformée de Fourier (IRTF), par spectrométrie Raman, et par microscopie électronique à balayage couplée à la diffraction des rayons X (SEM-EDX) a indiqué l'utilisation des colorants tels que le jaune de chrome, le blanc de plomb, le bleu de Prusse et l'hématite. Le traitement s'est concentré sur la réduction sélective de multiple couches de vernis par un processus à quatre phases utilisant des mélanges de solvants basés sur Keck #2, Pomerantz #3, #4, et Rabin #2, avec le but initial de réaliser différents niveaux du nettoyage. Les anomalies, telle qu'une couche tenace et la saleté dans la craquelure, ont été traitées séparément. Les pertes ont été comblées jusqu'à un niveau qui rendait lisible la surface décorative et reliait logiquement l'ensemble, sans toutefois dissimuler les traces d'usage et l'âge des chaises.

TITULO—Examen y tratamiento de un juego de sillas "klismos" atribuidas a John y Hugh Finlay RESUMEN—Este trabajo describe el examen y tratamiento de un juego de cuatro sillas auxiliares "klismos", atribuidas a John y Hugh Finlay de Baltimore, Maryland (1815–1825), que están en la colección del *Metropolitan Museum of Art* (Museo metropolitano de arte) de Nueva York. Radiografías y dibujos detallados de la construcción y una comparación entre las cuatro sillas indicó una coordinación de trabajo entre los ebanistas, pintores y tejedores de la esterilla dentro del taller Finlay. El análisis de corte transverso estratificado contribuyó a diseñar el tratamiento y a entender una capa azul intrigante y la pintura de las sillas decoradas con esterilla. El análisis con espectroscopía de infrarrojos por transformada de Fourier, espectrografía Raman, y espectrometría dispersiva de Rayos X y microscopio electrónico de barrido, indico la utilización de pigmentos tales como amarillo de cromo, blanco de plomo, azul de Prusia y hematita. El tratamiento consistió en la reducción selectiva de múltiples capas de barniz en un proceso de cuatro pasos con mezclas de solventes con base en Keck #2, Pomerantz #3, #4, y Rabin #2, creando inicialmente varios niveles de limpieza. Algunas anomalías de la condición de los objetos, tales como una capa muy difícil de remover y la suciedad dentro del craquelado, se manejaron en forma separada. Las perdidas fueron llenadas y pintadas hasta el punto de que fuera legible la superficie decorada, y hubiera coherencia dentro del juego, sin ocultar el uso y la edad de las sillas.

TÍTULO—Exame e tratamento de conjunto de cadeiras estilo klismos, atribuídas a John e Hugh Finlay RESUMO—Este artigo descreve o exame e o tratamento de um conjunto de quatro cadeiras sem braço estilo klismos atribuídas a John e Hugh Finlay de Baltimore, MD (1815–1825), as quais pertentem à coleção do *Metropolitan Museum of Art* (Museu Metropolitanto de Arte) de Nova Iorque. Radiografias, desenhos detalhados da construção e comparações entre as quatro cadeiras indicaram uma coordenação incomum entre os artesãos, os pintores e os empalhadores na loja dos Finlay.

A análise estratificada transversal ajudou na definição do tratamento e compreensão da decoração, incluindo uma intrigante camada básica de azul e assentos de palhinha pintados. Análises com FTIR, espectrometria Raman e SEM-EDS indicaram o uso de pigmentos como amarelo cromo, branco-de-chumbo, azul da Prússia e hematite.

O tratamento concentrou-se na redução seletiva de múltiplas camadas recentes de verniz, em um processo de quatro etapas, utilizando uma mistura de solventes à base de Keck #2, Pomerantz #3, #4, e Rabin #2, inicialmente criando vários níveis de limpeza. Anomalias encontradas, tais como uma camada persistente e sujeira em fissuras de *craquelé,* foram tratadas separadamente. As perdas foram preenchidas e pintadas de tal forma que resultaram em uma superfície decorada legível e em um conjunto coerente, sem ocultar o uso e a idade das cadeiras.

1. INTRODUCTION

The American Wing in the Metropolitan Museum of Art in New York is currently undergoing major renovation and rearrangement of its period rooms and galleries. The late neoclassical galleries were the first to reopen at the end of November, 2006. Four painted Baltimore klismos chairs, attributed to John and Hugh Finlay, were part of the new exhibition plan and required surface treatment. The museum's department of American decorative arts initially purchased nine of eleven known chairs of this set with funds from the Mrs. Paul Moore Gift in 1965 (accession numbers 65.167.1 thru 65.167.9). The Metropolitan Museum of Art currently owns four chairs, referred to in this paper as #5, #6, #8, and #9 (65.167.5, −6, −8, and −9) (table 1). Between 1974 and 1994, five chairs were deaccessioned to other American museums and collections in exchange for objects to complement the museum's collection. The participating institutions were the Baltimore Museum of Art (65.167.2&4), the Munson-Williams-Proctor Institute Museum in Utica, NY (65.167.3), the High Museum in Atlanta, GA (65.167.7), and the Kaufman Americana Foundation (65.167.1).

The treatment and examination of the Kaufman chair (65.167.1) has been published previously (Fodera et al. 1997). This paper aims to complement the information given there, and to present new information on construction of the Metropolitan's chairs, based on examination and comparison of joinery, toolmarks, and dimensions. Extensive comparison between the four available chairs indicated a very structured approach to the assembly of the wooden frame and the

Table 1. Condition, Analyses, and Treatment

Chair	Accession number	Condition	Samples (Treatment Stage*)	Analysis (see table 3)	Varnish reduction	Resaturation, inpainting, finish
#5	65.167.5	▪ paint loss: 40% top of seat, 15% tablet, 5% front seat rail, 1% other surfaces ▪ 2-3 later layers of varnish ▪ at least two later caned seats	2 cross sections (2 BT)	---	1. Pomerantz #3B	Same on all chairs:
#6	65.167.6	▪ paint loss: 20% top of seat, 10% tablet, 25% front seat rail, 1% other surfaces ▪ 2-3 later layers of varnish ▪ stubborn layer on tablet and front seat rail ▪ at least two later caned seats	8 cross sections (4 BT, 1 DT, 3 AT)	FTIR analysis of remaining varnish layer after removing stubborn layer	1. Pomerantz #3B 2. 4% ammonium hydroxide solution on stubborn layer	1. Resaturation: 15% Paraloid B-72 in Cyclosol 53 2. Filling with modostuc
#8	65.167.8	▪ paint loss: 1% throughout ▪ 3-5 later layers of varnish ▪ distinctly darker than any of the other chairs ▪ severe craquelure in the finish of the tablet ▪ at least one later caned seat	5 cross sections (4 BT, 1 AT)	---	1. Pomerantz #3B, including dark varnish 2. mechanical removal of dirt of craquelure from gilding	3. Inpainting: gouache and watercolors in acrylic medium
#9	65.167.9	▪ paint loss: 2% front corners, 5% gilding of tablet ▪ 1-5 later layers of varnish ▪ at least two later caned seats	17 cross sections (15 BT, 2 AT) 5 swabs with varnish (DT)	FTIR, Raman, SEM-EDS of pigments and varnishes	1. Keck #2 2. Pomerantz #4B 3. Pomerantz #4B and Rabin #2 (1:1 mixture) 4. Rabin #2	4. Finish layer: Regalrez 1126 in Solvent 340

*BT: before treatment; DT: during treatment; AT: after treatment painted decoration. Minor differences in dimensions and shapes of the wooden elements or the decoration could be ascribed to handwork or dimensional changes of the wood. Examination of the decoration, and stratification of original and later materials, and analyses of pigments and binding media were compared to the stratification and analysis of the Kaufman chair (65.167.1), and indicated a similar build-up of the ground layers on all chairs. The number of cross sections and analysis of pigments was insufficient to draw conclusions for the ornamentation.

1.1 BALTIMORE PAINTED FURNITURE AND THE FINLAY BROTHERS

Maryland Grecian or Empire furniture is characterized by an emphasis on bold ornamentation, contrasting colors of wood, and the love for painted decoration. Baltimore, one of the largest cities in the nation at the time, had its own distinct furniture forms and decoration schemes (Elder 1972; Hastings and Bigelow 1998). Baltimore fancy or painted furniture was very popular and demanded prices similar to those of contemporary mahogany furniture (Hastings and Bigelow 1998). This trend has been ascribed to the influence of individuals such as the architect Benjamin Henry Latrobe, as well as wealthy patrons and leaders in Baltimore itself (Weidman et al. 1993).

Some of the most sophisticated late neoclassical furniture in Maryland is documented to have been produced by the firm of John and Hugh Finlay of Baltimore. Many attributions, such as for this set of chairs, have followed, based largely on stylistic comparison and to a lesser extent on material evidence. Results reported in this paper will add to the available material information.

John, the older of the two brothers, started the firm in 1799 as a coach painter, and by 1803, he advertised the firm together with his brother Hugh. They soon had important commissions for sets of seating furniture for President James Madison and rich merchants such as Alexander Brown and James Wilson. After 1816, Hugh operated the firm by himself, employing 68 people (men, women, and boys) including chair makers, coach, and sign painters (Maryland Historical Society 1984). Upon Hugh's death in 1830, John returned to the business until it closed in the late 1830s, possibly because of changing tastes.

1.2 THE SET OF CHAIRS

The set has been described as the finest of all Baltimore painted chairs in the late neoclassical style. The chairs are commonly thought to be part of a set of eleven or twelve that descended through the Arunah Shepherdson Abell family of Baltimore. Since A. S. Abell, the founder of the *Baltimore Sun*, did not come to Baltimore until 1837, the set of chairs may have been originally owned by Charles and Mary Ann Carroll of the Greek Revival house Litterluna in Baltimore County. Their granddaughter was married to a member of the Abell family (Weidman et al. 1993).

The chairs are of the klismos form, meaning a neoclassical design featuring saber rear legs, turned front legs (instead of more archaeologically correct saber legs), and a curved protruding crest rail or tablet. Two features common to the construction of Baltimore klismos chairs are not found in these chairs: turned rear stiles, and a rolled front seat rail (Weidman et al. 1993). All view surfaces of the chair are painted with neoclassical designs (fig. 1).

Being part of a set, the chairs are identical in construction, colors, decorative scheme, and original stratification. The only differences between the chairs are the central decoration of the tablets, and the damage and repairs linked to later treatments. The central decoration of the tablet depicts a different pair of mythological creatures on each chair: male and female standing sphinxes flanking an urn (chair #5), dragons flanking a shield (chair #6), lions with human heads flanking a caduceus (chair #8), and griffins flanking an urn (chair #9).

The overall background on the set of chairs is painted a bright yellow. Dark green ornaments with highlights in black, light green, and metal powder are applied in prominent areas, reminiscent of brass appliqués. Winged thunderbolts and crossed torches, such as are found on the side seat rails and stay rail of the chairs, are typical designs for Baltimore painted furniture. Ornaments were often based on French designs, for instance those of Percier and Fontaine, rather than English designs (Weidman et al. 1993). Simulated recessed panels in orange and red, and painted shadows behind the ornaments contribute to the trompe l'oeil effect of the painted decoration. Curiously, the shadows are painted at the front edge on the proper left side, suggesting light coming from behind, while they are painted at the rear edge on the proper right side,

Fig. 1. One of a set of klismos side chairs (65.167.8) in the collection of the Metropolitan Museum of Art, purchased with Mrs. Paul Moore Gift, 1965, attr. to the Finlay brothers, Baltimore, Md., 1815–1825, maple, paint, gilding, and caning, H 34 in. (86.4 cm), W 20 9/16 in. (52.2 cm), D 23 3/4 in. (60.3 cm), seat height: 16 1/2 in. (41.9 cm); before treatment. The chair is considerably darkened by later varnishes, and losses are liberally overpainted.

suggesting light coming from the front. The mythological beasts and floral scrolls on the tablets are executed in gold leaf on a dark green field. A frieze of griffins and scrolled acanthus leaves flanking a vase, such as on chair #9, is another ubiquitous motif of Baltimore painted furniture, and has been associated with Plate 56 of Thomas Sheraton's drawing book of 1793 (Sheraton 1972).

Brass pins under the rear seat rail presumably held in place a cushion, enhancing the comfort of the caned seat. Chairs made for the White House by the Finlay brothers and designed by the architect Benjamin Henry Latrobe in 1808, had similar attachments for loose cushions, according to Latrobe's drawings (Weidman et al. 1993). Perhaps one only used cushions in winter and sat on the caning in warmer months. Remnants of gilding or a "changing varnish" are present on some of the pins. A changing or colored varnish was often applied to make a baser metal such as brass look like gold (Thomson 1991), and can be difficult to distinguish by eye from real gold.

2. EXAMINATION

The assessment of the chairs started with a careful visual examination with and without ultraviolet illumination, followed by taking small samples of the painted decoration for cross sectional stratification analysis. In addition to the usual examination report, technical drawings made in Adobe Illustrator CS2 served to document the dimensions of all parts and joints (fig. 2). X-radiographs revealed the dimensions of joints, the location and orientation of nails and screws, as well as the orientation of the grain in the tablet and stay rail (fig. 3).

2.1 STRUCTURE, CANING, AND DECORATION

The description and conclusions drawn in this section represent all four chairs, unless otherwise noted.

The wood that is visible on the inside of the seat rails appears to be maple. Mortise-and-tenon joints (not pegged) connect all major structural elements, except for the tablet. All tenons are parallel to the grain direction of their structural element and have an upright orientation except for the rear seat rail, which has double horizontal tenons. A sliding dovetail, or a double rabbet, and two screws secure the tablet to each stile. Square plugs hide the location of the screws on the front of the tablet. The chair maker achieved the curve of the tablet by bending; the curved stay rail was cut from a straight piece, however.

Details such as scribe lines, the location and angle of drilled holes, impressions of the original caning in the paint, and drips of paint on the inside of seat rails were vital in determining the manner and sequence of assembling, painting, and caning the chairs. The sequence of assembling the chairs hinged on the physical evidence of the caned seat.

The holes of the caning are at an angle and form a straight line on the top of the seat rails. This strongly indicates that the holes were drilled from the top of

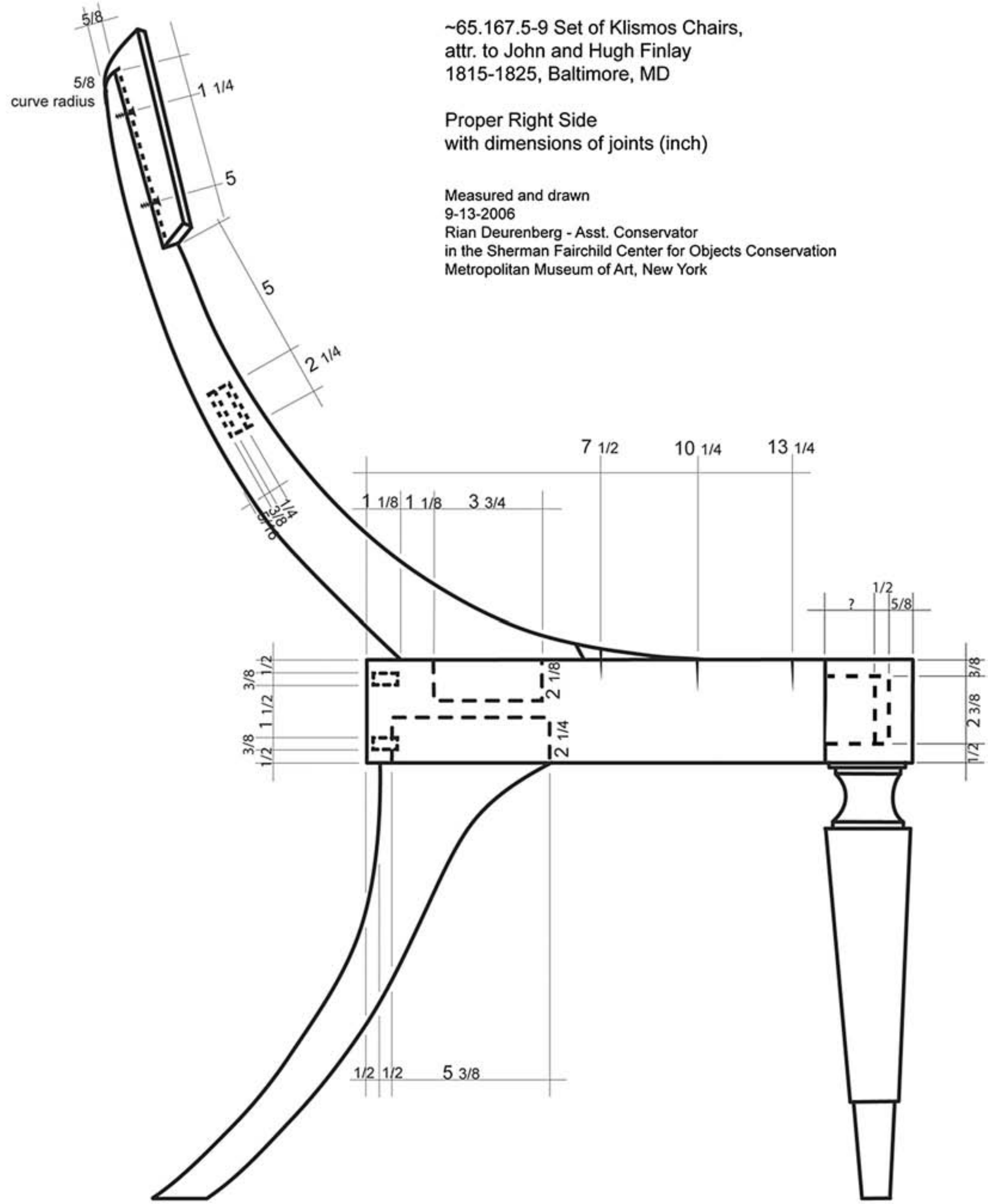

Fig. 2. Adobe Illustrator CS2 drawing with joints and dimensions of the proper right side of the klismos chairs. All chairs were identical as far as construction was concerned. Minor differences in dimensions and shapes of the wooden elements between the four chairs could be ascribed to the use of hand tools or dimensional changes of the wood. Note the mortise-and-tenon joints, with horizontal tenons on the rear seat rail; the sliding dovetail or double rabbet of the tablet secured with two screws.

Fig. 3. X-radiograph of the joints of the proper right seat rail with the rear stile and rear leg of klismos chair (65.167.9), the Metropolitan Museum of Art, purchased with Mrs. Paul Moore Gift. Almost the entire outline of both joints and some of the painted decoration can be discerned. The rough bottom of the mortises (a) and the tightness of the joints (b) indicate quality yet speed of the chair maker's work. The irregularly spaced paint drips on the inside of the seat rails (c) are evidence of once-painted caned seats. The evenly spaced holes for the caning (d) are slightly darker than the surrounding wood in this image.

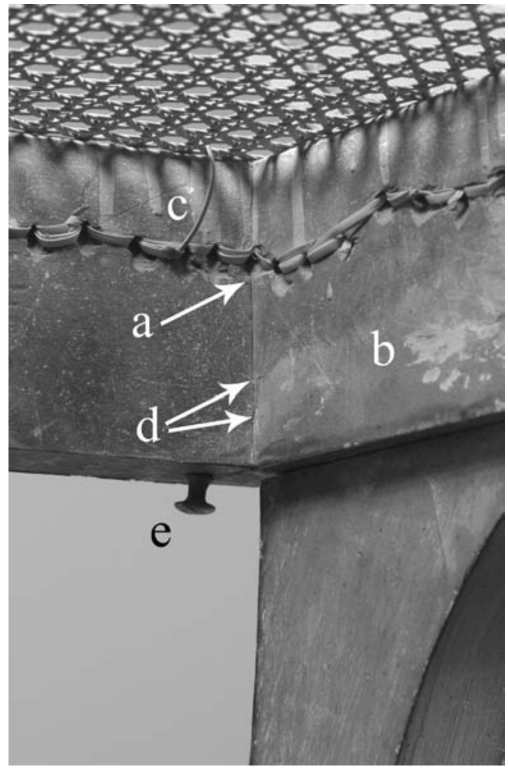

Fig. 4. Inside of the proper left rear corner of the seat of klismos chair (65.167.6), the Metropolitan Museum of Art, purchased with Mrs. Paul Moore Gift. Several clues to the sequence of assembling the chairs are contained in this small area, such as the holes for the caning that go through the joints (a), the splashes of paint on the inside of the seat rail around the rear leg (b), the drips from painting the caned seat (c), and the scribe lines for the horizontal tenons of the rear seat rail (d). One of the small brass knobs for holding the pillow in place is indicated with (e).

the seat rails down. The implication is that the top of the chair could not have been attached to the seat at this point. The fact that several of the holes are partly covered by the rear stiles confirms this premise. Since some of the holes cut through the joinery of the seat rails, the seat frame must have been assembled before drilling.

So far the evidence was straightforward and the chair had been assembled as one would expect. However, the caning had left a distinct mark in the original paint. A complete stratification of ground and yellow paint layers being present, at least the bottom half of the chair must have been painted before caning. One would assume that all woodworking (assembly and drilling holes) would be completed before painting and caning, to avoid shuffling the chair parts back and forth between chair makers, painters, and caners. The evidence indicates a different approach, however. The bottom half of the chair was assembled at the time of painting: there are large areas of excess paint on the inside and bottom of the seat rails around the legs, originating from painting the legs while they were attached to the frame (fig. 4). Paint in the corners of the joints of the rear stiles and stay rail indicates that the top of the chair was assembled as a unit when the painter applied ground layers and yellow paint. But the chair maker appears not to have joined the top part to the seat yet, because there is also paint underneath the rear stiles. Other indications are a clear-cut break of the paint at the joint of the rear stiles and seat rails, and the lack of paint splashes on the inside of the seat rails below the rear stiles, as was the case around the legs. The break in the paint may have occurred later as a function of the stress on the joints or as part of moisture-induced movement of the wood, considering that the grain direction runs vertically in the rear stile and horizontally in the seat rail, almost perpendicular to each other. Perhaps this unusual sequence was preferred to facilitate caning the seat, but it did involve a work schedule of partial assembly, painting, caning, and then final assembly.

In summary, the physical evidence suggested that: all parts were milled and shaped; the backrest was joined and glued separately from the seat and legs; the holes for the caning were drilled; the two halves of the chair were painted; the seat was caned; the two halves were adhered together.

2.2 PAINTED DECORATION

Using a stereomicroscope, the painted surfaces were examined and a total of 32 samples were obtained for cross sectional stratification analysis with a compound light microscope. The majority of samples (17) were taken from the first chair that was treated and examined (chair #9). This is significantly more than during the treatment of the Kaufman chair (65.167.1), when only two samples were taken (Fodera et al. 1997). The samples provided insight in the stratification of the various ornaments, the composition of later layers of varnish and original paint, and the results of the treatment. Samples of the other three chairs were taken to verify the results of UV examination and solvent testing of the later varnish layers.

Detailed analysis results are included in this paper for three samples from the painted decoration of chair #9 (#9-12, #9-14 and #9-17) (Wypyski 2006; Rizzo 2007). Results of current analysis with attenuated total reflectance-Fourier transform infrared microspectroscopy (ATR-FTIR), Raman spectroscopy, energy dispersive X-ray spectrometry in the scanning electron microscope (SEM-EDS) were compared with the analysis of pigments on the Kaufman chair (65.167.1), which were identified with SEM-EDS only (Fodera et al. 1997). During treatment, a sample of the remaining varnish layer on chair #6 was taken and analyzed as well. In addition, pyrolysis-gas chromatography mass spectrometry (Py-GC/MS) was performed on selected scrapings. Table 2 summarizes the FTIR, Raman, and SEM-EDS analysis results.

The following samples were chosen for their inclusion of various layers of the original painted decoration:

Sample #9-12: Proper right front leg, outside, winged thunderbolt ornament on top of yellow background (fig. 9)

Sample #9-14: Crest rail, proper left gilt scroll on green field on top of yellow background (fig. 5)

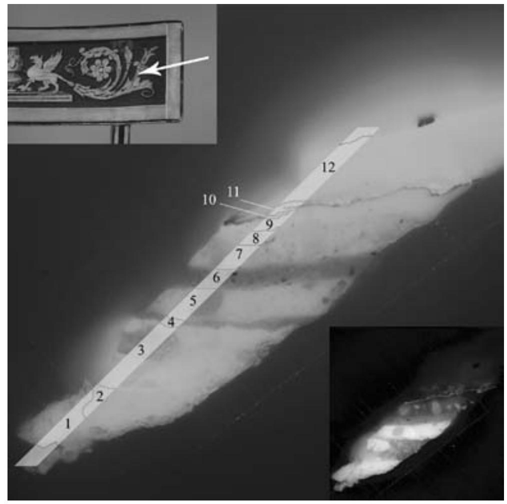

Fig. 5. Photomicrograph of cross section (sample #9-14, chair 65.167.9) from gilt decoration of tablet, with insert of sample location and insert of the same sample in visible light; UV illumination with UV-18 filter for excitation between 390–420 nm, 500×, showing the ground layers (layers 1–3), the yellow background (layer 4), the green field (layers 5–7), the gilt decoration (layers 8–10), and varnish layers (layers 11 and 12). Layer 1: blue ground; 2: white ground; 3: transparent white ground; 4: yellow background; 5: white ground; 6: blue paint; 7: green glaze; 8: mordant; 9: gilding; 10: red glaze of highlights; 11, 12: varnishes.

Sample #9-17: Inside of proper left rear leg, drip of yellow paint from caning holes on top of yellow background, after varnish reduction (fig. 6)

As already visible in areas of loss, the stratification of the painted decoration included a mysterious light blue ground on all four chairs, as well as the Munson-Williams-Proctor Institute Museum's chair (65.167.3) and the Kaufman chair (65.167.1). In some areas, a thin layer of white was present underneath the blue paint, presumably another ground layer. Current analysis on sample #9-17 (chair #9) identified the blue pigment in the layer as Prussian blue in a lead white matrix. The same blue pigment was found on the Kaufman chair (Fodera et al. 1997). ATR-FTIR suggested oil as a binder of the layer. It was one of the first layers of paint but it is unclear what its purpose was. Most likely, the painter applied the blue layer as a ground coat for a fashionable green or perhaps blue final layer of paint (Bristow 1996). For an unknown reason, the color scheme appears to have changed to a yellow background. Since there is no finish layer

Table 2. Analysis by Stratification Layer

Decorative Element	Stratification Layer	X-section #/ Sample*	(ATR-)FTIR Results	Raman Results	SEM-EDS Results	Interpretation
Finish layers	Later varnishes	Scrapings/ swabs, chairs #8, #9	Shellac (layer with light orange fluorescence) All others: unspecified resinous material**	---	---	Shellac (layer with light orange fluorescence) All others; unspecified resinous material
	Remaining varnish after removal stubborn layer	#6-05	Some saponification in the (probable) oil containing varnish layer; possible lead drier, chrome yellow	---		Also found in sample from before treatment, so uncertain if caused by ammonium hydroxide solution; lead drier and chrome yellow are probably contaminations from layer below
	Original varnish	#9-12, #9-17	Unspecified natural resin mixture	---	---	Natural resin varnish
Gilt decoration on tablet	Red highlight on gold	#9-14	---	---	Mostly iron, relatively large amount of lead	Probably hematite, and red or white lead
	Gold	#9-14	---	---	Gold alloy of approximately 22kt, with 6.5% silver and 0.4% copper	Gold alloy of approximately 22kt, with 6.5% silver and 0.4% copper
	Mordant	#9-14	Oil medium with lead-carboxylate peaks; traces of calcite, lead white, and Prussian blue	---	---	Oil medium with probable lead drier; traces of pigments probably picked up from layer below
Dark green field of tablet	Green glaze	#9-14	---	---	Small amounts of iron and chromium, large amount of lead	Prussian blue, chrome yellow, lead white
	Dark blue	#9-14	---	---	Small amounts of iron, large amount of lead and calcium	Prussian blue, lead white, calcium carbonate
	White ground	#9-14	---	---	Lead	Lead white
Winged thunderbolts	Highlights (black and light blue)	---	---	---	---	---
	Green and orange	#9-12	---	---	---	---
	Dark blue	#9-12	---	---	---	---
Yellow background	Yellow glaze	---	---	---	---	---
	Yellow	#9-12, #9-14, and #9-17	Chrome yellow (#9-12 and #9-17), oil (#9-12), lead drier (#9-12)	Chrome yellow (#9-12)	Almost entirely lead and chrome, few particles with lead (#9-14)	Chrome yellow in oil medium with lead drier; finely ground
Ground layers	Transparent white ground	#9-14, #9-17	---	---	Large amount of lead, smaller amount of calcium, lower concentration of pigment	Lead white and calcium carbonate, lower concentration of pigment
	White ground	#9-14, #9-17	---	---	Large amount of lead, smaller amount of calcium	Lead white and calcium carbonate
	Blue ground	#9-17	Prussian blue, lead white, oil	Lead white, Prussian blue	Lead, larger particles contain iron	Prussian blue, lead white in oil medium
	White/ transparent grounds under blue ground	---	---	---	---	---
Miscellaneous	Yellow paint of caning holes	#9-17	Chrome yellow, oil medium	Lead white, chrome yellow	---	Lead white, chrome yellow in an oil medium; coarsely ground
	Black overpaint, over outlines	#9-12, scraping	Ivory black, silicates, probably oil	---	---	Ivory black, silicates, probable oil medium

* Sample #9-12 is depicted in fig. 9, sample #9-14 in fig. 5, and sample #9-17 in fig. 6

** Additional pyrolysis-gas chromatography mass spectrometry (Py-GC/MS) of selected swabs confirmed greater presence of shellac in the orange fluorescent varnish and components of oxidized conifer resin, oil, and beeswax in all extracts, some of which were probably contaminations.

(glaze, varnish, other paint) or dirt on top of the blue paint, it does not appear to ever have been the finished decoration. Using the blue paint purposely as a ground layer would have been a waste of pigment, especially considering the need for two more layers of white paint to hide it underneath the yellow paint. Since the chairs have a fairly unique design and are of extraordinary quality, it seems less likely that the chairs were built and painted "on spec," waiting for the right customer; it is possible that the chairs were originally intended for another customer who never completed the order.

Identification by SEM-EDS indicated that the pigment in both white ground layers was almost entirely lead white with some calcium carbonate. The top layer appeared to contain a little yellow pigment in some samples and generally had a much lower pigment concentration than the bottom layer. Some cross sections of chairs #6 and #8 indicated multiple layers of the first white ground. Perhaps they were applied as the painter saw fit to cover the blue paint, or it could indicate multiple painters working on the chairs. The analyses of the white and blue ground layers were congruent with the Kaufman chair (65.167.1), although

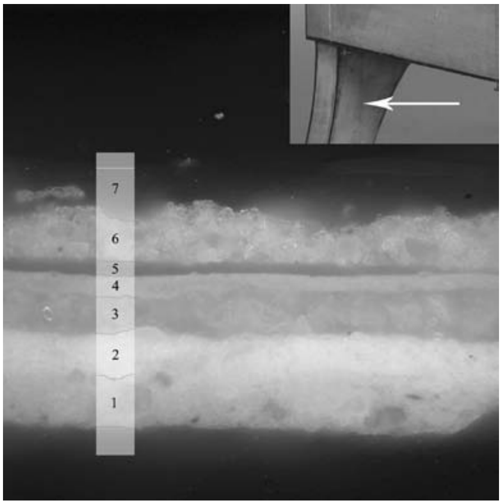

Fig. 6. Photomicrograph of cross section (sample #9-17 of chair 65.167.9) from paint dripped on the inside of the rear legs as a result of painting the caned seat, with insert of sample location; visible light, 500×, showing the ground layers (layers 1–3), the yellow background (layer 4), the original varnish (layer 5), yellow paint drips of once-painted caned seats (layer 6), and later varnish layers that are indistinguishable in visible light (layer 7). Layer 1: blue ground; 2: white ground; 3: transparent white ground; 4: yellow background; 5: original varnish; 6: yellow paint drips; 7: later varnish layers.

glaze layers between the layers were then found as well (Fodera et al. 1997). These glaze layers were only present in one or two samples of the Kaufman chair, while twelve samples of the four chairs at the Metropolitan Museum do not show these layers. Therefore, the glazes probably have an anomalous origin, such as a later varnish layer that penetrated the separating ground layers.

FTIR and Raman spectroscopy on all three samples (#9-12, 9-14, 9-17) characterized the pigment in the yellow background as chrome yellow ($PbCrO_4$). FTIR showed oil as the binder of the layer, with a probable addition of a lead drier. SEM-EDS confirmed that the main components in the yellow pigment were chromium and lead, consistent with the identification of chrome yellow. A few other particles in the layer also consisted mainly of lead, and possibly are remnants of the lead drier. SEM-EDS analysis on the Kaufman chair (65.167.1) indicated chrome yellow for the yellow pigment as well (Fodera et al. 1997). Except for chair #9, all four chairs showed a yellow glaze layer on top of the yellow background, which was not further analyzed. It is unclear why chair #9 did not have this glaze layer.

The chairs are an early example of the use of chrome yellow on decorative painted objects. Perhaps the discovery of the new pigment triggered the change in color scheme on the chairs. Although the mineral crocoite had been discovered in 1770 and its composition of lead chromate, $PbCrO_4$, had been established in 1797, it was first mentioned as a pigment by Vauquelin only in 1809 (Newman and Farrell 1994). The pigment was generally thought to have been commercially available starting around 1818–1820, but recent research indicates an earlier date. One of the earliest documents of the availability of this pigment in Baltimore is a mention in the *Federal Republican & Commercial Gazette* of March 23, 1812, three to seven years before the presumed date of manufacture of the chairs (Fodera et al. 1997).

Multiple layers of another yellow paint were gathered in the holes of the caning and many large yellow paint drips on the inside of the seat rails remained as the only evidence of a possible painting of the caned seat, since all seats were previously replaced. In a cross section, these yellow paint drips were located on top of the original varnish and below a later varnish. This is consistent with the findings that the caning was applied after the chairs were painted, and does not imply that the seats were not painted originally. In both paints (yellow background of the decoration and yellow paint of caning holes), analysis indicated the use of chrome yellow pigment in an oil medium. However, the chrome yellow pigment of the caning holes was more coarsely ground and mixed with lead white, according to FTIR and Raman spectroscopy (fig. 6). All evidence pointed to the paint of the caning holes and thus to the paint of the caning being early, if not original. There was no conclusive evidence that the paint of the caning was of a later date. This could indicate that the caned seat was originally painted yellow or light yellow.

Gilt scrolls and mythological beasts, the latter different on each chair, adorn a dark green field in the center of the tablet. ATR-FTIR suggested that the greenish translucent layer below the gilding is an oil size containing lead-carboxylate peaks, which may derive from the use of a drier and from some lead white. It appeared that during the application of the size, lead white particles, as well as traces of calcite and Prussian blue, were picked up from the layer below before it had dried, giving the mordant a greenish tone. With

SEM-EDS, the gilding was found to be a gold alloy of approximately 22 kt, with 6.5% silver and 0.4% copper. The red and orange highlights on the gilding consisted mostly of iron, probably in the form of hematite, along with a relatively large amount of lead, possibly present as red lead or lead white pigment, as indicated by SEM-EDS. Analysis of this layer on the Kaufman chair (65.167.1) pointed to iron earth pigments (which contain hematite), associated mineral impurities such as calcium carbonate, and a trace of Prussian blue (Fodera et al. 1997).

The dark green field of the tablet is possibly a "verte antique" rendering, a predominant treatment of painted ornaments on pieces attributed to the Finlay shop (Weidman et al. 1993). In this technique, glazes and gold or bronze powders are applied on top of multiple layers of green and black paint to achieve depth of color and the illusion of corroded copper (Mussey 1998). The dark green field of the tablet of chair #9 appeared to have a more straightforward stratification of a white ground layer, followed by a blue paint layer and green glaze, all on top of the yellow background (fig. 5). In a cross section from the tablet of chair #6, the green glaze appeared to be on a thin grey-blue layer, directly on a light yellow ground layer, without the yellow background, white ground, or blue paint layer. The blue layer of chair #9 appeared to be mostly Prussian blue mixed with lead white and calcium carbonate, while the green glaze appeared to contain Prussian blue, lead white, and chrome yellow, based on finding iron, lead, chromium, and calcium in the pigments of these layers with SEM-EDS. Analysis of the green field of the Kaufman chair (65.167.1) indicated Prussian blue and an unidentified pale yellow, possibly litharge (Fodera et al. 1997), and does not specify multiple layers. Litharge was not found in present analyses; perhaps the yellow pigment in the layer sampled from the Kaufman chair was contaminated by lead white or lead driers, leading the pigment identification to the possibility of litharge, which is composed of lead monoxide. The white ground layer for the green field (on top of the yellow background) appeared to be composed of lead white.

The stratification of the green ornaments (outlines, sabots, winged thunderbolts, fasces on front seat rail, and field of the tablet) showed different layers of green and blue tones. Presently the tones of all ornaments are very similar, but they may have had subtle differences originally. The size of the Finlays' shop makes it possible that the decoration was divided by the skill level or specialty of the painter. The decoration of the chairs would certainly lend themselves to such a division, but the physical evidence can presently only lead to speculations on this matter.

Most of the painted ornamentation appeared to be freehand, including the gilt mythological beasts and floral scrolls of the tablets. Since the designs of the scrolls matched very closely, it is likely that the painter transferred the design from a pricked pattern. The other ornaments varied more widely in dimension and layout and were possibly entirely freehand, except for a general mark of the location. Further research is needed to indicate whether both types of ornamentation (freehand and patterns) were the work of one or more painters or painting divisions in the workshop.

All pigments are contemporary with the attribution of the chairs. The original varnish appeared to be a natural resin varnish mixture, possibly with oil, according to analysis by ATR-FTIR. Shellac was also found in this layer, but is probably a contamination from a later varnish layer.

3. TREATMENT HISTORY AND CONDITION

All chairs had the same types of damage, but the extent of each type varied from chair to chair. Present damage ranged from liberally overpainted paint losses, to multiple layers of obscuring overvarnish, substantial wear, and damage from replacing the caned seats.

3.1 CONDITION OF ORIGINAL MATERIALS

Structurally the chairs were all in good condition: some parts were slightly misaligned but the joinery was secure and stable. The paint was securely attached to the surface, but had suffered losses in paint and ground layers, abrasions, dents, and liberal overpainting. Chairs #5 and #6 had the largest amount of paint loss, especially along the edges of the front of the seat and the tablet, ranging between 1–40% of a given surface, while the other chairs had only 1% loss (table 1). At least 95% of the paint losses were inpainted during previous treatments.

EXAMINATION AND TREATMENT OF A SET OF KLISMOS CHAIRS, ATTR. TO JOHN AND HUGH FINLAY

3.2 PREVIOUS SURFACE TREATMENTS

In the three years following the acquisition, the Metropolitan Museum of Art sent out all nine chairs for surface treatment in two groups. The first treatment report dated from December 13, 1967, and recorded that a contract conservator treated chairs 65.167.4-7 and 9. The same contract conservator treated a second group of chairs (65.167.1-3, 8) similarly in July 1968. The treatment reports stated, "Shiny varnish cut with powdered pumice, lost gesso areas refilled with gesso. Lost painting & scuffmarks painted in with Liquitex. Coated with shellac. All chairs given coat of Oz cream polish. New cane seats antiqued with oil color in methacrylate." (Anonymous 1967; Anonymous 1968).

However, this was certainly not the first time the chairs were refinished. As many as five later layers of varnish were present in some cross sections of chairs #8 and #9 (fig. 7). Casual application of the later varnishes had sometimes resulted in large, disfiguring drips. A number of areas, such as the rear and inside of the legs, had evidently received less attention and had only one or two later layers of varnish. The varnishes had different colors of fluorescence, suggesting various compositions. This was confirmed to some extent by scientific analysis.

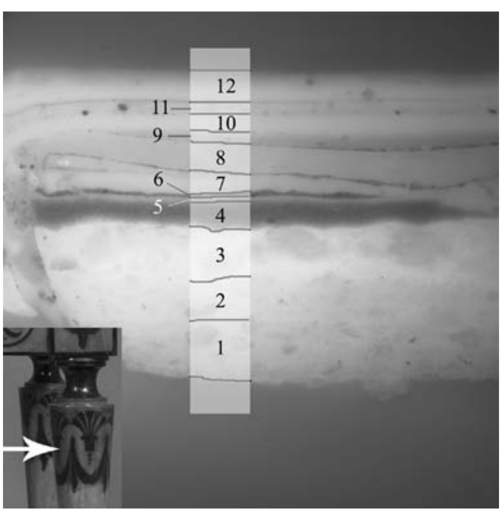

Fig. 7. Photomicrograph of cross section (sample #8-04, chair 65.167.8) with yellow background and later layers of varnish, with insert of sample location; UV light with UV-18 filter for excitation between 390–420 nm, 500×; showing the ground layers (layers 1–3), the original decorative and varnish layers (layers 4–7), and four later varnish layers (layers 8–12). Layer 1: blue ground; 2: white ground; 3: transparent white ground; 4: yellow background; 5: original varnish; 6: red glaze of decoration; 7: original varnish (two layers); 8–12: later varnishes.

Otherwise similar to the other chairs, Chair #8 was distinctly darker than any of the others and had a severe craquelure in the finish of the tablet. Chair #8 appeared to be the only chair of the nine that had this craquelure, according to black-and-white pictures of the chairs taken at the Metropolitan Museum in early 1966, before the chairs were sent out for treatment of the finish. The craquelure was then already present as alligatoring. A short note on the 1968 treatment record states that "chairs 1, 2, 3, 8 (were) first restored by . . . " (Anonymous 1968), raising the question of whether the craquelure could be the result of that previous treatment. However, upon chance examinations, it was observed that two of the three other chairs in this group, the Kaufman chair (65.167.1) and the Munson-Williams-Proctor Institute Museum chair (65.167.3), did not appear to have the severe craquelure, making it less likely that the craquelure seen on chair #8 was a result of the earlier restoration treatment referenced in 1968.

Attempts were made to identify later and original varnish layers on chairs #6, #8, and #9 through analysis with ATR-FTIR and Py-GC/MS. Analyses were performed on three microscopic scrapings, four of the best cross sections, and five swabs used for varnish removal. The samples included the original varnish layers, a stubborn layer of chair #6, the dark layer of chair #8, and the various later varnish layers on chair #9. ATR-FTIR analysis on cross sections indicated unspecified natural resin mixtures in the later varnishes and more specifically shellac in the varnish with orange fluorescence. Additional Py-GC/MS of selected swabs confirmed greater presence of shellac in the orange fluorescent varnish and components of oxidized conifer resin, oil, and beeswax in all extracts, some of which are probably contaminations. Without more exact means to identify the layers it is not possible to compare the stratification of the overvarnish campaigns on the chairs.

Previous inpainting of losses was often poor in both craftsmanship and color, obscuring the original painted decoration and often easily discernable with the unaided eye. For instance, the corners of the seat were completely overpainted, while the damage to the outlines and the painted ornament underneath (already overpainted, yet in acceptable condition) was relatively minor. All of the outlines, as well as the sabots and concave parts of turned front legs, had been repainted with a thick black paint to hide the wear on the edges. The inpainting materials fluoresced almost black under UV illumination in comparison to the surrounding paint and varnishes. In cross sections, the inpaint was often the top or second layer in the stratification, being from a relatively recent treatment. Apart from some of the black overpaint, previous inpainting materials were not analyzed. Scrapings of the black overpaint were analyzed by FTIR and Py-GC/ MS and in cross section #9-12 (chair #9), indicating a mixture of ivory black, silicates and drying oil. The presence of conifer resin and shellac components could not clearly be attributed to this or another layer.

3.3 CANED SEATS

None of the chairs retains its original caned seat. A commercial company recaned all chairs, except for chair #8, in January 1967. Black-and-white photographs taken at the Metropolitan Museum of Art in 1965 and 1966 showed broken seats on most chairs, but the caning on chair #8 was in good condition at that time. The photographs also showed that the insides of the rear stiles of chair #8 were already damaged, presumably from drilling out the pegs to remove the old caning. This suggests that the caning present at that time was already a replacement. The chairs received new cushions on several occasions between April 1966 and July 1972.

4. TREATMENT OF THE SET OF FOUR CHAIRS

The treatment goal was to reduce the thickness and darkness of the later varnishes, remove the disfiguring inpainting, make the appearance of the set more coherent, and be sympathetic to age and wear. To keep the project more manageable, the chairs were treated one at a time. Chair #9 appeared to be in the best condition and was treated first. The approach was similar for all chairs, but specific problems required minor modifications of the treatment.

4.1 TREATMENT DESIGN, MATERIALS, AND APPLICATION

The layers being largely unidentified, treatment relied on solvent testing. Several differences between the current set of four chairs and the Kaufman chair (65.167.1) made it necessary to approach the treatment another way. Firstly, chair #9 had three more layers of overvarnish than the Kaufman chair (Fodera et al. 1997). Secondly, chair #9 did not appear to have the stubborn layer that was the main struggle in the treatment of the Kaufman chair. Even though chair #6 did appear to have the stubborn layer, the treatment used on the Kaufman chair (xylene, followed by a 7 and 14% ammonium hydroxide Carbopol 940 gel) proved to be unsuitable, since it also removed the original varnish.

Therefore a new treatment was designed. Many small spot tests aided in determining the solubility of all layers involved, later as well as original. Solvents such as Stoddard solvent, cyclosol 53, ethanol, acetone, and mixtures of them were used for the spot tests. Use of a Teas chart was helpful for visualizing the solubility range of the layers as well as the relation between different solvent blends. The software program "Solvent Solver: A Calculator for Working with Teas Fractional Solubility Parameters" facilitated calculating solvent blends for testing (Ormsby 2006). Using the program, it was easy to find a solvent blend at a particular spot on the Teas chart or design a solvent blend with similar Teas solubility parameters as traditional solvent blends, but with solvents that were less toxic, aggressive, or volatile. For example, traditional Pomerantz #4, containing acetone 25%, Shellsol 25%, Cellosolve 50%, was replaced with a new blend named Pomerantz #4B, containing acetone 35%, ethanol 20%, and Stoddard solvent 45%.

In practice, four stages of varnish reduction could be distinguished during the solvent tests on chair #9, although some cross sections showed as many as five later varnish layers. The four stages were linked to varnish layers by their fluorescence color in UV. Colored areas were marked on a Teas Chart to roughly represent the solubility data obtained for each of the stages: from the first and bottommost later varnish (UV light blue), the second (UV dark orange), to the third (UV light orange), and the fourth and topmost layer (UV yellow) (fig. 8). The dark orange and light blue fluorescing layers had overlapping solubilities in the smallest triangular area between solvents 18, 13,

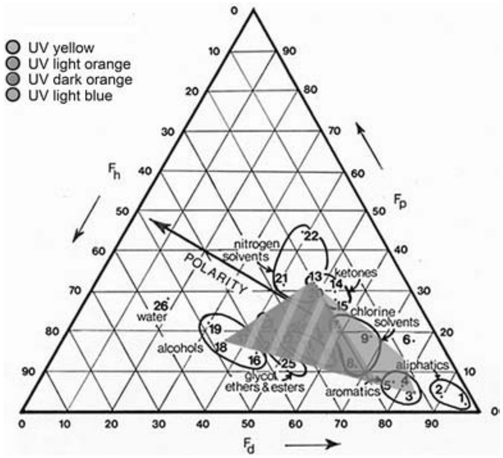

Fig. 8. Teas diagram with colored areas indicating the solubility of the various layers of varnish, from the topmost later varnish (UV yellow) to the bottommost later varnish (UV light blue). The solubility of the later varnishes became gradually more polar as the layers increased in age. This is indicated by the dark orange and light blue hatched area on the left side of the diagram, whereas the yellow area covered the complete trapezium-shaped areas. The hatched area represents the lower two layers (UV dark orange and UV light blue), which had overlapping solubilities, the yellow area represents the topmost varnish layer. The original Teas chart used for this image was published in 'Solvent Abuse: Some observations on the safe use of solvents in the cleaning of painted and decorated surfaces,' by Alan Phenix, in The Building Conservation Directory, London: Cathedral Communications, 1997. Courtesy Alan Phenix.

and 8 (acetone, ethanol, and a solvent blend equivalent to chloroform) or F_d 35–65, F_p 9–32, F_h 20–46; the light orange fluorescing layer completely overlapped the previous solubility area and covered the triangular area between solvents 18, 13, and 5 (acetone, ethanol, and the equivalent to benzene) or F_d 35–75, F_p 7–32, F_h 20–46; and the yellow fluorescing top layer completely overlapped both previous solubility areas and covered the largest area of solubility, more or less trapezium-shaped, between solvents 18, 13, and 3 (ethanol, acetone, and xylene) or solubility parameters F_d 35–85, F_p 5–32, F_h 10–46. The equivalents to benzene and chloroform were solvent blends of acetone, ethanol, and mineral spirits calculated to have the same solubility parameters as these solvents. As an aside, the number of solvent tests executed on the varnishes of the chairs was not sufficient to confirm the premise that swelling regions do not necessarily form a continuous area on the Teas Chart (Phenix 2002).

Thus, the older the varnish layers were, the smaller the area of solubility and the more polar the solvents needed to dissolve the layer. Conversely, all layers dissolved with solvents from the dark orange and light blue hatched triangular area, but only the top layer was soluble in solvents from the entire trapezium-shaped area. It is possible that this difference was caused not only by a difference in materials but also by light degradation and oxidation.

To remove one layer safely from another with solvents, the solubility parameters of the layers needed to be different. The Teas chart was used to determine the appropriate solvent or solvent blend by its location on the chart where the solubilities of the two layers did not overlap. The area where two subsequent layers did not overlap was fairly large between the two topmost layers (UV yellow and UV light orange), but much smaller between the next two layers (UV light orange and UV dark orange). Because the earlier varnishes had a much smaller area where the solubility parameters did not overlap, removal of these varnishes was more problematic. The blends had to be mixed quite precisely to selectively dissolve the varnishes, and certain application techniques offered additional control.

The application technique, such as cotton swabs, gels, or poultices, provided optimal control for each treatment stage. Solvent gels had been used during the Kaufman chair treatment (Fodera et al. 1997), but in our experience, seemed fairly aggressive and surprisingly hard to control, even at short exposure times, as the effect was not directly visible, the gels tended to flow, and the varnish layers that were to be removed were of varying thickness. The addition of a detergent in the gel or solvent solution did not appear to increase its efficacy. The following gels were tried: acetone gel (25 ml acetone, 5.0 g Laponite RD, 52.5 ml deionized water), ethanol gel (50 ml ethanol, 10 g Laponite RD, 150 ml deionized water), ethanol/xylene solvent gel (20 ml ethanol, 80 ml xylene, 20 ml Ethomeen C12, 2 g Carbopol, 1.5 ml deionized water), Pomerantz #4B gel (35 ml acetone, 20 ml ethanol, 45 ml Stoddard solvent, 20 ml Ethomeen C25, 2 g Carbopol, 12.5 ml deionized water), and xylene gel (100 ml xylene, 20 ml Ethomeen C12, 2 g Carbopol, 1.5 ml deionized water).

For the first few layers, cotton or paper poultices under a Mylar polyester sheet provided the necessary contact time between the solvent and the surface. During the later stages, the application of solvent blends proceeded with hand-rolled swabs. This technique allowed for a quicker evaporation of the solvents, enabling a more specific reduction of the layers. Even though poultices have their limitations regarding visibility, the benefit of using ungelled solvents is that they simply evaporate and do not leave a residue, which is sometimes problematic when using gels. For instance, the Pomerantz #4B gel removed the unwanted varnish well, but no solvent mixture could be found that dissolved the gel and could thus be used for rinsing the surface and ensuring all residue would be removed. Ungelled Pomerantz #4B gave the same varnish reduction result and was therefore preferred.

4.2 EXECUTION OF THE TREATMENT

4.2.1 Treatment on Chair #9

It was deemed most important not to overclean the surface and remove the original varnish and patina (Kenny 2005) (fig. 9). In fact, it was fairly easy to remove all layers of varnish and get a very bright painted surface, but the intention was not to make the chairs look "like new." With the wear present on the chair, a crisp decoration would not be appropriate. However, to achieve an appropriate level of clarity and because the majority of the discoloration and dirt was in the bottommost layers, it was finally decided to remove all but a skimmer of the first overvarnish on top of the original varnish (fig. 10). The overvarnish was left because its solubility parameters were very close to those of the original varnish and it therefore could not be removed safely. Because scientific analysis has shown that even so-called mild solvents, like the Stoddard solvent used in this treatment, can have a leaching effect on oil-based films, it also seemed prudent to leave some of the later layers as a barrier layer on top of the original materials (Sutherland 2003). Since almost all inpainting, being of a relatively late date, was contained within the removed layers of varnishes and was of a quality beneath current museum standards, it was sacrificially removed. Only the overpainting of the dark outlines was left behind, as it did not dissolve or swell in any of the solvent blends without damaging the original layers, and mechanical removal proved to be prohibitively labor intensive.

This approach left behind a surface with a suitable amount of wear and dirt, although new inpainting was required in many areas to unify the decoration on each

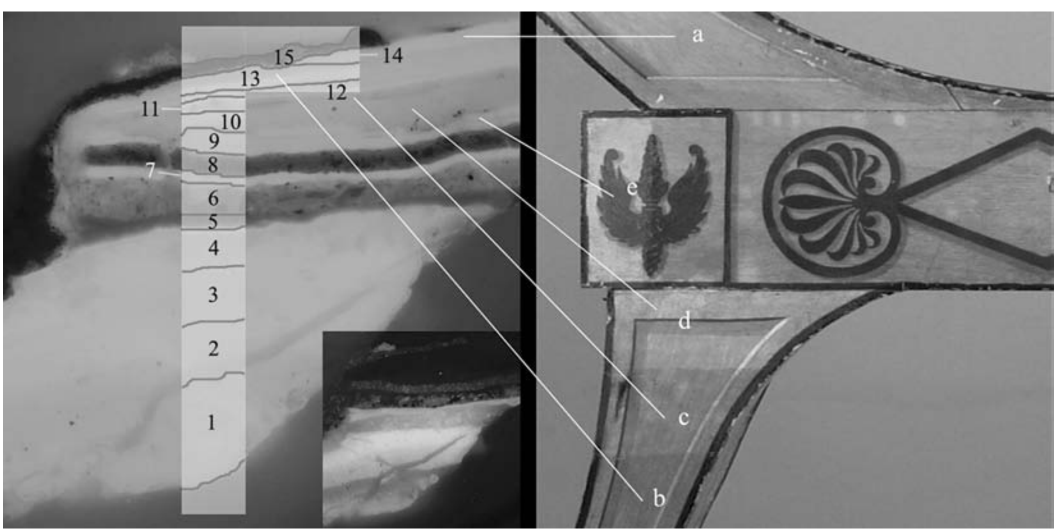

Fig. 9. Varnish reduction on the proper right seat rail of klismos chair (65.167.9), the Metropolitan Museum of Art, purchased with Mrs. Paul Moore Gift, with revealed layers linked to the layers in a cross section (sample #9-12) on the left and an insert of the same cross section in visible light. Four areas (b–e) show an increasing level of varnish removal from the bottom area on the leg (b) to the far left side of the seat rail (e), while the rear stile above the seat rail (a) still contains all later varnishes. Each area is linked to a layer in the cross section. UV illumination with UV-18 filter for excitation between 390–420 nm, 500×. Layer 1: white ground; 2: blue ground; 3: white ground; 4: transparent white ground; 5: yellow background; 6: blue paint; 7: original varnish; 8: green paint; 9: original varnish (three layers); 10–14: later varnishes; 15: black overpaint.

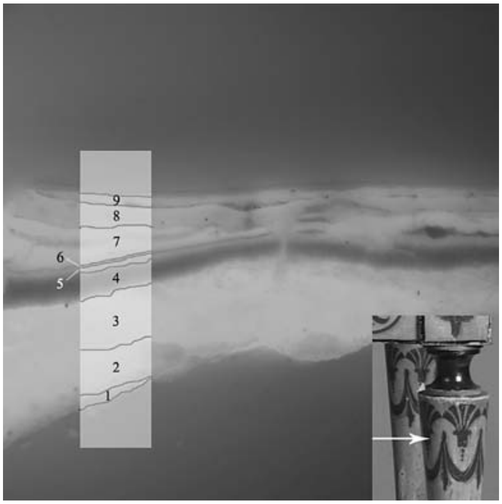

Fig. 10. Photomicrograph of cross section (sample #8-05, chair 65.167.8) after varnish reduction, with an insert of the sample location. Comparing it to the cross section (sample #8-04, Fig. 7), which was taken at the same location before varnish reduction, it can be seen that only the three topmost layers have been removed (layers 10–12 in Fig 7.). The two bottommost later varnishes (layers 8–9) were not removed in order to protect the original paint and varnishes and leave behind an appropriately aged yet readable surface. UV illumination with UV-18 filter for excitation between 390420 nm, 500×. Layer 1: blue ground; 2: white ground; 3: transparent white ground; 4: yellow background; 5: original varnish; 6: red glaze of decoration; 7: original varnish (two layers); 8–9: later varnishes.

chair and the chairs as a set. A small area on the back of the rear legs was left untouched as a document of the finish history. In summary, the varnish reduction on the first chair (#9) proceeded as follows:

Top layer with a dark yellow fluorescence: Keck #2 (20% acetone, 10% diacetone alcohol, and 70% Stoddard solvent) on paper tissue compresses under Mylar polyester sheet for softening; subsequent removal with cotton pads and swabs

Layer with a bright orange fluorescence (shellac): Pomerantz #4B (acetone 35%, ethanol 20%, and Stoddard solvent 45%) with cotton swabs

Layer with a dark orange fluorescence: 1:1 mixture of Pomerantz #4B and Rabin #2 (50% acetone, 20% ethanol, 30% Stoddard Solvent), or only Rabin #2 on swabs

Finally: Rabin #2 on cotton swabs to rinse surface, reduce occasional blanching and visibility of cracks in the darker areas of the decoration.

4.2.2 Treatment on Chairs #5, #6, and #8

Having determined the level of varnish reduction, treatment of the remaining chairs proceeded faster, removing several layers at a time. A solvent blend Pomerantz #3B (37% acetone, 31% ethanol, and 32% Stoddard solvent) with the same Teas solubility parameters as traditional Pomerantz #3 (acetone 20%, Shellsol 20%, Cellosolve 60%) was found to dissolve most of the unwanted varnishes on the remaining chairs.

Fortunately, Pomerantz #3B also dissolved the extremely dark finish on chair #8; however, the dirt in the craquelure on the tablet of chair #8 proved to be extremely tenacious. Even after removal of the fissured varnish, the dirt that had been in the fissures was left behind, encrusted to the original varnish (fig. 11). Neither solvents nor gels could dissolve the dirt. As it was very disfiguring, it was decided to mechanically remove the dirt from the gilt decoration, but not from the yellow painted border and green field, as they are visually less important. Mechanical removal with a small scalpel blade under magnification proved to be time-consuming, but rewarding. The craquelure had damaged the red and orange highlights, which showed as losses after removal of the dirt. Minimal inpainting of these losses improved the appearance of the decoration considerably.

Fig. 11. Detail of the middle of the tablet of klismos chair (65.167.8) the Metropolitan Museum of Art, purchased with Mrs. Paul Moore Gift, during varnish reduction. The dark orange varnish with the severe craquelure is still present on the proper left side of the tablet. Dirt, gathered in the craquelure, remained encrusted on the surface even after the varnish with the craquelure was removed (proper right side of tablet).

Some of the surfaces on the third chair (chair #6), such as the tablet and the front seat rail, appeared to have an additional coating that is presumably the same as the stubborn layer on the Kaufman chair (65.167.1). As mentioned earlier, the article by Fodera and others (1997) discusses treatment of the chair following its acquisition by the Kaufman Americana Foundation in 1994. The conservators also had a hard time finding a way to remove this dark and disfiguring layer and finally chose a 7–14% ammonium hydroxide gel in Carbopol. This gel formula was evaluated, but found unsuitable for chair #6, as it quickly removed original varnish as well.

Many solvents and solvent blends were tested, but none were successful in removing the layer. A raised pH seemed to be the only approach that worked. A solution of 4% ammonium hydroxide applied with poultices and swabs was slightly less aggressive and more controllable. The extremely alkaline solution (pH 13) swelled the layer, after which it was removed mechanically. An even more dilute solution was used for clearing the residue with swabs.

The treatment had no visible effect on the original varnish and paint, provided there was minimal mechanical action. The short contact time and fast evaporation of the ammonium hydroxide solution limited its penetration into the substrate. A cross section taken after varnish removal (#6-05) showed no obvious damage to the original varnish, such as a jagged surface or fissures, although the latter could have been spaced too far apart to be included in the sample. Highly alkaline solutions may cause saponification of oil-based layers, especially aged binding media that have become more acidic. FTIR analysis indicated that some saponification had occurred in the varnish layer—which probably contains oil—beneath the coating. However, this phenomenon was also found in a sample from before treatment. Thus, the saponification in the sample after varnish removal was not necessarily caused by the ammonium hydroxide solution.

4.2.3 Filling, Loss Inpainting, and Finishing of All Chairs

Large and protruding old fills were mechanically reduced to an appropriate level and covering area. Resaturation with a thin coat of 15% Paraloid B-72 in Cyclosol 53 prepared the surface for filling and inpainting of the most obvious and disturbing losses. The choice for this varnish was based on the ease of applying the varnish thinly and the fact that the slow evaporation rate of Cyclosol 53 minimizes brush marks (Heginbotham 2001). Cyclosol 53 did not appear to affect the original varnish and paint. Where necessary, losses were filled with Modostuc, mixed with a little cold fish glue to increase the hardness, and leveled with damp cotton swabs. Gouache, followed by toning layers of watercolors, was used to inpaint the losses. An acrylic medium, removable with Cyclosol, was mixed with the inpainting materials and served to maintain saturation and fixation of the colors. Under UV illumination, the inpainting materials are easily recognized by the black fluorescence of the gouache and a very bright yellow fluorescence of the acrylic medium used for the toning layers.

Fig. 12. Klismos chair (65.167.9) the Metropolitan Museum of Art, purchased with Mrs. Paul Moore Gift, after treatment. After reduction of the later, obscuring varnish layers, removal of disfiguring inpainting, and selective inpainting of losses, the chair has a much more legible appearance, yet with an appropriate amount of use and age, displaying corners where paint is worn off, and a slightly soiled and dented surface.

EXAMINATION AND TREATMENT OF A SET OF KLISMOS CHAIRS, ATTR. TO JOHN AND HUGH FINLAY

Regalrez 1126 in Solvent 340 completed the treatment, providing a final, protective coat on the chairs. The varnish contained 20 g Regalrez 1126, 2.0 g Kraton G1650, 0.4 g Tinuvin 242, 50 g Solvent 340. It is resoluble in aliphatic solvents of low aromaticity, whereas a polar or aromatic solvent is needed for removing the gouache paint or the acrylic medium that were used for the new inpainting. This difference in solubility makes it possible to selectively remove the newly added materials during a future conservation treatment. Regalrez varnish is easy to apply, and gives a sympathetic gloss. It has found wide application in the field of paintings conservation as a top varnish, but less in conservation of furniture and objects (Piena 2001).

The resulting surface appeared naturally aged with wear in plausible areas, such as the feet and the corners of the seat, and a thin craquelure pattern. With minimal inpainting and toning, the painted decoration was significantly more legible with a uniform varnish and a soft sheen (fig. 12).

5. CONCLUSIONS

The chairs of this set are icons of Baltimore painted klismos chairs, yet little of their technical detail is known. This report of our examination and treatment aims to add to the available knowledge of a set that is attributed to the renowned Finlay shop, the source of some of the best in painted furniture.

Examination and interpretation of the physical evidence, results of x-radiography, and through the use of detailed drawings, it is suggested that (1) the chairs were assembled with mortise and tenon joints; (2) the curve of the tablets was achieved by bending, rather than cutting; (3) the tablet was attached with a sliding dovetail or double rabbet, and secured with screws that were hidden under square plugs; (4) the chairs were assembled in a bottom and a top half, painted, caned, and then finally assembled; (5) the caning was likely originally painted with a coarsely ground chrome yellow oil paint.

Concerning the painted decoration: (1) the chairs are early examples of the use of chrome yellow; (2) there is an unexplained Prussian blue ground layer; (3) the gilt decoration of the tablet is executed in circa 22 kt gold on an oil mordant, with red highlights of probably hematite; (4) the dark green field of the tablet and some of the green ornaments may have been simple verte antique treatments of a paint and glaze layer of combinations of Prussian blue, lead white, calcium, and chrome yellow; (5) the stratification of the various ornaments on chair #9 is different, perhaps suggesting that different painters were responsible for them; (6) most of the ornamentation appears to be entirely freehand, with the exception of the scrolls of which the design may have been transferred from a pattern. UV surface examination in concert with cross sectional stratification analysis was invaluable for understanding the complicated surface of multiple later layers of varnish and overpaint. Analysis of the composition of original and later varnishes proved to be inconclusive.

The goal of the treatment was to reduce the thickness and darkness of as many as five later varnishes, yet be sympathetic to the age and wear of a set that had been used and admired over a period of almost 200 years. Using the Teas diagram and Solvent Solver program, different levels of cleaning were presented for discussion with the curator on the first chair. This chair (#9) was treated with the following solvent blends in a four-step process: Keck #2 with paper compresses and cotton swabs, Pomerantz #4B with swabs, 1:1 mixture of Pomerantz #4B with Rabin #2 with swabs, and a final rinsing with Rabin #2. Having determined the level of varnish reduction, the remaining three chairs were treated with a solvent blend (Pomerantz #3B), which removed multiple layers at a time. The dirt that had gathered in the cracks of the removed layer, and was left behind on the tablet of chair #8 after varnish reduction, was mechanically removed from the gilt decoration only. The extremely tenacious dark layer on the tablet and front seat rail of chair #6 was swelled with a 4% solution of ammonium hydroxide after which it was mechanically removed. A barrier layer of Paraloid B-72 in Cyclosol 53 was applied, the most disturbing losses were filled with Modostuc, inpainted with gouache in acrylic medium, toned with watercolors in acrylic medium, and a final coat of Regalrez 1126 in Solvent 340 was applied.

The major differences between the current treatment and the Kaufman chair treatment (Fodera et al. 1997) were caused by the increased number of varnish layers that needed to be removed, the call for several levels of cleaning, an apparently different reaction to materials, and the presence of the stubborn layer on only one chair. The designed treatment was deemed least intrusive, but most effective in improving the appearance of the chairs, accomplishing the treatment goal.

More art historical investigation is needed to create an accurate view of the Finlay's business model, shop practice, and painted furniture, as well as the provenance of the set of chairs. Further research could investigate the possibility that multiple painters worked on the chairs, examining shop records with listings of employees, other known fancy painters in early 19th-century Baltimore, similarities of the execution of the ornaments, and whether they were freehand or stenciled. Also, cross sectional stratification could indicate if a particular ornament was applied with the same paint layers on every chair, and/or if each ornament had a specific stratification, as suggested by the stratifications of the ornaments on chair #9. Perhaps the investigations would indicate a division of labor, based on the skill level or specialization required for the application of the various layers and ornaments. It would also be interesting to know if the remaining five known chairs of the set have the same blue ground layer, perhaps providing an indication as to when and why the color scheme changed. Ascertaining whether green and blue painted furniture of the period has a blue ground layer could further support the theory of changing the coloration of the chairs from green or blue to yellow. And, finally, many pigments were left unstudied, and these could be identified, as well as the exact composition of the binding media. Comparison with other Finlay pieces could be useful for future attributions and for strengthening current attributions.

APPENDIX

The compound light microscope was a Zeiss Axioplan 2 with a SPOT Pursuit 4MP Slider digital camera by Diagnostic Instruments, Inc. The embedding medium was Bioplastic with MEK hardener, and samples were collected with a scalpel blade.

Fourier transform infrared microspectroscopy was used for analysis of scrapings and solvent extracts from swabs. The samples were either crushed on, or let to dry in case of extracts, on a Low–e slide (MirrIR, Kevley Technologies) and analyzed in reflection mode through the 15× objective of the Hyperion infrared microscope, interfaced to a Bruker Vertex 70 spectrometer (Bruker Optics). Layers in cross section were analyzed through an attenuated total reflectance (ATR) 20× objective, featuring a germanium crystal (Bruker Optics). The spectra were acquired at a 5 cm^{-1} resolution, in the range 4000–600 cm^{-1} and 32–128 scans.

Pyrolysis-gas chromatoghraphy/mass spectrometry was performed on scrapings and solvent extracts, which were introduced in an Ultra Alloy cup (Frontier Lab.) and treated with 3 μL 25% TMAH (tetramethyl ammonium hydroxide) in methanol, as the methylating reagent. Thermally assisted hydrolysis and methylation were carried out at 500°C in the microfurnace of the Double-Shot Pyrolyzer 2020iD (Frontier Lab.), interfaced to the gas chromatograph Agilent 6890 series II, coupled with an Agilent 5973N mass spectrometer. Helium gas was used as the carrier at 1 ml/min flow. An UA (Frontier Lab) capillary column (30 M × 0.25 mm × 0.25 μm) was used for the chromatographic separation. Split ratio was 30:1; inlet temperature was set to 300°C and the MS transfer line to 280°C. The GC oven temperature program was 50°C for 2 min; 10°C/min to 310°C; isothermal for 20 min.

Raman micro-spectroscopy was carried out on cross sections using the 100× objective of the Senterra dispersive Raman microscope (Bruker Optics). Analysis was carried out on single particles in cross sections, using a 785 nm laser. Acquisition was performed at resolutions of 3–5 cm^{-1} and 3–10 cm^{-1} in the spectral ranges 72–1521 cm^{-1} and 70–3200 cm^{-1}, respectively; a 30-second time scan and laser powers between 10 and 25 mW were used.

Compositional analyses of the embedded paint samples were done using an Oxford Instruments INCA analyzer equipped with an energy dispersive X-ray spectrometer (EDS) using a Link Pentafet SATW X-ray detector attached to a LEO Electron Microscopy model 1455 variable pressure scanning electron microscope (VP-SEM). Analyses were performed on uncoated samples using the variable pressure mode of the SEM, with the chamber pressurized with 100 pascals of nitrogen, operated at an accelerating voltage of 20 kV.

ACKNOWLEDGMENTS

The author would like to thank A. Rizzo, assistant research scientist, and M. T. Wypyski, research scientist, department of scientific research, for their analyses of the materials; P. M. Kenny, curator of American decorative arts and administrator of the American Wing, and M. Manuels, associate conservator in the Sherman Fairchild Center for Objects Conservation, for their support and input in the expected final appearance of the chairs; and R. S. Wilkinson, furniture conservator and principal at Fallon & Wilkinson, LLC for his help in trying to understand the assembly of the chairs based on the material evidence.

All photographs, radiographs, images, and drawings are courtesy of the Metropolitan Museum of Art. This paper was originally presented at the Eighth International Symposium on Wood and Furniture Conservation in Amsterdam, the Netherlands, Nov 17–18, 2006.

REFERENCES

Anonymous. 1967. Report of treatment. Treatment report, 65.167.1–9. Objects Conservation Department, Metropolitan Museum of Art, New York, N.Y.

Anonymous. 1968. Report of treatment. Treatment report, 65.167.1–9. Objects Conservation Department, Metropolitan Museum of Art, New York, N.Y.

Bristow, I. C. 1996. *Interior housepainting colours and technology 1615–1840*. New Haven, Conn.: Yale University Press.

Elder, W. V. III. 1972. *Baltimore painted furniture, 1800–1840*. Baltimore, Md.: Baltimore Museum of Art.

Fodera, P. L., K. N. Needleman, and J. L. Vitagliano. 1997. The conservation of a painted Baltimore sidechair (ca. 1815) attributed to John and Hugh Finlay. *Journal of the American Institute for Conservation* 36: 183–92.

Hastings, L. D., and D. Bigelow. 1998. Collaborations past and present: A classical success story. *Painted wood: History and conservation*. Proceedings of a symposium organized by the Wooden Artifacts Group of the American Institute for Conservation of Historic and Artistic Works and the Foundation of the AIC, held at the Colonial Williamsburg Foundation, Williamsburg, Virginia, 11–14 November 1994, eds. V. Dorge and F. C. Howlett. Los Angeles, Calif.: The Getty Conservation Institute. 437–53.

Heginbotham, A. 2001. What's old is new: B-72 and the treatment of degraded furniture finishes. *Postprints of the Wooden Artifacts Group*. Washington, D.C.: 41–56.

Kenny, P. M. 2005. Personal communication. Curator of American decorative arts and administrator of the American Wing, Metropolitan Museum of Art, New York, N.Y.

Maryland Historical Society. 1984. *Furniture in Maryland, 1740–1940: The collection of the Maryland Historical Society*. Baltimore, Md.: The Society.

Mussey, R. D., Jr. 1998. Verte antique decoration on American furniture: History, materials, techniques, technical investigations. *Painted wood: History and conservation*. Proceedings of a symposium organized by the Wooden Artifacts Group of the American Institute for Conservation of Historic and Artistic Works and the Foundation of the AIC, held at the Colonial Williamsburg Foundation, Williamsburg, Virginia, 11–14 November 1994, eds. V. Dorge and F. C. Howlett. Los Angeles, Calif.: The Getty Conservation Institute. 242–54.

Newman, R., and E. Farrell. 1994. House paint pigments: Composition and use, 1600–1850. *Paint in America: The colors of historic buildings*, ed. Roger W. Moss. New York, N.Y.: J. Wiley. 279–80.

Ormsby, M. 2006. Solvent Solver: A calculator for working with Teas fractional solubility parameters. http://palimpsest.stanford.edu/packages/solvent_solver.html (accessed 09/01/05).

Piena, H. 2001. Regalrez in furniture conservation. *Journal of the American Institute for Conservation* 40: 59–68.

Phenix, A. 2002. The swelling of artists' paints by organic solvents and the cleaning of paintings: Recent perspectives, future directions. *AIC Paintings Specialty Group Postprints*. American Institute for Conservation 30th Annual Meeting, Miami. Washington, D.C.: American Institute for Conservation. 71–86.

Rizzo, A. 2007. Examination and analysis report, 65.167.6 and 65.167.9. Department of Scientific Research, Metropolitan Museum of Art, New York, N.Y.

Sheraton, T. [1793] 1972. *The cabinet-maker and upholsterer's drawing-book*. Reprint, New York, N.Y.: Dover Publications.

Sutherland, K. 2003. Solvent-extractable components of linseed oil paint films. *Studies in Conservation* 48:111–35.

Thomson, C. 1991. "Last but not least"—Examination and interpretation of coatings on brass hardware. In *Postprints of the Wooden Artifacts Group from the AIC Meeting of June 3–8, 1991 in Albuquerque, N.M.* Wooden Artifacts Group. Washington, D.C.: American Institute for Conservation. n.p.

Weidman, G. R., and J. F. Goldsborough, with R. L. Alexander, S. T. Colwill, M. E. Hayward, and C. A. Rogers. 1993. *Classical Maryland, 1815–1845: Fine and decorative arts from the Golden Age.* Baltimore, Md.: Maryland Historical Society, the Museum and Library of Maryland History.

Wypyski, M. T. 2006. Analysis report, 65.167.9. Department of Scientific Research, Metropolitan Museum of Art, New York, N.Y.

FURTHER READING

Hill, J. H. 1967. *The Furniture craftsman in Baltimore, 1783–1823.* Master's thesis, University of Delaware, Newark, Del.

Humphries, L. 2003. Provenance, patronage, and perception: The Morris suite of Baltimore painted furniture. In *American Furniture*, ed. Luke Beckerdite. Hanover: Chipstone. 138–212.

Kirtley, A. A., T. Heller, and M. McGinn. 2003. Lloyd family painted furniture revisited. In *The Catalogue of Antiques and Fine Art*. 174–7.

Kirtley, A. A. 2002. New discoveries in Baltimore painted furniture. In *The Catalogue of Antiques and Fine Art*. 204–9.

Percier, C., and P. Fontaine. [1801] 1812. Recueil des décorations intérieures: Comprenant tout ce qui a rapport à l'ameublement, comme vases, trépieds, candélabres, cassolettes, lustres, girandoles, lampes, chandeliers, cheminées . . . miroirs, écrans, etc. . . . composé, par C. Percier et P.F.L. Fontaine, exécuté sur leurs dessins. Paris: Published by authors.

Phenix, A. 1997. Solvent abuse: Some observations on the safe use of solvents in the cleaning of painted and decorated surfaces. *The building conservation directory.* London, U.K.: Cathedral Communications.

Raley, R. 1959. *The Baltimore Country House, 1785–1815.* Master's thesis, University of Delaware, Newark, Del.

SOURCES OF MATERIALS

Acetone, ammonium hydroxide, diacetone alcohol, ethanol, Stoddard solvent, xylene
Fisher Scientific
2000 Park Lane Drive
Pittsburgh, PA 15275
www.fishersci.com

Bioplastic with M.E.K.
Ward's Natural Science
5100 West Henrietta Road
Rochester, New York 14692
(585) 359-2502
http://wardsci.com

Carbopol 934
Noveon Inc.
9911 Brecksville Rd.
Cleveland, OH 4414-3297
(800) 331-1144

Cold fish glue
Lee Valley Tools Ltd.
1080 Morrison Drive
Ottawa, Ontario, K2H 8K7
Canada

Cyclosol 53
Pride Solvents & Chemical Co. of NY, Inc.
6 Long Island Ave
Holtsville, NY 111742
(631) 758-0200
www.pridesol.com

Ethomeen C12, C25
Akzo Nobel Chemicals, Inc.
300 South Riverside Plaza
Chicago, IL 60606
(914) 693-6946, (800) 424-9300

Gloss medium and varnish
Liquitex
PO Box 246
Piscataway, NJ 08855
(888) 4-ACRYLIC
www.liquitex.com

Gouache, Designers
Winsor & Newton, Colart
Whitefriars Avenue
Harrow Middlesex HA3 5RH
U.K.
+44 (0) 208 4274343
www.winsornewton.com

Kraton G1650
Kraton Polymers U.S., LLC
2982 Washington Blvd.
PO Box 235
Belpre, OH 45714-0235
(832) 204-5400
www.kraton.com

Laponite RD with water, pH 7-8
Laporte Absorbents
Southern Clay Products, Inc.
1212 Church Street
Gonzales, TX 78629

Modostuc
Plasveroi
Via Camussone n.38
fraz. Giovenzano di Vellezzo Bellini
Italy

Paraloid B-72
Rohm and Haas, Canada, Inc.
2 Manse Road
West Hill, Ontario
Canada, M1E 3T9
www.rohmhaas.com
(416) 284-4711

Regalrez 1126
Loos & Dilworth, Inc.
61 East Green Ln.
Bristol, PA 19007
(215) 785-3591
www.loosanddilworth.com

Tinuvin 292
Ciba Specialty Chemicals
540 White Plains Rd.
PO Box 2005
Tarrytown, NY 10591-9005
(800) 431-1900
www.cibasc.com

Watercolor, Schmincke Horadam Aquarell
H. Schmincke & Co.—GmbH & Co KG, Fabrik feinster Künstlerfarben
Otto-Hahn-Straße 2
D-40699 Erkrath
+49(211) 2509-0
www.schmincke.de

RIAN M. H. DEURENBERG is associate conservator at Fallon & Wilkinson, LLC, a private conservation lab in Connecticut, and is a professional associate with AIC. Most recently she held a two-year position in the Sherman Fairchild Center for Objects Conservation at the Metropolitan Museum of Art in New York, where she worked on neoclassical furniture for the reinstallation and renovation of the American Wing. After graduating from the furniture conservation program at the Netherlands Institute for Cultural Heritage (ICN) in 2001, she has worked in private and institutional conservation labs in both the Netherlands and the United States, including a three-year Andrew W. Mellon Fellowship at the Philadelphia Museum of Art. Address: Fallon & Wilkinson, LLC, 240 Scotland Rd, Baltic, CT 06330; r.deurenberg@fallonwilkinson.com