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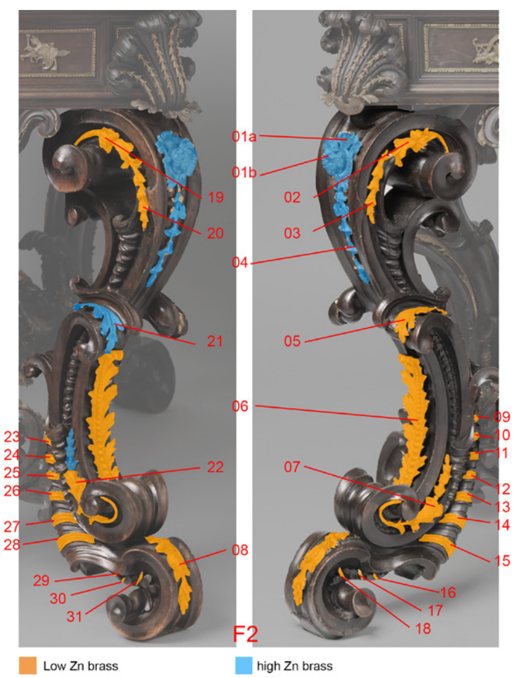

Wooden Artifacts Group Postprints

Presentations from the 2017 AIC Annual Meeting in Chicago, Illinois
Wooden Artifacts Group Sessions

Wooden Artifacts Group

Postprints of the Wooden Artifacts Group Session and Joint Session of Architecture + Wooden Artifacts

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WOODEN ARTIFACTS GROUP

POSTPRINTS OF THE WOODEN ARTIFACTS GROUP SESSION AND THE JOINT SESSION OF ARCHITECTURE + WOODEN ARTIFACTS

ANNUAL MEETING

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JAN DORSCHEID AND ARIE PAPPOT

Count Lamberg's Roman Table in the Rijksmuseum

ABSTRACT—In 2016, the Rijksmuseum acquired a unique Roman baroque table made for Count von Lamberg, ambassador to the Court of St. Peter at the Vatican, in the early 18th century. The table is made of deeply carved and stained pear wood. It is embellished with accentuating and intricate gilt-bronze mounts in place of the more commonly used raised gesso gilding. Research into the table's gilt mounts revealed the use of a unique type of copper alloy differing distinctly from the set alloy standard used in Paris at the time.

1. INTRODUCTION

The Rijksmuseum has had a unique Roman baroque center table in its collection since 2016 (fig. 1). The coat of arms of Count Leopold Joseph von Lamberg (1654–1706), Austrian Imperial Ambassador to the Court of St. Peter at the Vatican between 1700 and 1705, is mounted atop the intricately curved stretcher. The table has extravagantly carved legs with a complex arrangement of overlapping C- and S-scrolls terminating in inward-turning scroll feet and supports a green *verde antico* marble top. It is embellished with numerous intricate gilt-bronze mounts in place of the more commonly used raised gesso gilding. Although recognizably relatable to contemporary Italian designs, the table is quite a unique example for its time.

To maintain its structural stability, the table required interventive treatment, which will be described briefly. Focus will be given to the technical study of the gilt mounts, with which contemporary copper alloy examples were also compared. Revealing the use of a type of copper alloy that differs distinctly from the set alloy standard used in Paris at the time, the compositional results point to a less researched casting tradition in Italy. By analyzing the alloy composition, this study will attempt to reveal the context of the table's material technology and cultural tradition, and make suggestions for avenues of further research.

2. HISTORICAL CONTEXT

Although the carcass and its facades of false drawer-fronts appear to be somewhat old fashioned, the Roman baroque center table must have been trend setting for its time (Baarsen 2016, 286). Instead of the more common raised gesso gilding or accentuating gilding, numerous gilt mounts decorate the table. The overall design recognizably relates to drawings by the woodcarver and sculptor Filippo Passarini (Di Castro and Jatta 2009, 115) from the late 17th century, as well as those by Carlo Fontana (1638-1714), an architect (Braham and Hager 1977, 125, fig. 286) who worked for Bernini in his early career in the second half of the 17th century (Montagu 1996, XV and 121). Additionally, the base of a late 17th century *pietre dure* silver cabinet designed by the Austrian architect Filippo Schor, made by the German carvers Franz and Dominikus Steinhart for Palazzo Colonna in Rome, provides a further link, as it bears resemblances in its bold carving and applied mounts (Strunck 2005, 236ff). A pair of pier tables at the National Museums Scotland and the V&A mirror the flamboyant arrangement of its carved structure but do not have the lavish gilt-bronze mounts (V&A 2017).

Ceremoniously staged between an Earl's coronet and a trophy, the coat of arms of Lamberg is mounted to the top of the stretcher (fig. 2). Lamberg was a wealthy collector of art acquainted with Fontana (Polleroß 2010, 437) and must have commissioned the center table during his time in Rome. When political tension arose between the Bourbons and the Austrian House of Habsburg, Lamberg was ordered to return to Austria in 1705. He passed away shortly afterward in 1706 (von Wurzbach 1865, 35-36).

3. TECHNOLOGICAL EXAMINATION, CONDITION, AND TREATMENT

The table is constructed from four legs connected by threaded bolts to a cross-stretcher and joins with tenons into the carcass.

Fig. 1. Table, after treatment, ca. 1700-05, stained pear, poplar, and walnut, mounts of gilt bronze, top of *verde antico* marble, 63 x 130 x 98 cm.

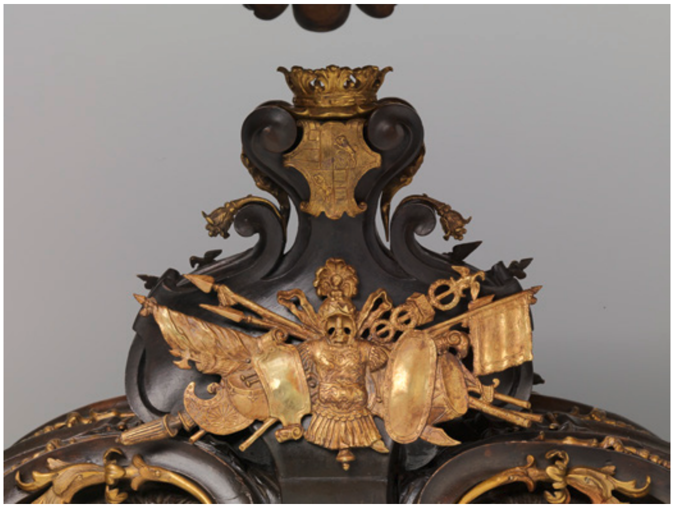

Fig. 2. Detail: Coat of arms between Earl's coronet and trophy.

The carcass, including its facades of false drawer fronts, is constructed from poplar planks with applied walnut moldings. The mounted marble slab is resting on top. The feet and stretcher are made using deeply carved pear (*Pyrus* spp.). The different woods are stained relatively uniformly. Pear was often used for its fine uniform texture and stained to imitate darker woods. Indicated by UV light illumination, resin varnishes must have been applied at some point with the mounts removed and on another occasion with the mounts in place. A tinted wax was applied overall at a later stage.

Utilizing small tenons and threaded bolts, the unusual joinery of the center table very much reflects the work of a sculptor rather than a cabinetmaker. Considering the substantial weight of the marble, one would expect continuous stiles and different structural solutions instead of small tenons and threaded bolts joining the individual parts. Twisted and warped members cause a somewhat lopsided overall appearance and are possibly a consequence of the use of easier-to-carve and not fully seasoned timbers. These twisted members, as well as the small tenons and threaded bolts located in structural weak spots, have contributed to the overall instability of the center table. In addition, numerous subsequent changes and treatments have caused further complications in the current treatment of this object.

Although location markings are present in some instances, undoing previous alterations to reconstruct the original configuration could arguably be considered a very significant intervention. Based on the geometric arrangement of the joinery and a systematic trial series, an optically and structurally more favorable leg-stretcher configuration could be determined. Ultimately, it was decided that the most favorable arrangement consisted of the stretcher being turned 180° and the exchange of diagonally opposite legs (numbers 2 and 4). Several additional structural modifications were also essential to maintain the table's stability and optical balance: since the joints between the legs and the carcass are only held in place by a small tenon without any significant supporting surface, fitted wedges following the rounded shape of the foot were mounted to create a continuous support area. This distributes the weight of the heavy marble table top evenly over the four feet.

Despite the rearrangement of the components and the addition of the fitted wedges, the table remained somewhat lopsided. Various possibilities such as repositioning the bolts or replacing them with modified hardware were discussed. Considered the least interventive and most effective option, it was decided to replace the bolts with offset hardware to join the stretcher and the feet and to raise the stretcher by approximately 3 cm on one side. Additional minor treatments were undertaken on the table. For example, minor fractures and breaks were reattached with animal glue. Finally, the hazy surface was dry-cleaned and buffed to achieve a uniform sheen.

3.1 GILT MOUNTS: ANALYSIS AND TECHNOLOGICAL COMPARISON

The Roman center table is decorated with 297 individual mounts, not including four missing mounts on the underside of the stretcher. Although the carved structure in itself appears daring, the sheer number of gilt mounts is astonishing and became the focus of a dedicated technological study. There is no evidence for a different set of mounts or fasteners in the wooden structure. Yet some of the mounts that were removed during the treatment seem to have been cast from other mounts on the table, evidenced by outlines and dimensions that are almost identical. For example, the palmetto mounts with the pearl-string at the rear show identical casting flaws, but the color of the gold and the detailing are slightly different (fig. 3).

Upon closer inspection, it became evident that after the original cast mount was fitted to the table, it cracked and was repaired. From the crack in the gold layer on the surface, it

Fig. 3. Palmetto mounts with string of pearls. Left: Original, front and back. Right: Copy, front and back.

appears that the original mount was bent to fit to the leg after the gold had been applied. To avoid overheating and damaging the gilding, the mount was reinforced from the reverse with low-temperature lead-tin solder. This repair was reproduced perfectly in the copied mount (fig. 4). When comparing the two mounts with X-radiography, slight differences in the porosities are visible, which may have been caused by the casting material, different alloy composition, or both. Although the outlines are copied relatively precisely, undercuts and details have been lost in the recast mount.

3.1.1 Alloy Analysis

To further establish if select mounts had gone missing and were subsequently cast from the remaining original ones, the alloys were analyzed with XRF. Trace elements in metal alloys may suggest ore sources and trade routes (Glinsman 2004, 97). A calibration and quantification model based on the so-called copper CHARM (Cultural Heritage Alloy Reference Materials) set (Heginbotham et al. 2015) together with the fundamental parameters software called *PyMca* (Solé et al. 2007) was applied to gain meaningful results. To get a better understanding of the manufacturing, materials, and technological traditions used on the mounts, the XRF readings were collected from the back of one dismantled foot in a first approach and considered representative of all mounts (fig. 5).

The majority of these examined mounts were cast from a low-zinc brass. The alloys contain quite varied compositional results with an average of 86 to 93 wt% copper with minor additions of tin, zinc, and lead, and high impurities, which is indicative of late 17th and early 18th century copper alloys (table 1). The remaining minority of the mounts are made of relatively pure and industrially refined alloys with a high zinc portion of approximately 28 wt% and a low percentage of impurities such as antimony, arsenic, nickel, and silver. This group of high zinc copper casts probably dates to after 1870 (Heginbotham 2017) and can be further divided into three groups: mercury gilded, electroplated, and one with no traces of gilding.

In a second approach, readings were collected from most of the mounts present on the Italian center table. XRF spectra were collected from the front and categorized by the previously established groupings. Out of a total of 241 analyzed mounts, 197 mounts were identified as belonging within the group of

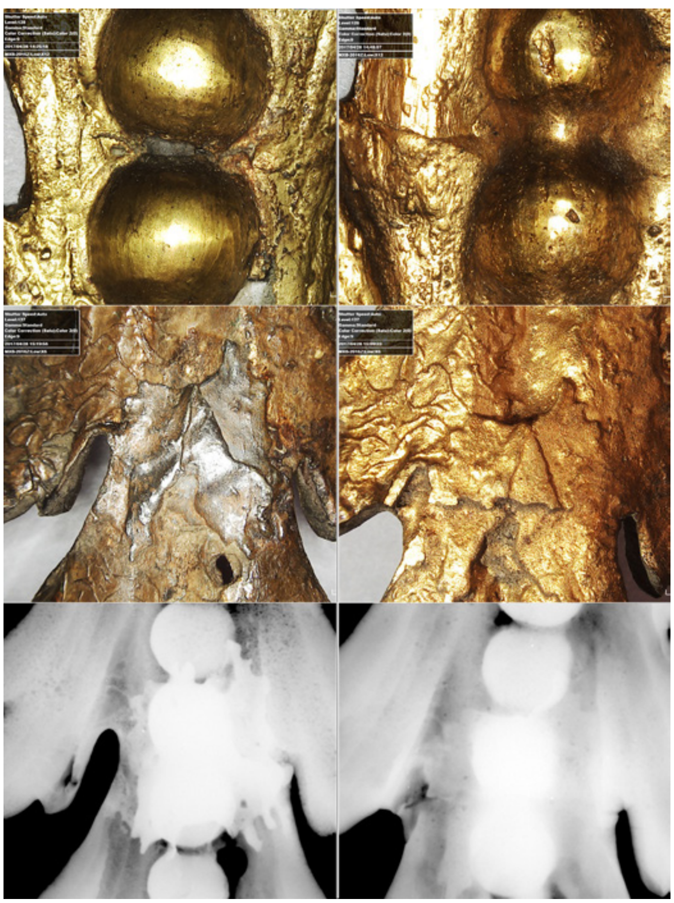

Fig. 4. Details of crack and repair in magnification (6x) and x-ray. Left column: Original mount. Right column: Copy. Top row: Front. Center row: Reverse. Bottom row: X-ray.

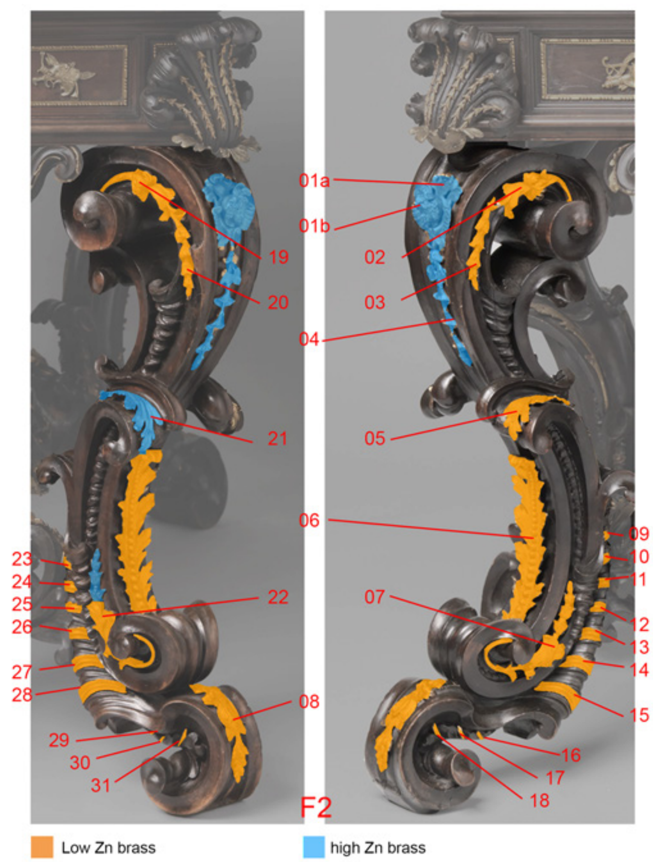

Fig. 5. Mapping of groups and locations of mounts on demounted leg (F2).

Table 1. XRF Composition (in wt%) of the Low-Zinc Alloys of the Mounts on the Italian Center Table

Test Location	Mount	Group	Fe	Ni	Cu	Zn	AsKb	Se	Ag	SnK	Sb	Pb	Bi	Au*	Hg**
01a	mask plate, reverse	high Zn	0.40	0.23	73.48	23.90	0.02	0.01	0.02	0.51	0.03	1.17	0.00	5.00	0.00
4	tendril below mask	high Zn	0.06	0.02	71.12	28.02	0.02	0.41	0.02	0.01	0.02	0.02	0.00	0.00	0.00
2	leaf	low Zn	0.33	0.18	92.48	3.06	0.66	0.02	0.16	1.81	0.33	1.20	0.00	10.34	1.57
3	hanging leaf	low Zn	0.57	0.19	92.54	3.13	0.27	0.00	0.12	1.59	0.32	1.43	0.03	5.77	1.50
5	acanthus	low Zn	0.19	0.19	91.02	4.93	0.14	0.00	0.09	1.47	0.27	1.87	0.00	0.03	0.00
6	acanthus, pearls	low Zn	0.22	0.20	91.19	4.97	0.05	0.00	0.09	1.50	0.30	1.64	0.00	0.67	0.14
08a	grapes	low Zn	0.23	0.19	94.47	2.58	0.13	0.00	0.10	1.18	0.28	1.10	0.00	0.65	0.11
10	leaf detail	low Zn	0.50	0.15	89.11	6.96	0.11	0.01	0.10	1.02	0.22	1.93	0.00	2.71	0.49
14	leaf detail	low Zn	0.18	0.19	93.77	2.86	0.02	0.00	0.10	1.23	0.30	1.59	0.00	3.35	0.76
26	leaf detail	low Zn	0.26	0.18	93.58	2.95	0.07	0.00	0.11	1.22	0.27	1.59	0.02	3.66	0.78
27	leaf detail	low Zn	0.25	0.20	93.64	3.12	0.04	0.00	0.11	1.17	0.28	1.42	0.00	1.92	0.36
19	leaf detail	low Zn	0.47	0.20	92.10	4.02	0.17	0.00	0.12	1.61	0.29	1.19	0.02	3.03	0.42
21	acanthus	high Zn	0.05	0.02	70.98	28.65	0.02	0.00	0.01	0.01	0.01	0.03	0.00	0.00	0.00
22b	leaf tendril	low Zn	0.87	0.18	88.57	7.07	0.30	0.01	0.11	1.50	0.24	1.24	0.00	6.82	1.00

*gold values are indicative and were not included in normalizing the results to 100% **results for mercury are not calibrated against standards

low-zinc brass. Corresponding with the previously established visual evidence, it was determined that for the remaining high zinc mounts, almost without exception one mount of each shape matches with one that has been categorized as original low-zinc brass. The results of this technical study support the observation that certain mounts have indeed been cast off of original mounts, and that the mounts therefore accurately reflect the original overall appearance.

3.1.2 Technological Comparison

Historically, copper alloys with higher percentages of copper (90%-95%) seem to have been preferred for mercury gilt casting, and high amounts of lead were avoided. This preference is particularly exemplified in the comparison of copper alloys for gilt objects to those used for ungilt objects of ancient Chinese, Greek, and Roman origin (La Niece and Craddock 1993, 197; Oddy et al. 1990, 119). In Theophilus' 12th century treatise *De diversis artibus*, it is also described that silver and pure copper are easier to gild than brass, and that lead can spoil the gilding if not carefully extracted from the alloy (Theophilus 1979, 145-146).

However, the preferred copper alloy for gilding used in Paris from the late 17th to the mid-19th century had a zinc content ranging between approximately 13% and 25%, as well as some tin and lead (Heginbotham 2014, 158). When Matthew Boulton was setting up a workshop in Birmingham to produce French-style ormolu in the 1760s, he initially chose an alloy with a higher percentage of copper because it was easier to gild. However, the color of the finished gilding was too red for the tastes of the time, and he soon adopted the alloy composition with a higher percentage of zinc from the French (Chapman 1994, 232; Goodison 1974, 127-128, 148). The choice between an easier-to-gild alloy of high copper and a more favorably colored alloy with a lower percentage of copper seems to have been a trade-off still deliberated in the early 19th century. The French chemist D'Arcet experimented with different alloying recipes to eventually establish an optimal gilding alloy containing about 78% of copper, 17% zinc, and some tin and lead (D'Arcet 1818, 8-18) (table 2).

The considerable difference in alloy composition between French gilt bronze and the compositional readings of the mounts on the table could possibly indicate deliberate choices concerning the casting, chasing, and gilding properties. Whereas contemporary Parisian guild regulations prescribed the use of either brass or bronze alloy, a single Roman workshop could produce both bronze and brass medals, which were very popular collectors' items, as well as sculpture and ormolu (Lamouche 2013, I. 36-42). This overlap is the result of guilds not being as strictly regulated in Italy as they were in France (Montagu 1996, 3). Although there was a huge tradition of casting in Italy, there was no highly developed industry for furniture mounts specifically. Besides gilt bronze mounted marble sculpture and altar pieces in Rome, most examples of furniture decoration consist of small gilded sculptures and figures (Lamouche 2013, III. 52, 101, 161).

In 16th century Italy, Giorgio Vasari mentions a casting alloy for sculptures made of a mixture of two-thirds copper and

Table 2. Average Composition (in wt%) of the Low-Zinc Alloys of the Mounts on the Italian Center Table in Comparison to the Porta del Paradiso (Ferretti and Siano 2008, VI) and Kornmann (Glinsman 2004, Acc. No. 1957.14.1075,), and the recipes of Vasari (1568), and D'Arcet (1818)

	Copper	**Zinc**	**Tin**	**Lead**
Italian Table	93.3	3.6	1.5	1.6
Porta del Paradiso (1425-1452)	91.9	3.5	1.3	1.3
Kornmann (1628)	90.0	3.7	2.8	2.2
Vasari (1568), recipe	92	8		
French (D'Arcet 1818), recipe	78	17	3	1

one-third brass that consists of approximately 92% copper and 8% zinc (Brown 1960, 164). Research undertaken on the gilt-bronze panels of the *Porta del Paradiso* in Florence dating to the second quarter of the 15th century identified a similar alloy composition as that mentioned by Vasari (Ferretti and Siano 2008, 199). Several Roman portrait medals from the first half of the 17th century, for example one made by Johann Jakob Kornmann in the collection at the National Gallery of Art in Washington, DC, likewise resemble the aforementioned alloy composition and are relatively similar to the calculated average for the mounts on the Italian table (see table 2).

4. CONCLUSION

The technical study of the Italian center table made for Lamberg in Italy in the early 18th century proved to be very fruitful. The overall design corresponds strongly with designs by Fontana, Passarini, and Schor. The completion of the treatment including the structural alterations reestablished the table's proud appearance and structural stability. Situated among French furniture from the mid-18th century in the Rijksmuseum galleries, the Italian table from the collection of Lamberg has been placed in context.

Surrounding the technological casting tradition, the analysis of the alloys utilized for the mounts has raised new questions. The preference of the French in using one recipe and the Italian preference of using another is noteworthy and could aid in future provenance studies. Likewise, the use of a copper alloy with low zinc can be further pursued to clarify the circumstances surrounding the exact attribution of the gilt mounts with a traditional school, foundry, or recipe in Italy. For example, the comparison of mounted sculpture and ormolu decorating Roman altar pieces could be an avenue of future research that may provide additional evidence of this practice and link to these results.

ACKNOWLEDGMENTS

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APPENDIX. ANALYTICAL EQUIPMENT

Microscopic equipment. Microscopic examination was conducted using a Hirox RH-2000 Digital Microscope, equipped with 1/1.9 type 238 million pixels CMOS image sensor, and a MXB-2016Z 20-160x Zoom Lens with an AD-2016LOW magnification adapter. Image capture and editing were done in Hirox RH-2000 software.

X-ray fluorescence. Sample sites were analyzed using an DELTA (Premium) Handheld XRF spectrometer equipped with an Rh tube, SDD detector, Al filter. Instrument settings were 40 kV, 35 µA, and 20 seconds. The resulting data (peaks) were deconvoluted using *PyMca* (Py-multichannel analyzer) software developed by the European Synchrotron Radiation Facility (ESRF) (http://pymca.sourceforge.net) (Solé et al. 2007). The data were exported from *PyMca* into a multielement calibration spreadsheet developed in Excel by Arlen Heginbotham, in which a calibration model was built implementing a validation procedure.

X-ray radiography (x-ray). X-ray was conducted with a GE Eresco 280 MF tube head (DC 280Kv/340W min 1.2 mA, focus 0.5 mm) equipped with a Seifert DP435 manipulator system with C-arm. Image processing was done with CR 35/HD-CR 35 NDT Plus Image Plate scanner and D-Tech Software (DÜRR NDT GmbH & Co. KG). Parameters: 140 kv, 2.2 mA, 10 seconds, 1.2-1.3 meter distance.

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PAIGE SCHMIDT, JONATHAN THORNTON, AARON SHUGAR, REBECCA PLOEGER, AND JIUAN JIUAN CHEN

Interpreting Thonet: Treatment of a Gebrüder Thonet Bentwood Rocking Chair

ABSTRACT—A Gebrüder Thonet bentwood rocking chair owned by a private client was treated and analyzed. Major treatment steps included the reconstruction of the chair's missing back splat and compensation of large areas of stripped and sanded finish. The wood was determined to be beech (*Fagus*) via wood identification using polarized light microscopy. Cross sections of the finish were examined using polarized light microscopy and long-wave UV visible fluorescence. Additional finish analysis was performed, including transmitted Fourier Transform Infrared Spectroscopy and X-ray Fluorescence. The results indicate that original finish layers may be present.

1. INTRODUCTION

A bentwood rocking chair was brought to the SUNY Buffalo State College Art Conservation Department's fall 2015 clinic by a private owner and was accepted for treatment. The chair, which had been all but lost to the dump, had been picked up off the side of the road by the owner, who recognized and identified the chair as a Gebrüder Thonet by a paper label and stamp marking on the interior front edge of the seat rail (fig. 1). This label, in conjunction with the chair's design, identified in the 1904 Gebrüder Thonet catalog as Rocking Chair Number 221, dates the piece from between 1899 and 1921 (Von Vegesack and Thonet 1997). Michael Thonet (1796–1871), who founded Gebrüder Thonet in the mid-19th century, developed the first patented manufacturing techniques for the mass production of solid bentwood furniture, opening the door to an entirely new consumer market. Recognizing the historic value of Gebrüder Thonet bentwood furniture, the owner of the rocking chair had the missing caning on the seat professionally replaced before bringing the rocking chair into the Art Conservation Department for conservation treatment.

In addition to several structurally unstable elements, losses, and unoriginal upholstery tack holes, the chair was missing its original back splat, a major component of the chair's aesthetic continuity and intended function. Substantial areas of the finish were stripped and the surface was sanded, leaving newly exposed bare wood visible on nearly half of the chair. Given the degraded and worn appearance of the remaining finish, as well as the damage incurred through partial stripping, the owner was also interested in learning more about the possibility of the presence of original finish. Little is published on the original finishing techniques employed by the Gebrüder Thonet Company, and it was decided that an investigation of the finish on the rocking chair in comparison to the available literature may shed light on the nature of the original finish. Breaks in the chair also allowed for access to otherwise hidden areas of wood that would be filled during treatment, providing favorable conditions to sample the chair for wood identification. As a student planning to pursue wooden artifact conservation, it is valuable to have the opportunity to analyze the finish and practice wood sampling and identification.

In consideration of the use life of the rocking chair, and the historical value of the rocking chair as a functional object, it was decided to take a conservative approach to the object's treatment. Priority was given to structural stabilization and replacement of the missing back splat, which required the construction of a custom mold. The overall treatment, including fills and finish compensation, was informed by the existing wear on remaining elements of the chair. Since the chair would be returning to a private home after treatment, conservation grade materials were chosen that would be durable in a dynamic living space.

2. HISTORICAL BACKGROUND

2.1 VENEER, WOOD LAMINATES, AND BENTWOOD

Veneering is a technique that dates before 3000 BC and has served distinct stylistic and functional purposes throughout the history of woodworking and furniture making. The layering of thin veneers of wood into parallel-grain laminations and cross-grain ply is also an ancient practice, with early examples of plywood coffins dating from 2700 BCE (Morley 1999). During the 17th and 18th centuries, veneering for decoration and the purpose of concealing structural features in furniture construction became particularly popular. However, it was not until the 19th and 20th centuries that plywood (cross-grain laminations) and laminated wood (parallel-grain laminations) gained popularity as structural elements in furniture design (Knight and Wulpi 1927). Although veneers and laminated structures were not a new concept when Thonet began experimenting with laminations in the early 19th century, his innovative methodology and extensive use of wood lamination in his furniture overcame prior limitations of the technique.

Fig. 1. Detail of Gebrüder Thonet stamp and paper label found on the interior front edge of the seat rail.

Bending solid wood was also not a novel concept at the time of Thonet's inception of bentwood manufacturing techniques. Bentwood has a long history of use for traditional shipbuilding, basketry, coopering, weaponry, instrument construction, and many other object types, each of which employs different methods to manipulate the material. Due to wood's limited flexibility without conditioning, wood has historically been kerfed, boiled, steamed, and treated with chemicals to increase the material's dynamic range.

Craftsmen have long understood the characteristics of distinct woods as well, which lend themselves to specific applications. Yew and ash, for example, are common woods used for the construction of bows due to their elasticity and strength (Taylor 2001). Typically, dense-grain wood better serves the purposes and demands of wood bending due to the resilience and elasticity of the cells.

Furniture with bentwood elements also already existed by the 18th century with the inception of the English Windsor chair, and in 1808 Samuel Gragg was granted a US patent for building a chair entirely from bentwood (Von Vegesack and Thonet 1997) (fig. 2). However, it was Thonet's development of mass manufacturing processes of solid bentwood that revolutionized the production of bentwood furniture and created an industry.

Fig. 2. Samual Gragg's "Elastic Chair," 1808-12. Courtesy of Winterthur Museum.

2.2 GEBRÜDER THONET

Thonet, born in Boppard-am-Rhein, Prussia (present day Germany), was trained as a cabinetmaker and began experimenting with lamination bending around 1830. His first major strides in the development of lamination bending was devising a system to obtain compound curves; however, the structural instability of the laminated compound curves that he was able to produce compelled him toward new experimentation with solid bentwood. In 1842, Thonet and his family moved to Vienna at the bequest of Prince Klemens von Metternich, the prime minister to Emperor Franz Josef. With beneficiary support from the Imperial Court, Thonet continued to experiment and advance his designs, and in 1850 he produced Chair No. 1, which incorporated several lengths of solid bentwood (Wilk 1980). In 1853, Thonet founded Gebrüder Thonet, naming his five sons co-owners (fig. 3). In the following years, Gebrüder Thonet successfully developed mass manufacturing processes for bending solid wood, and in 1856 the company received a patent for its methods. In the spirit of industrialization, the craft of creating furniture was scaled up, and specialized factory workers were employed to bring the imaginative and previously impossible furniture designs of Gebrüder Thonet to life.

Fig. 3. Michael Thonet, seated center, and his sons, 1850s. Courtesy of Victoria and Albert Museum.

Whereas Thonet's lamination furniture was made of several types of wood veneers, his solid bentwood furniture was made entirely out of beech (*Fagus*). The company built several factories and purchased multiple beech wood forests in modern day Czech Republic and Hungary. The interchangeability of parts was key to the concept of mass production for the company, and Gebrüder Thonet continued to incorporate both laminated and solid bending systems in their designs. When Thonet's patent expired in 1867, competitors began to produce bentwood furniture as well. Most notable of these early competitors was the Jacob and Josef Kohn Company.

The first step in the process of manufacturing bentwood chairs was to prepare logs. Originally, the logs were transported directly to the factory for processing; however, sawmills were eventually built directly in beech wood forests, and the logs were cut and turned before being transported to a factory. These turned rods were then air-dried, steamed, and tested for weaknesses. Next, the steamed rods were bent into iron molds (figs. 4, 5) and placed in warm drying rooms to stabilize the moisture of the wood. After being removed from the molds, the pieces were then machined for hardware, sanded, and finished. The exact materials used to finish Thonet chairs is unknown, but the 1904 catalog offers furniture, depending on the model, painted (*lackiert*), polished (*poliert*), or both (Thonet 1980). Available coloring included natural, walnut, palisander, mahogany, black, oak, aged oak, green, and red.

Fig. 4. Thonet factory steam wood bending, 19th century. From Wilk (1980).

2.2.1 Rocking Chair Number 221

The first examples of rocking chairs are found in the 18th century, with the American Windsor rocker (ca. 1750) being the most recognized. Originally, these chairs were side chairs or armchairs modified with runners to form rockers (Renzi, Renzi and Thillmann 2007). The form lent itself well to the technique of bending wood, and Gebrüder Thonet rocking chairs embraced the curvilinear rocking chair as an expression of the potential of bentwood. Furniture collectors and Thonet scholars Chiara and Giovanni Renzi and Wolfgang Thillmann wrote, "Thonet's rocking chairs made rocking chairs a 'classic' item of furnishing" (Renzi, Renzi and Thillmann 2007, 9).

The first Gebrüder Thonet rocking chair was produced in 1860. Rocking Chair Number 221, the designation of the chair brought in for analysis and treatment, was first manufactured in 1899. Only two pieces were produced the first year, whereas 195 were produced in 1900 (Thillmann 2015). Rocking Chair Number 221 was designed as a part of a larger set of furniture, including an armchair (*Fauteuil*), side chair (*Sessel*), and sofa (*Kanapee*), all with the same model number. This set (chair number 221 was first introduced in 1895) was indicative of the emerging art nouveau style to follow (Wilk 1980). For an additional fee,

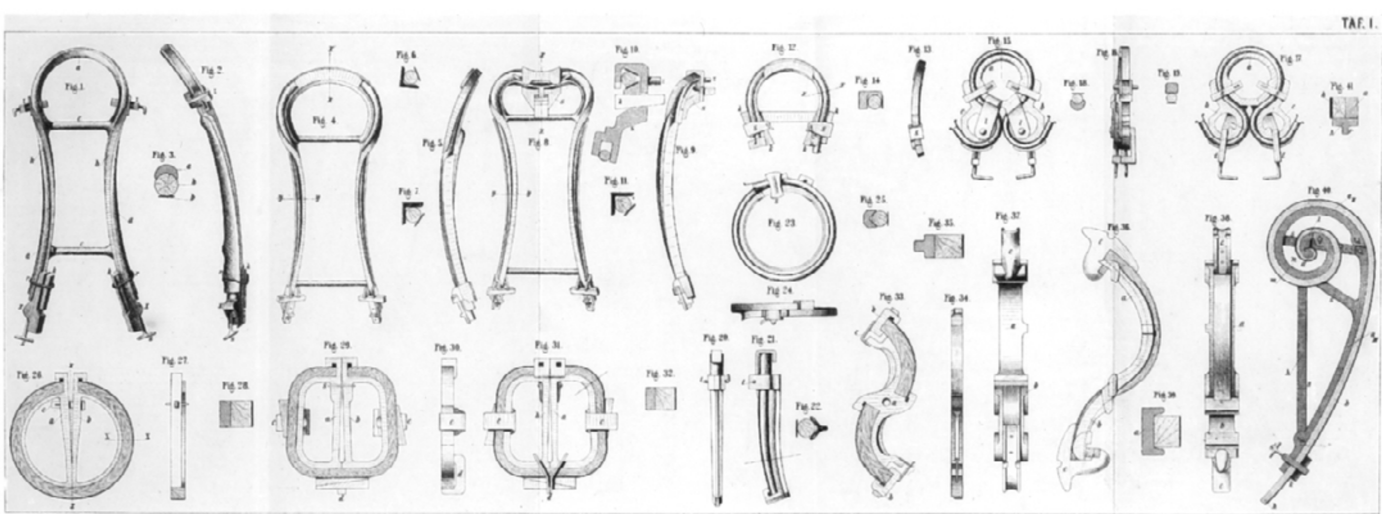

Fig. 5. Thonet iron bending forms for bending solid wood. Courtesy of Victoria and Albert Museum.

the furniture offered in set number 221 could be engraved in the simple style (*graviert*) or modern style (*modern graviert*). The engraving could also be bronzed (*bronziert*) (Thonet 1980).

Rocking Chair Number 221 was constructed out of 14 pieces of bentwood, including a laminated back splat (Thillmann 2015). This back splat would have been created out of several layers of veneers molded in warm presses (Wilk 1980). The back splat is positioned in slotted joints along the bottom of the crest rail and top of the lower rail. Each fanned slat of the back splat was further secured with a small nail and plugged hole. Figure 6 illustrates the rocking chair with back splat as it was depicted in the 1904 catalog.

As is described in the catalog, the entire chair (with exception of the back splat) was joined with screws with galvanized heads. It was recommended to costumers that the hardware be tightened occasionally (Thonet 1980). All 14 of the wooden pieces of the chair (with exception of the back stretcher) were engraved in the simple style, and the seat was caned.

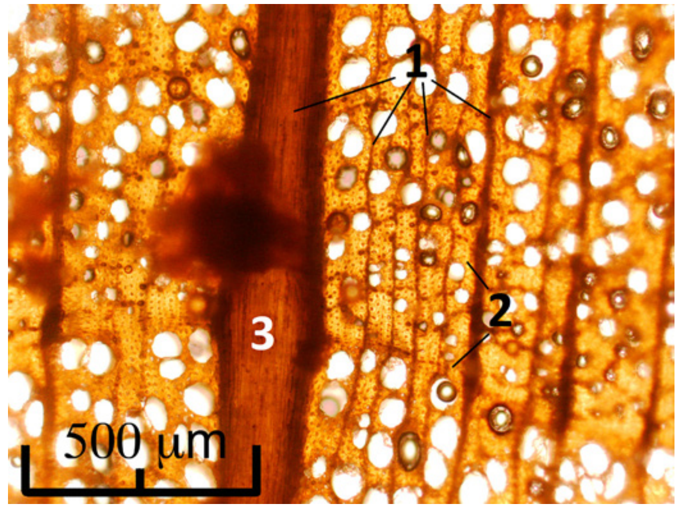

Fig. 7. Micrograph of transverse section. PPL. (1) Variable ray size and irregular distribution. (2) Pores decrease size at latewood. (3) Ray nod.

3. MATERIAL ANALYSIS AND EXAMINATION

In addition to treatment, material analysis of the wood and finish was also conducted with the help of Professor Jiuan Jiuan Chen, Dr. Aaron Shugar, and Dr. Rebecca Ploeger. Questions regarding wood identification and finish analysis are commonly asked of wooden artifact conservators, and the condition of the rocking chair exposed suitable access points for sampling, providing me the opportunity to practice this valuable skill.

Fig. 6. Rocking Chair Number 221 as seen in the 1904 Thonet catalog.

3.1 WOOD IDENTIFICATION

Although the identity of the wood did not affect treatment decisions, the condition of the chair provided an ideal opportunity to practice wood sampling and identification, both of which are important skills for wooden artifact conservators. For wood identification, a small (approximately 5 x 5 x 4 mm) sample was cut from a damaged and already broken edge of the back of the crest rail with a scalpel. Transverse, radial, and tangential sections (figs. 7–9) were taken from this sample using a GSL1 microtome. These sections were then analyzed with a polarized light microscope to

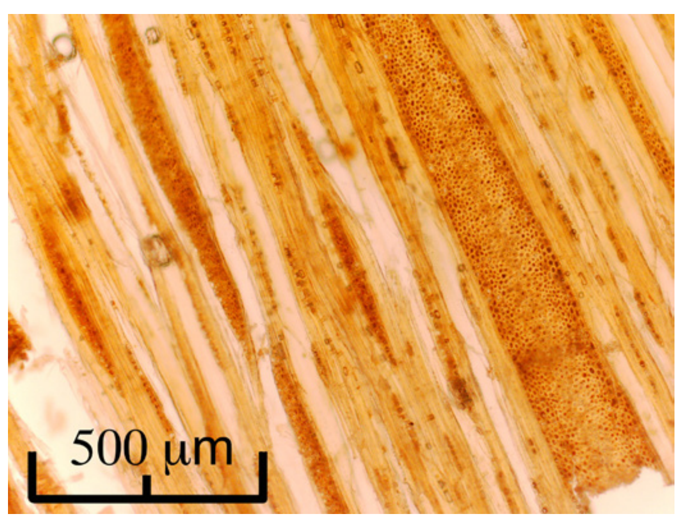

Fig. 8. Micrograph of tangential section. PPL. Multiseriate rays.

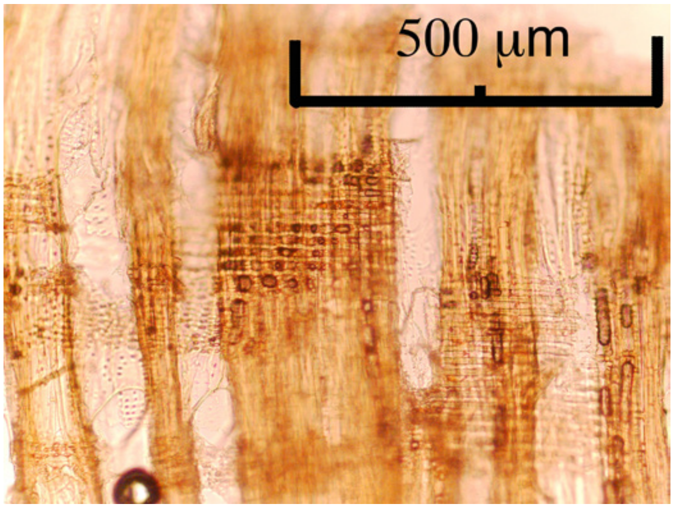

Fig. 9. Micrograph of radial section. PPL. (1) Simple perforation pits. (2) Homogeneous procumbent ray cells. (3) Longitudinal parenchyma.

identify characteristics of the cellular structure of the wood. It is reported that Gebrüder Thonet used beech (*Fagus*) for solid wood elements of their furniture, which was the anticipated result of wood identification of the rocking chair (Wilk 1980).

Due to the presence of fibers and vessel elements, as well as upright and procumbent ray cells, the wood can be identified generally as a hardwood. The pores appear diffuse porous; however, pore size decreases abruptly at the late wood to early wood transition. Ray nodes are also visible in the transverse section. The radial section revealed homogeneous procumbent ray cells, with no upright ray cells present and simple perforation pits. A wide range in the number of cells across the width of the ray is visible in the tangential section, with most rays appearing multiseriate. These cellular features are all characteristic of beech. Whether the wood is American beech (*Fagus grandifolia*) or European beech (*Fagus sylvatica*) cannot be determined. However, due to the known historical context of the chair's production, it is most likely European beech (Hoadley 1990; Schweingruber 1990).

3.2 FINISH ANALYSIS

Although the finish on the rocking chair was partially stripped before it was brought into the Art Conservation Department for treatment, the owner was interested in preserving what remained of the finish and learning about the possibility of the presence of an original finish. Visual inspection of the finish included long-wave UV visible fluorescence (UVA-Vis), microscopic examination of cross sections, and analysis of dispersed media and pigment particles with polarized light microscopy (PLM). Transmission FTIR and XRF were conducted to characterize the chemical composition of the finish layers. This information was then compared to what little information has been written about Gebrüder Thonet finishes to assess the possibility of the presence of an original finish.

Fig. 10. Sanded proper right stile, comparison of normal illumination (left) and UVA-Vis (right). (1) Exposed wood. (2) First layer(s) of nearly nonfluorescent finish. (3) Second layer(s) of bright orange-yellow finish. (4) Top layer(s) of nearly nonfluorescent finish.

Analysis began with a macroscopic visual examination of the chair using long-wave UV radiation. The excitation of materials induced by this radiation causes some materials to fluoresce, and the variance between fluorescence characteristics can aid in identifying different materials present. Although definitive material identification cannot be inferred through UVA-Vis alone, certain materials tend to fluoresce in characteristic ways and can help to guide further analysis.

The fluorescence of the surface of the chair was highly variable. However, four distinct areas of fluorescence were ultimately distinguished. This was best exhibited in areas where the chair was partially stripped and sanded, revealing layers of varying fluorescence (fig. 10). Areas of bare exposed wood, the base layer, fluoresced a pale blue-green. The next layer or layers of finish exhibited little to no fluorescence. Above this, a layer or layers of finish fluoresced bright orange-yellow to orange, which is typically indicative of shellac. Last, the top layer or layers of finish

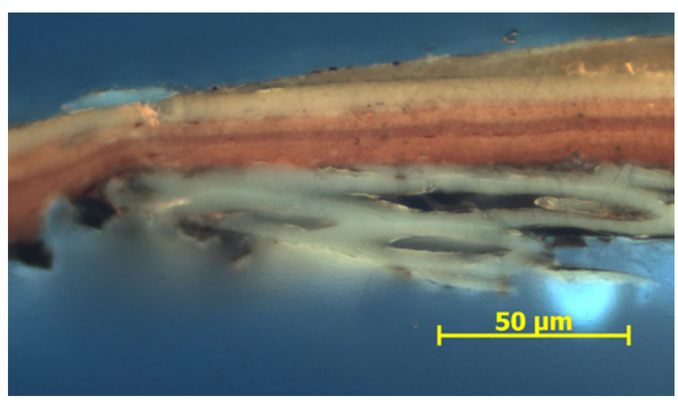

Fig. 11. Micrograph of Sample 5 (taken from area of the chair with the nearly nonfluorescent topcoat) cross section with UVA-Vis.

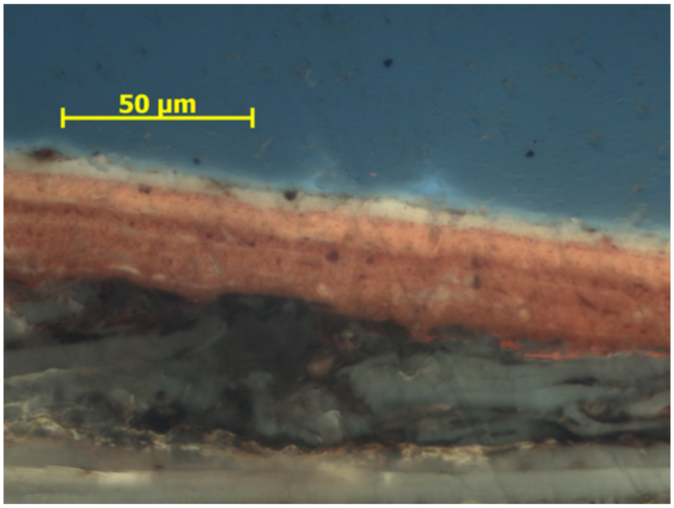

Fig. 12. Micrograph of Sample 9 (taken from area of the chair with the orange fluorescent topcoat) cross section with UVA-Vis.

exhibited little to no fluorescence. This layer appeared to have only been selectively applied to areas of the chair, suggesting that it was added as a touch-up material and is not original.

Cross sections of the finish were taken to gain an understanding of the layering structure of the finish in relation to the macroscopic layers visible with long-wave UVA-Vis. Sections from areas of the chair with the fluorescent orange top layer(s) were taken, as well as sections from areas of the chair with the nearly nonfluorescent top layer(s) (figs. 11, 12). The coloring agent used for the finish (e.g., dye, pigment) was also of interest when viewing the cross sections. Although some possible pigment particles were visible in the cross sections, it was not possible to determine whether this was dirt or particles used as a bulking agent rather than a colorant. The even coloration of the layers may suggest the presence of a dye rather than pigmentation.

The layering structure of the finish seemed to be fairly consistent across the chair, with the presence or lack of a dull yellow-brown topcoat being the most visibly significant variable. This layer may be associated with the nearly nonfluorescent top layer, present on portions of the chair, seen macroscopically. With the aid of transmission μ-FTIR, XRF, and the analysis of dispersed pigment with PLM, a theory was formed for the layering structure of the rocking chair's finish, and it is believed that an original finish is present.

Transmission μ-FTIR was used to chemically characterize the organic materials present within the fluorescent and nonfluorescent layers of the finish (figs. 13, 14). The closest spectral library match for the base nonfluorescent layer(s) was seedlac, indicating that shellac is present. Shellac typically fluoresces a bright orange; however, the interaction of the material with other substances, such as wood, can alter the fluorescence observed. The use of dyes for coloration and bulking materials could also affect the fluorescence. The fluorescent layer(s) on the chair most closely matched the spectral library for an aged mixture of copal, sandarac, and shellac (fig. 13). Shellac is often mixed with oils or natural resins for French polish, a high-gloss finishing technique, which may have been employed on Gebrüder Thonet furniture. The mixture of shellac and a natural resin could also explain the yellow-orange fluorescence of the topmost fluorescent layer(s).

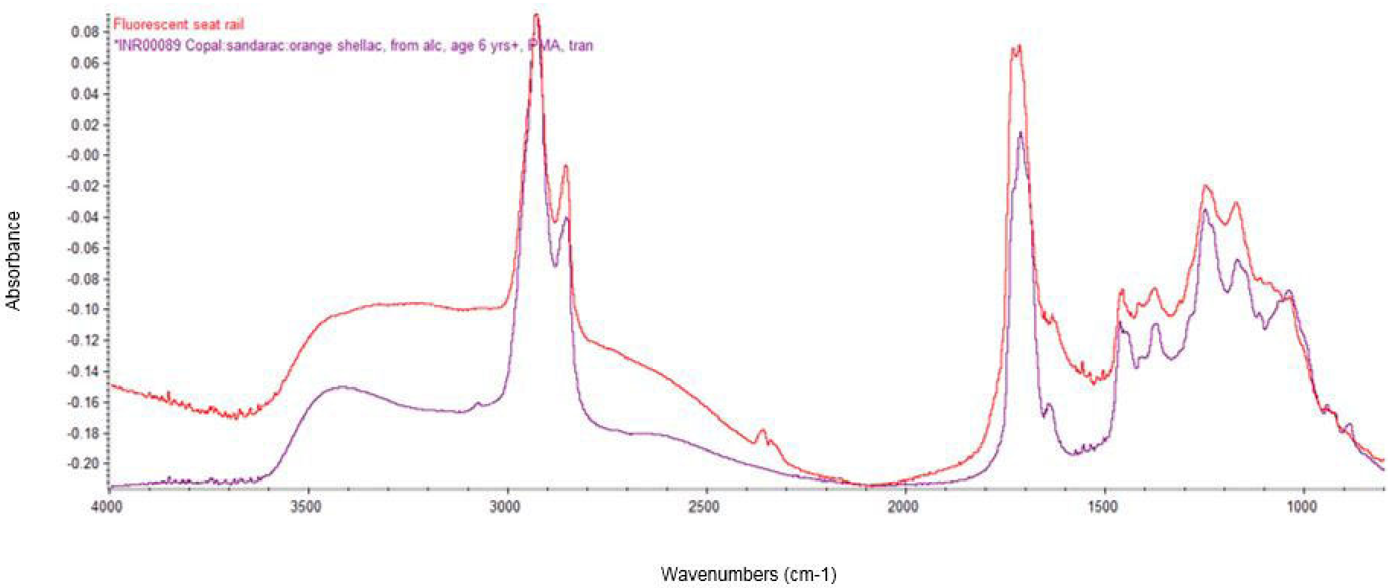

Fig. 13. Transmission FTIR spectra. Red spectrum represents a sample taken from the fluorescent layer of the finish on the seat rail. Blue spectrum represents library spectrum of a copal, sandarac, and orange shellac blend.

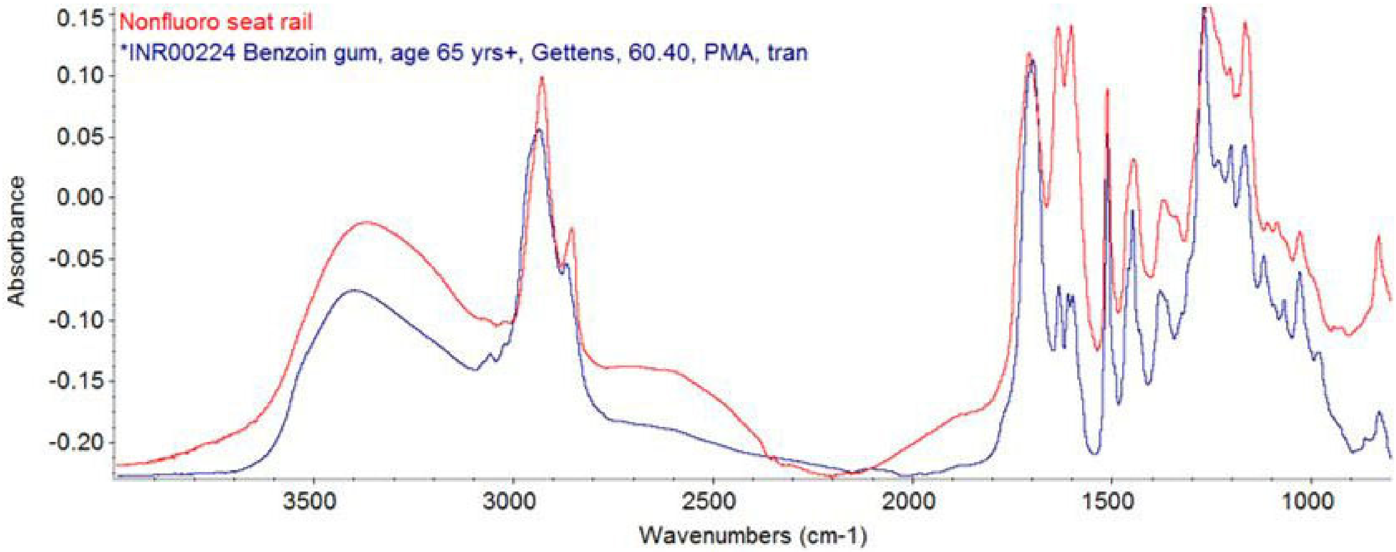

Fig. 14. Transmission FTIR spectrum. Red spectrum represents a sample taken from the nonfluorescent top layer(s) of the finish on the seat rail. Blue spectrum represents library spectrum of a natural resin.

The nonfluorescent top layer(s) of finish present on sections of the chair most closely matched several natural resins, including benzoin gum (fig. 14). Although this layer may not specifically be benzoin gum (which technically is not a gum), these results suggest that another natural resin may have been used. The lack of a good match in the spectral library may also indicate another material, including more modern synthetic resins that would not be present in the library database.

XRF was used to identify elements present in the finish, which can aid in identifying pigments, if present. The engraved

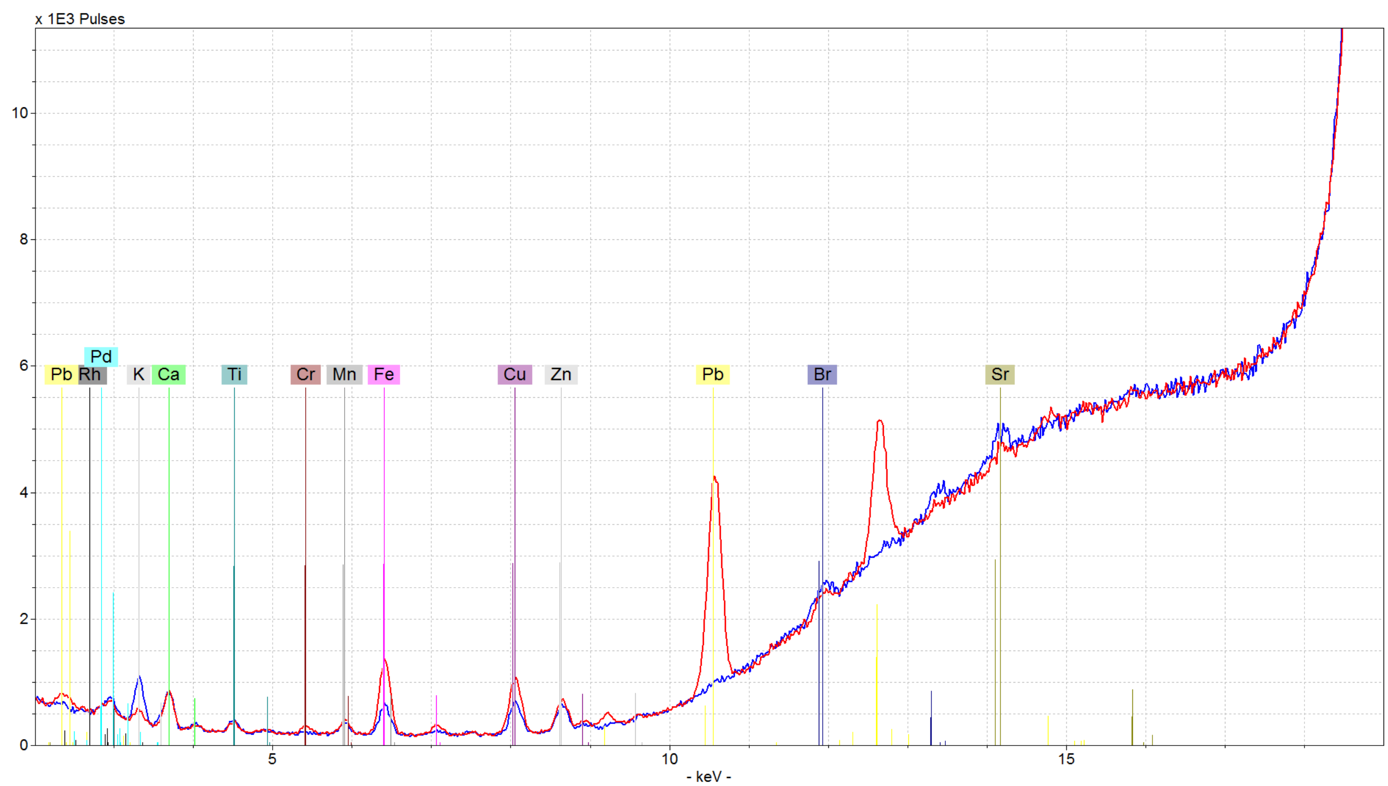

Fig. 15. XRF spectra. Red spectrum represents the finish on the front of the seat rail. Blue spectrum represents the exposed wood substrate.

Fig. 16. PPL photomicrograph of dispersed finish media. The binding media appears dyed, and small particles of pigment and dirt are present.

lines of the finish were also analyzed with XRF to determine whether they were bronzed, in which case higher peaks of copper would be present in the spectrum for the engraved lines than in the spectrum for the rest of the finish across the chair.

In comparison to the bare wood, the finish contained higher amounts of lead, iron, and copper. However, only the lead peak is significantly higher than the base peak of the bare wood (fig. 15). Therefore, the iron and copper peaks are likely from dirt on the surface of the chair. The engraved lines of the chair were also analyzed using XRF to determine whether they would have been bronzed. The spectrum did not show any elevated peaks for elements indicative of a separate treatment of the engraved lines than the rest of the rocking chair's finish, indicating that they were not bronzed.

PLM revealed that some pigment particles are present in the finish (fig. 16). However, it appears that the media is colored with a dye. Since most of the pigment particles remained bound in the finish material, it was difficult to determine whether multiple distinct pigment particles were present. XRF indicated the presence of lead in the finish in comparison to the bare wood substrate. Some of the pigment particles present may be a lead-based bulking material. Some of the particles are characteristic of zinc white; however, XRF did not indicate a greater presence of zinc in the finish than the bare wood substrate. Without more thorough pigment dispersal and separation from the binding media, and further investigation of the pigment particles, it is not possible to confirm the exact identity of the particles. Both lead and zinc white are commonly used as bulking materials for shellac, and it is likely that the particles here are being used for this purpose.

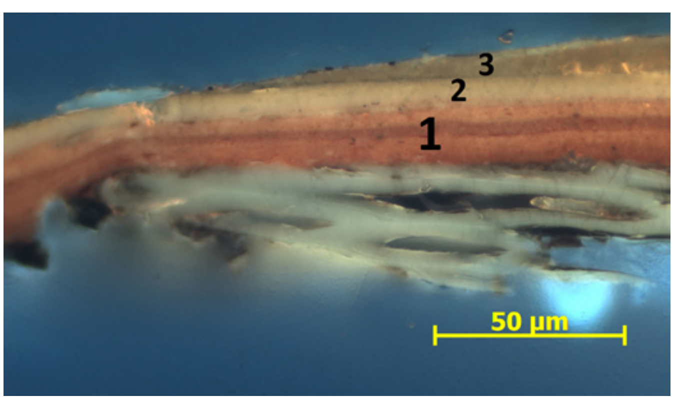

Fig. 17. Micrograph of Sample 5 cross section with UVA-Vis. (1) Dyed shellac with pigment particles used as a bulking material. (2) Original clear topcoat, composed of shellac and a natural resin. (3) Later coating, possibly a modern synthetic resin.

Based on a comprehensive interpretation of these analytical results, it is theorized that the base layers of finish are composed of a dyed shellac with pigment particles used as a bulking material and that the yellow-orange fluorescent layer is the original clear topcoat, composed of shellac and a natural resin, which could explain the variability in the layer's fluorescence when viewed macroscopically. The nearly nonfluorescent coating, only present on parts of the chair, is most likely a later addition, possibly composed of a modern synthetic resin (fig. 17). However, due to the time constraints of the project, no definitive interpretation of the finish could be reached.

Fig. 18. Rocking Chair Number 221 with missing back splat.

Based on the results from material analysis, it is possible that original finish is present on the rocking chair. According to Alexander von Vegesack, Gebrüder Thonet furniture was first stained, then a shellac solution was applied as a topcoat (Von Vegesack and Thonet 1997). Per the 1904 catalog, consumers could choose to have their furniture colored and lacquered or only lacquered (Thonet 1980). It is not possible to derive the exact methods or materials used from these vague descriptions; however, it can be simply stated that if a piece of furniture was colored, this layer or layers were first applied to the furniture with a topcoat of a shellac-based solution.

3.3 CONDITION

Due to the missing back splat, the chair cannot function as intended. The other structural elements of the chair, including the rockers, stiles, and arms, appear stable. The condition of the finish and number of holes and losses in the wood are aesthetically disfiguring.

3.3.1 Structure

The most significant structural concern is the missing back splat (fig. 18). The splat would have been a fan back joined at the lower rail and crest rail with slotted joints. The joint was reinforced along the crest rail with nails. There is a crack parallel to the grain running along the lower back section of the crest rail and a 7 x ¼ in. loss along the proper left side of this crack. The crack and resultant loss are most likely related to the missing back splat.

Most of the screwed joints appear stable. There is a missing screw on the proper left underside of the arched front stretcher (*Reifenbogen*) (Wilk 1980). Gaps from ranging from ⅛ to ¼ in. wide have formed between the proper right arm and stile and seat rail, exposing the screw threads of the joining hardware. The underside of the arm at the seat rail joint is cracked. Two holes along this crack suggest that the crack was the result of a previous attempt to fasten the arm to the seat rail with additional hardware. At present, there are two visible additional nails and a screw, which were added post production, joining the proper right arm and seat rail. The heads of these nails and screw are on the outside of the arm, unlike the proper left arm, which retains only its original two screws inserted from the inside of the seat rail. Most of the screw plugs appear intact, except for two missing plugs on the underside of the arm where it is joined to the armrest.

The seat rail of the chair has many unoriginal upholstery tack holes, in addition to remaining upholstery tacks on the underside of the rail. The chair seat was recently recaned and the caning is in good condition.

There are many small losses and abrasions in the wooden structure of the chair. The largest areas of loss are on the proper right armrest (approximately 4" long and of varying depth), along the crack on the back of the crest rail, and on the bottom proper left side of the lower rail (1½" by ½"). The loss on the lower rail is partially filled with a powdery brown material. There are also many cross-grain stress fractures along the bent sections of the rockers, proper left armrest, and arched stretcher.

Fig. 19. Stripped and sanded finish from the proper right side of the chair.

3.3.2 Finish

Most of the finish on the proper right side of the chair has been stripped, revealing bare beech wood (fig. 19). The finish is almost entirely removed from the front of the crest rail. The right side of the proper right stile, rocker, armrest, and seat rail have been wiped bare, with a gradation of finish left intact on the proper left side of these elements. There are numerous losses in the remaining finish resulting from abrasion, cracks in the strained bentwood, and losses in the wooden substrate.

The remaining finish is covered in a general layer of dirt and grime. There are several accretions on the chair, including what appears to be gum under the proper right armrest and white paint drips and contact transfers scattered across the entire surface. There is excess animal glue (identified by UVA-Vis) residue from a previous repair along the back of the seat rail.

4. TREATMENT

4.1 CLEANING

As determined by solubility and cleaning tests of the finish, the overall surface was cleaned with 2% to 4% solutions of triammonium citrate and 1% Surfonic JL-80x, adjusted to a pH of 6.5.

4.2 STRUCTURAL COMPENSATION

4.2.1 Upholstery Tack Holes and General Losses

The chair exhibited areas of wear typical of a used piece of furniture, which is evidence of its use life and valuable to the chair's historical integrity. Therefore, areas of loss in the remaining finish and structural losses incurred through use, including a loss along the exterior front edge of the proper right armrest, were not compensated or filled. Only losses that appeared to be recent or resulted in structural instability were filled. Structural fills were completed with Araldite AV 1253 epoxy putty over a barrier layer of B-72. The upholstery tack holes along the top of the seat rail were also filled in this manner, and all fills were inpainted with Golden Acrylics. Prior to filling, the areas immediately around the areas to be filled were lightly coated with wax to facilitate easy cleanup of excess fill material.

4.2.2 Back Splat

A back splat was created to replace the missing splat, which proved to be particularly challenging due to the compound curve imposed by the different radii of the curves of the crest rail and lower rail. The replacement back splat was constructed out of two interior layers of bendable plywood, positioned cross ply, with beech veneering on the front and back of this plywood core. A mold was created to clamp the laminations in place after gluing, which was created to reflect the compound curvature of the back of the chair. This was completed by first tracing the two curves at the crest rail and lower rail, which define the upper and lower limits of the radius of the back splat's curvature. These curves were then transferred to mat board and cut out to create templates for the outer dimensions of the mold. These templates were used to create angled ribs out of strips of 1-in. plywood, which were epoxied to a plywood base with Araldite AV 1253. The top of each rib was filed and sanded to gradually transition between the curvatures of the templates. A sheet of Masonite was then cut to fit the mold form and bent over the ribs to fair the form and ultimately create the plane of the compound curve. The Masonite was epoxied along the top of the two edge ribs and screwed across the top of every rib to create the mold face. This face was waxed with paste wax to prevent adhesion of the replacement piece upon gluing.

The layers of bendable plywood were adhered with fish glue and clamped in place on the mold with band clamps. A thin sheet of aluminum was used to cover the form once it was on the mold to distribute the pressure of the ratchet straps and clamps Next, the beech veneer was hammer veneered to the plywood form with hot hide glue.

Since a clear catalog image of Rocking Chair Number 221's back splat was not available to create a pattern for the reconstruction, images from the associated furniture set number 221, which provided a clear profile of the fanned back splat, were used instead and modified to fit the rocking chair's dimensions. The pattern for the back splat was applied to the form with charcoal and cut with a scroll saw. A small scorp and riffler were used to engrave the lines along the fanned slats, and the final shape of the back splat was finished with sandpaper and files (fig. 20).

Fig. 20. A scorp and riffler were used to engrave the splats of the fanned back splat.

To position the splat in the slots of the crest rail and lower rail without disassembling the chair, a scarf joint was cut at the bottom of the splat so that each piece could be individually fitted into place (fig. 21). The splat was inserted into the chair in two halves, and the scarf joint was adhered with carpenter's glue. Small nails were inserted through original nail holes or fill material along the back of the crest rail to further secure the top of the splat in place. The splat was inpainted to a level that matched the wear on the rest of the chair. A base tone was achieved by

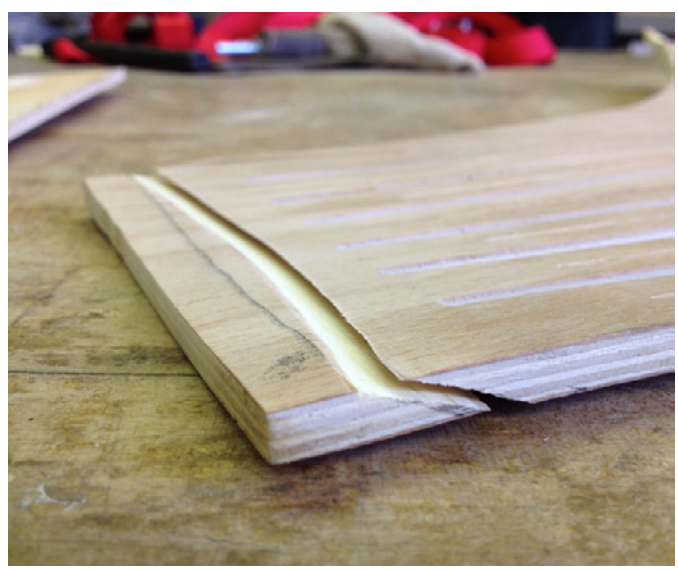

Fig. 21. A scarf joint was cut at the bottom of the back splat so that it could be positioned in place without disassembling the chair.

Fig. 22. After treatment, completed back splat.

Fig. 23. After treatment, color compensation on proper right side of the chair.

padding on ruby shellac, and color was applied with Golden Acrylics.

4.3 STRUCTURAL STABILIZATION

Failed and excess hardware was removed from what little wood remained of the right arm. This hardware included an assortment of nails and screws. The resulting losses from hardware holes were filled with Araldite AV 1253 epoxy putty. The arm was resecured to the seat rail with patinated new screws that matched the style of the originals (¼ in. 1¾ length slotted flat head steel wood screws).

4.4 FINISH COMPENSATION

The overall finish compensation was treated much the same way as the back splat. Only areas where the finish had recently been stripped and sanded were inpainted completed to a level that matched the remaining finish. A barrier layer of blonde shellac was padded onto the bare wood in these areas, and brush-applied Golden Acrylics were used for color. Soluvar was selectively applied as a topcoat to adjust gloss. Areas of remaining finish on the opposite side of the chair were used as a guideline for the extent of compensation (figs. 22, 23).

5. CONCLUSION

This treatment sought to respect the historical integrity of the chair by stabilizing unsound structural elements and compensating areas of recent loss, both structural and aesthetic. The major missing element of the chair—the back splat—was replaced to achieve visual continuity and allow the chair to function as originally intended. Aesthetically, the chair looks whole, and the historical wear of the chair is respected, maintained, and imitated throughout replacement pieces and finish compensation.

Thonet scholar Christopher Wilk noted that "it is unlikely that Thonet and his sons ever thought of themselves as artists," the chief of their concerns being the success of their business and the quality of their furniture (Wilk 1980, 135); however, there is a dynamic individuality found when studying the contours of this chair, the hand-engraved lines, and the asymmetry of a process straddling the fence between craftsmanship and industrialization. A chair such as this holds great value as something inherently reproducible but inescapably unique. It was a pleasure to honor both the artistry of design and history of function of this one of a kind Rocking Chair Number 221.

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My sincerest gratitude goes to the faculty and staff in the Department of Art Conservation at Buffalo State College. Professor Jonathan Thornton is an inspiring and encouraging mentor, and I cannot express enough thanks for all of the patience and time he spent helping me with this project. He is my role model for the Renaissance man I aim to one day be, and the Irishman I hope to one day dress like. Professor Jiuan Jiuan Chen and Drs. Aaron Shugar and Rebecca Ploeger were incredibly helpful with the material analysis of this rocking chair, in addition to being all-around enthusiastic and wonderful advisors. I would also like to extend many thanks to all of the foundations and individuals who have helped to fund my education and make this experience possible. My family, especially Hank Schuman, has been an unending source of support, and I can only hope to begin to pay it all forward as I embark on my career and life journey ahead. And last but not least, I could not have asked for a better group of classmates and hope for all the best for the Class of 2017. I know our paths will cross again, and it will inevitably be in celebration.

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ALTON J. BOWMAN

A New Tool for the Traditional Toolbox

ABSTRACT—This article details the combination of traditional French marquetry techniques with contemporary computer numerically controlled (CNC) inlay methods. The project is the replacement of a lost marquetry top for a writing desk base attributed to Jean-Francois Oeben. The top chosen for reproduction was the well-known mechanical desk by Oeben at the Getty Museum.

Topics discussed are ethical considerations, the relative advantages of each process, and similar works by Oeben in public collections. Also noted are sources of period veneers and substitutions for commercially extinct woods.

1. INTRODUCTION

The writing deskcame up for auction at a dealer in Paris. It was listed as attributed to Jean-Francois Oeben. In all appearances, the base of the desk is consistent with desks by Oeben around 1760 (fig. 1). The base has exquisite marquetry, finely chased mercury gilt bronzes, and consistent quality throughout. Most importantly, the leaves in the marquetry are black, almost exclusively the trait of Oeben and those in his shop.

This desk is very similar to a desk in the Rijksmuseum in Amsterdam and also one in the Residence Museum in Munich. All three desks are longer in width and shorter in depth than typical extravagant mechanical desks at the Metropolitan Museum and the Getty Museum. The most glaring fault in this desk is the lack of a marquetry top. Oeben was famous for his complex and beautiful marquetry tops. He always provided writing surfaces inside his desks, as the tops were only for beauty. Since this desk has a writing slide in the drawer, suspicion is immediately drawn to the redundant leather top (fig. 2). On close examination, it is soon obvious that the leather top is not original but a modern replacement. Tragically, we will probably never know what disaster befell the original extravagant and unique top.

2. PROPOSAL

Since the top was confirmed as a reproduction, the desk seemed a perfect candidate for an upgrade to a reproduction marquetry top. We suggested that we copy an authentic Oeben top, specifically the much-studied version at the Getty Museum in Los Angeles. Scale drawings of this top had been published in a book by Pierre Ramond (2000), which importantly had also listed the species and locations of each wood used in the top. Most of the veneers could still be purchased in Paris at George Placage, the veneer dealer we visited on the French Exchange Tour in 2001. In addition, we had the beautiful computer-generated simulation of the original colors of the veneers by technicians at the Getty. The idea was approved to proceed (fig. 3).

3. PREPARATION FOR PRODUCTION

Using Ramond's list, the veneers were ordered from George. Amaranth was used for the background and dyed blue sycamore was chosen for the ribbon and border decoration. Two shades of green-dyed sycamore were selected for the leaves and branches. Ebony was not used as listed by Ramond because of recent discoveries at the Getty proving that the black leaves were not

Fig. 1. Desk before treatment

Fig. 2. Drawer writing surface

Fig. 3. Veneers from George, glued to 1/8-in. plywood

ebony but in fact were green-dyed holly that had turned black with age. Ebony was used for some leaves to match the black leaves on the base and some inlay lines. For the flowers, pear, holly, and satine, or bloodwood, were used as the original. Tulipwood was used for the outside border (fig. 4). Barberry, in France called *epine-vinette*, was unavailable at this time. Barberry is almost commercially extinct in Europe. In addition, European boxwood is virtually extinct. The available woods were purchased from George, and the search continued for the rare ones.

The project was delayed when a customs inspector in Miami, the port of entry, sent back the bundle with the tulipwood, a *Dalbergia* species, declaring that a permit was required. A letter to the Department of Interior confirmed that no permit was necessary, as it only applies to solid wood, and veneer is considered a product. The tulipwood was permitted when it was imported in solid form to France, where George processed it into veneers. The veneer was lost in airports, returned to George, and another shipping cost incurred. This delayed the project 60 days.

4. ETHICAL CONSIDERATIONS

Establishing legality of the veneers was possible but not easy. The ethical consideration of using rare materials, however, is another matter. Some people refuse to use tropical hardwoods altogether, whereas others will use tropical hardwoods if certified sustainably harvested. This project was fraught with ethical considerations. In the first place, it could be argued that removing the replacement leather was interfering with the history of the

Fig. 4. Tulipwood border prepared for cutting

Fig. 5. Ramond drawing

object. In addition, all of the remaining Dalbergia species will move to CITES Appendix I in February 2018, thus joining Brazilian rosewood, elephant ivory, and tortoise shell as being no longer available for import or export. Even extinct mammoth ivory, always a legal replacement for ivory, has been made illegal in New Jersey and California simply because it looks like elephant ivory. In France, endangered species are available to conservators by the government, the theory being that the craftsmen are preserved by preserving the materials. There is a probability that this will be the last time this project is achieved in the United States.

5. THE DRAWING

It was soon discovered that the proportions of the Getty top were not the same as the top we had, and the initial drawing would not fit (fig. 5). Julien Feller, a student from the Ebenisterie St-Luc in Tournai, Belgium, reached out via friends looking for an internship in Texas. Already a master carver, Feller became very helpful in changing the proportions of Ramond's drawing (fig. 6). Using a traditional point-to-point ratio method and aided with a calculator, Feller re-proportioned the original drawing and filled in open spaces by transposing leaves and flowers from opposite sides.

6. THE WOODS

Feller also arrived with some barberry veneers graciously donated from the stock at Ebenisterie St-Luc for our project by the marquetry teacher Paul Meersseman (fig. 7). A close relative of barberry growing in Texas and the Southwest was found to have similar characteristics. The plant is locally called *agarita* (*Berberis trifoliata*) (fig. 8). The wood has a strong yellow color and dense grain pattern, making agarita a good substitute for European barberry (*Berberis vulgaris*) (fig. 9). European boxwood was found in solid form at Carlton's Rare Wood in Atlanta, Georgia. Kentucky smoke tree was also acquired from Carlton's and quickly became a favorite for imitating barberry (fig. 10).

7. THE TOOLS

In the 18th century, decorations for tops like Oeben's were cut out with marquetry donkeys (*chevalets*) and then inlaid into background veneers with shoulder knives (fig. 11, 12). Chevalets in

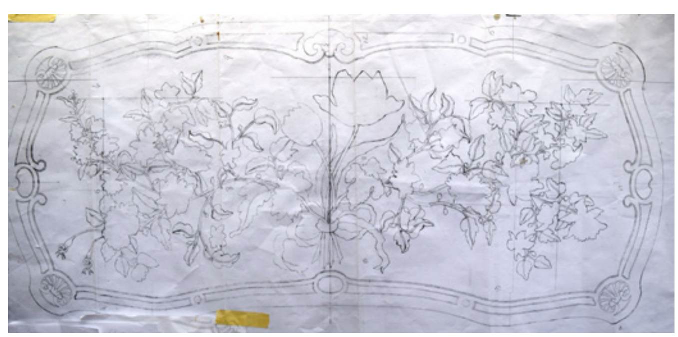

Fig. 6. Feller drawing

Fig. 7. Computer drawing

the 18th century were merely stools with vises to hold veneers while cut horizontally with fret saws. In the early 19th century, these tools were upgraded with a parallel slide mechanism that greatly improved accuracy and repeatability. This version is unsurpassed for marquetry even today according to many advocates.

Shoulder knives were shop-made tools used in Italy from at least the 15th century to do intarsia for church choir stalls. Another use was in the private studies of the wealthy, such as the Gubbio Studiolo now at the Metropolitan Museum. In our project, the CNC router will perform the inlay, and the floral decoration will be performed on the classical chevalet (fig.13).

The CNC router required for this project is a very sophisticated and expensive instrument requiring highly skilled and experienced programmers and operators. A web search discovered Custom Inlay, a small company that makes and inlays Bluegrass musical instruments in Caneyville, Kentucky. Their tool is a Techno-Isel, with a 1/32-in.bit for very fine cuts (fig. 14). The tool is accurate to 1/10,000 of an inch and is repeatable. A drawing is scanned into a computer, and a tool path is programmed

Fig. 8. European barberry

Fig. 9. Agarita

from that. The router will cut on the inside of the line and create the negative space at the proper depth. It will then cut out the inlay pieces on the outside of the drawing in veneer glued temporarily to 1/8-in. plywood. After cutting, the individual pieces are held in place with cellophane tape on the surface, and the plywood is removed from the backside by passing it through a thickness sander until matching the depth of the opening. The fit is very precise. Once the background and individual pieces are cut, the work of the CNC router is finished (fig. 15).

8. ADHESIVES

The balance of the project is mostly traditional. The green branches and stems are sand shaded in aquarium sand using a hot plate and then glued into place (fig. 16). Hide glue proved insufficient to hold the very small background pieces in place when cut at a high RPM, so slow-set epoxy was used as an

Fig. 10. Kentucky smoke tree

Fig. 11. Roubo chevalet, 18th century

adhesive for the background. Five-minute epoxy was used for the inlay pieces, as it was very fast and effective, and considering that this was not conservation, a nonreversible adhesive was not an issue. It will be a good test piece to determine the longevity of epoxy as an adhesive for veneers.For cutting with the chevalet, the flowers were glued temporarily to 1/8-in.plywood with spray adhesive and cut to drawings made directly on the veneers. Laminations were readily separated by lacquer thinner. After sand shading, the flowers were glued into the openings and clamped with blocks using waxed paper resist.

Fig. 12. Shoulder knives, 18th and 19th centuries

Fig. 13. Mesquite chevalet

The tulipwood border was cut out separately and glued in place around the perimeter of the amaranth. The fine inlay lines were installed traditionally. Engraving was done with a #11 veiner carving tool and filled with black hot melt shellac. With CNC work completed, the traditional floral work required 45 days.

Fig. 14. Techno-Isel CNC router

Fig. 15. Techno-Isel test pattern

Fig. 17. Completed top

9. FINISH

The top was scraped and block sanded in preparation for a hand-brushed shellac finish. To avoid bleeding when brushing shellac on amaranth and bloodwood, the first coat of shellac was sprayed. Fifteen subsequent hand-brushed shellac coats were hand sanded and polished bright to match the base. At this point, a decision had to be made whether to age the new veneers to match the 250-year-old base or leave it fresh and age naturally. The customer enjoyed the idea of a colorful presentation. It was decided to leave the new top as bright as the original might have been when delivered to an aristocrat more than two centuries ago (fig. 17, 18).

10. ANALYSIS

Analysis of the black leaves on the drawer was conducted with handheld XRF by Fran Baas and Laura Hartman of the Dallas Museum of Art. Results revealed strong peaks for iron (fig. 19). Similar results were found by Arlen Heginbotham on the Getty desk, the Rijksmuseum desk, and the desk at the Residence Museum in Munich. Old formulas for dying holly green included a mordant bath of ferrous oxide and then picric acid, which probably accounts for the iron. We believe that this is strong evidence to confirm attribution of the production of the desk to the shop of Oeben.

All spectra were gathered using a Bruker Tracer SD-III Analyzer: 40kv, 11.80-µA, yellow filter, 60 seconds.

11. CONCLUSION

The project was deemed a success because the CNC router reduced the laborious process of inlay by at least one-half. It is impossible to tell that the inlay was performed with a CNC router. In all aspects, the top appears to be a traditional reproduction.

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Fig. 16. Gluing in the pieces

Fig. 18. Assembled desk

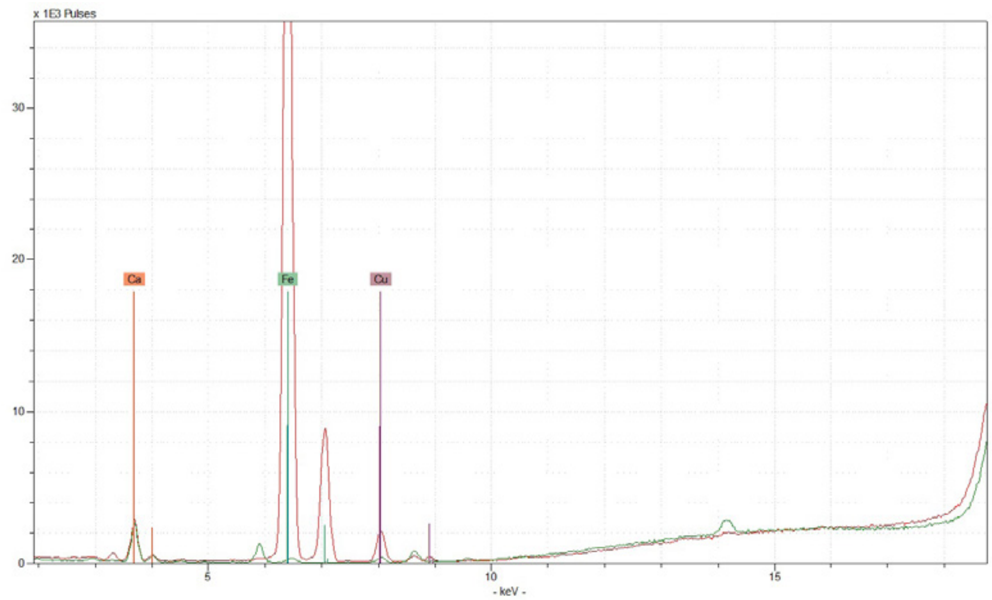

Fig. 19. XRF graph showing iron

Museum of Art, XRF analysis; and Jason Clark, Custom Inlay, Caneyville, Kentucky.

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SOURCES OF MATERIALS

Wood	Binomial	Source
Agarita, American barberry	*Berberis trifoliata*	Carlton's Rare Wood
Ebony	*Diospyros* spp.	George Placage
Holly	*Ilex aquifolium*	George Placage
Bloodwood, Satine	*Brosimum paraense*	George Placage
Blue-dyed sycamore	*Ficus sycomorus*	George Placage
Green-dyed sycamore	*Ficus sycomorus*	George Placage
Tulipwood	*Dalbergia frutescens*	George Placage
Amaranth	*Peltogyne* spp.	George Placage
Barberry, European	*Berberis vulgaris*	Donation
European pear	*Pyrus communis*	George Placage
Kentucky smoke tree	*Cotinus obovatus*	Carlton's Rare Wood
European boxwood	*Buxus sempervirens*	Carlton's Rare Wood

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MEGAN NARVEY

Understanding Currently Accepted Practice: Wood Fills and Conservation Material Decision Making

ABSTRACT—When choosing a wood fill material, there are many different combinations of adhesives and bulking agents that can be used successfully, yet there are few studies on the use and properties of these bulked adhesives. Without guidance from the literature, how do object conservators make decisions about what materials to use? A series of interviews was conducted with object conservators from a variety of backgrounds, working at six different museums in the United Kingdom. The results of the interviews show some obstacles in conservation practice that may at times prevent conservators from achieving high standards of material decision making.

1. INTRODUCTION

Wood is a ubiquitous material in museums, found across a spectrum of collections including archaeology, anthropology, social history, and the arts. Within a collection, a range of object types may be constructed from or include wood, varying in size from totem poles to beads. An object conservator must work with an array of different wood types, construction methods, decorated surfaces, age, condition, and more. They approach each treatment with additional skills gained from many different organic and inorganic material treatments. This variety of objects and experiences perhaps explains why treatments on wood are manifold.

In 1988, Grattan and Barclay listed the use of "plaster, concrete, bitumen, newspaper, toilet tissue, Plastic Wood, Polyfilla, epoxy resin, polyester resin/fiberglass, motorcar body filler, linseed oil putty, sawdust mixed with various resins, gesso, and various woods" as examples of materials previously used to fill wood (Grattan and Barclay 1988, 71). A more recent survey conducted in 2012 asked conservators what materials they use to fill wood: the answers included paper pulp, microballoons, paper tissue, wood flour, fumed silica, chalk, coconut shell flour, cotton fibers, wood, Plastazote, Flugger, plaster, wax, animal glue, acrylic resins, epoxy resins and putties, polyvinyl acetates (PVAs) and PVA emulsions, and Klucel G (Fulcher 2014). It is no exaggeration to state that there is an abundance of possible wood filler selections for use in conservation.

In this article, the use of bulked adhesives as wood fills by object conservators is examined. Although scientific studies on conservation adhesives are reasonably common, it is difficult to find studies of adhesives mixed with bulking agents. When there are so few modern comparative studies and so many materials to choose from, how do object conservators make decisions about what materials to use in treatment? To answer this question, a series of interviews with object conservators in the United Kingdom was conducted. To bring specificity and immediacy to the interviews, they were based on a case study.

2. CASE STUDY

The case study is the treatment of a Kwakwaka'wakw wooden figure (fig. 1), completed at the Museum of Anthropology at the University of British Columbia, Vancouver, Canada, in 2015. The object is constructed from western red cedar wood (*Thuja plicata*) and is historic but of an unknown age. It depicts a chief being carried on the shoulders of a slave and would have been displayed publicly to honor the greatness of the chief (Museum of Anthropology 2017).

The treatment was required to resolve two significant conservation issues: reattachment of a thumb fragment on the left hand of the chief, and removing and replacing the outstretched right arm of the chief to what is believed to be the original position. The reattachment of the thumb fragment comprises the case study, as it required the use of a bulked adhesive fill.

A detail of the broken joint can be seen in figure 2. The thumb fragment had evidence of four historic and unsuccessful methods of reattachment, including wooden pegs, iron-alloy nails, a gray adhesive that appeared to be an epoxy putty, and an unidentified shiny adhesive (fig. 3).

Examination of the object showed that there was little evidence of the shiny adhesive on the body: the adhesive had not transferred because of insufficient contact. The gray adhesive is bulkier and would have had better contact; however, this adhesive was too strong, and its use resulted in breakage and loss at the thumb joint. The evidence suggested that the wood was fragile and had been lost in the interior of the joint, and that an adhesive bulkier than the shiny adhesive and weaker than the gray adhesive was necessary to reattach the fragment to the body.

A fill material that could also serve as an adhesive to reattach the fragment was needed. The decision-making process relied on consultation and empirical testing due to a scarcity of similar case studies published in the literature. A 20% w/v Butvar B98 (polyvinyl butyral) solution in ethanol mixed with microballoons to a paste-like consistency was selected and applied to the area of loss with a spatula. The thumb fragment was fitted into

Fig. 1. Before and after treatment photographs of the Kwakwaka'wakw figure A17154. The treatment consisted of moving the position of the outstretched arm and readhering the broken thumb on the top figure's left hand.

place in its natural position on the body, and excess fill material was pressed out around the edges. After curing, the fill was carved down to a slight recess and inpainted (fig. 4).

Butvar B98 mixed with microballoons created a fill that was light, stiff, and easily carvable. It is strongly adhesive to wood, and the resin has good aging properties (Spirydowicz et al. 2001). The thickness of the mixture created an adhesive tacky enough to hold the thumb fragments in place while they cured, making it simple to create an adequate clamping mechanism using padding and weights.

3. INTERVIEWS

Although Butvar B98 and microballoons made a satisfactory fill for the case study, it was chosen primarily based on discussion with professional conservators and empirical testing. However, there are several other bulked adhesives popular in the literature that might have been used. To better understand how conservators choose conservation materials such as bulked adhesives in practice, a series of interviews with object conservators in the United Kingdom was conducted.

Care was taken in planning the interviews to avoid receiving idealized, general responses from the participants. First, the interviews were centered on the case study of the Kwakwaka'wakw figure so that all questions and answers could be specifically directed to answer one example of a particular wood fill. The case study was described in detail at the beginning of every interview, along with photos, and the participants were able to ask any questions that they found pertinent. However, the fill material that was used was not identified until the conclusion of the interview.

A second method to bring specificity and practicality to the interviews was to include a practical section with cured samples of four adhesive and bulking agent combinations, and to have the participants engage their empirical analysis skills by judging the samples on different physical characteristics. After extensive experimentation, the four samples were chosen based on their properties of ease of application, carvability, paintability, removability, low staining, and adhesion, and because they were not brittle or crumbly. These fill materials were:

A. 50% Paraloid B72 and microballoons
B. 30% Mowital B30H and microballoons

Fig. 2. Area of the broken thumb prior to treatment.

C. 1:1 Lascaux 360HV and 498HV neat, and fibrous cellulose powder

D. 20% rabbit skin glue and microballoons.

3.1 METHODOLOGY

Participants were carefully selected to provide a variety of object conservation perspectives, ensuring that there were current and former students of multiple training courses, trained in different decades, and working at different-size public and university museums. The interviews followed a three-stage approach:

1. Verbal description of the case study, accompanied by photos
2. Questionnaire and experiment
3. Open discussion.

After the case study was described in detail, the participants filled out a paper questionnaire. The paper questionnaire contained three components. The first component asked basic information about the conservators, including when and where they trained, and where they work; if and how the participants had treated a similar situation; how the participants would treat the case study and why; and what material characteristics they think are important in an adhesive wood fill.

In the second component, the participants experimented with the four sample fill materials described earlier, which were anonymized to reduce bias. The samples were presented as cured blocks, strips, and mock-ups of a wood fill (fig. 5), and the participants were asked to rank them based on physical appearance, flexibility, and density.

In the third component, the participants were asked which fill material they would choose from the four samples; whether they would still choose to use a different filling strategy for the case study; and whether they can guess the identity of the samples, to test whether the anonymizing process was successful. After the questionnaire was completed, an open interview was recorded. The interviews were allowed to proceed in a conversational

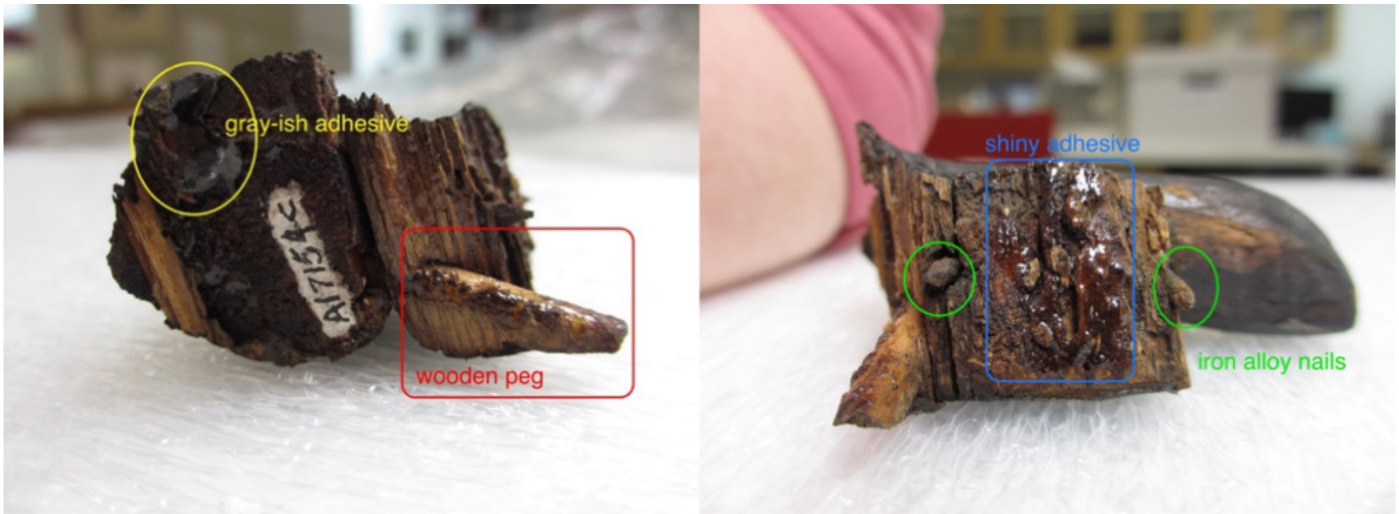

Fig. 3. Evidence of failed methods of reattachment on the thumb fragment.

manner so that topics of natural interest to the participant drove the interview.

4. RESULTS AND DISCUSSION

Eleven object conservators participated in the interviews. The participants included two students, four professionals in small to medium size museums, and five professionals in large museums. The data on when and where the participants trained in conservation can be seen in chart 1, and shows a modest variety for a small sample size.

Six participants reported that they had previously done similar wood fills to the one described in the case study, and two more described familiarity with other types of wood fill situations. Those who had done similar fills before wrote about having used a variety of adhesive and bulking agent combinations to do so, including Bonda Wood Fill (a proprietary filled polyester product), Paraloid B72 and microballoons, Paraloid B72 and Japanese tissue, Klucel G and Japanese tissue, and Lascaux 498HV and cellulose powder. Each of these participants described more than one approach depending on the object, and three participants did not name a particular combination but described having used many combinations in the past.

Suggested treatments for the case study example by the 11 participants include filling with Paraloid B72 with microballoons, twisted or macerated Japanese tissue, cellulose powder, or calcium carbonate; Klucel G with tissue fiber or Japanese tissue; Lascaux 498HV with cellulose powder, microballoons, or sawdust; methylcellulose with Japanese tissue; and animal glue with calcium carbonate. One participant wrote about using Klucel G, Lascaux 498HV, Paraloid B72, or Evacon R with either cellulose fiber, microballoons, or a similar bulking agent. The only filler combinations suggested by more than one participant were Paraloid B72 with microballoons and Klucel G with Japanese tissue, which have also been shown by Fulcher (2014) to be popular combinations.

Fig. 4. Excess fill material pressed out around the edges during treatment. The thumb joint after the fill was carved to a slight recess and inpainted.

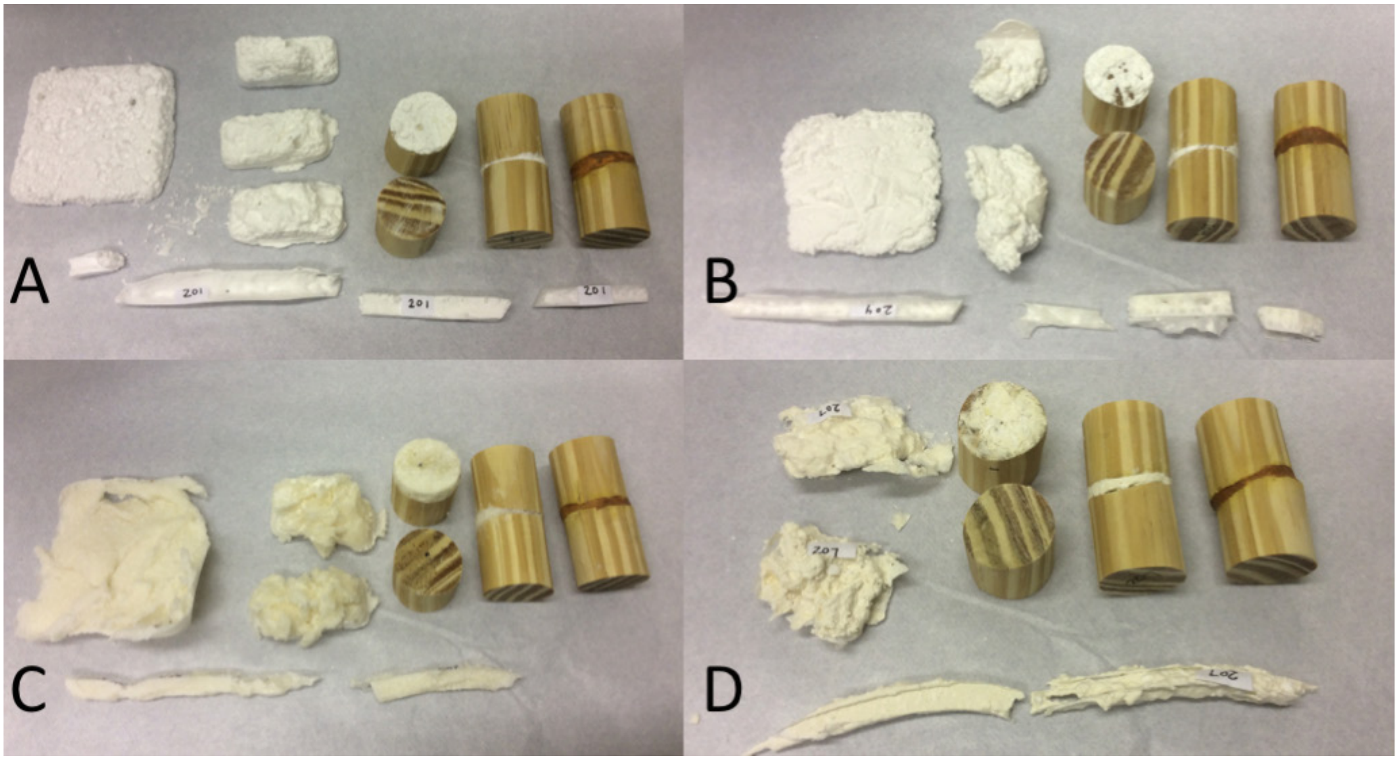

Fig. 5. Samples given to the participants to experiment with during the interviews. Each sample was presented as blocks, strips, and wood fill mock-ups. The mock-ups had each been carved flush to the wood surface. One mock-up fill was then painted while another was placed in the appropriate solvent atmosphere to break the joint and then removed with swabs from one side of the joint to show removability. A. 50% Paraloid B72 and microballoons; B. 30% Mowital B30H and microballoons; C. 1:1 Lascaux 360HV and 498HV neat, and fibrous cellulose powder; D. 20% rabbit skin glue and microballoons.

After the first question, it is impossible to know whether the variety of material choices presented by the participants is due to a lack of standardization in wood treatments or whether the "type" of wood fill described in the case study is still a very broad category of treatment. However, the next question narrows the field to a very specific fill—the particular example on the case study. Here, the participants still describe a variety of materials, including six different natural and synthetic adhesives combined with five different organic and inorganic bulking agents. This shows that the diversity of choices is not due to any

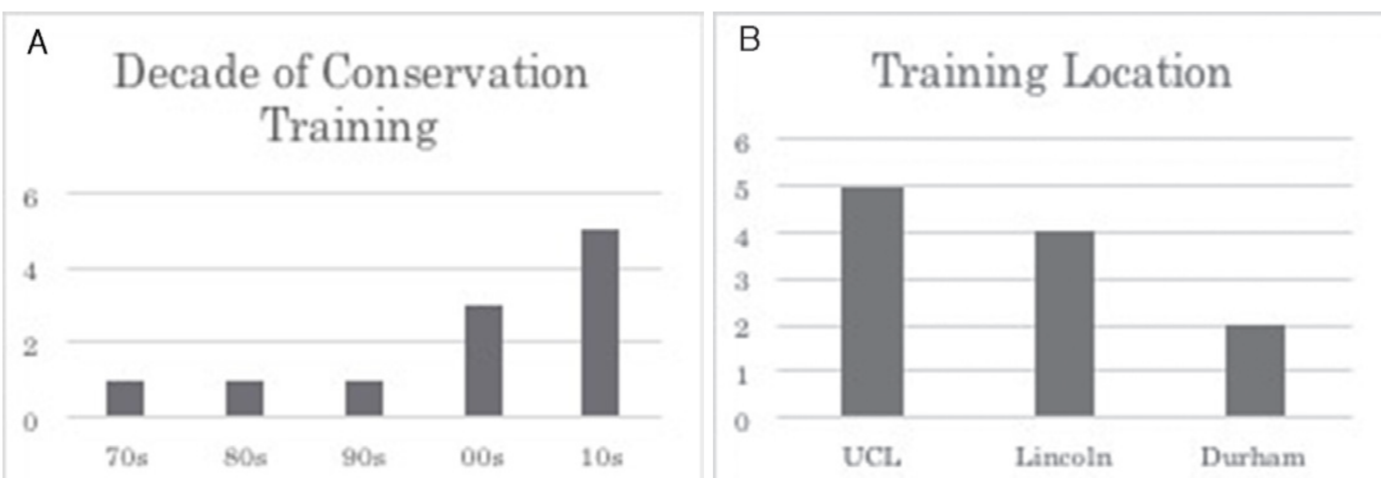

Chart 1. Graphs showing the distribution of training period (A) and location (B) among interview participants.

Table 1. List of Reasons Given for Selecting a Certain Fill Method Versus List of Reasons Considered Generally Important When Choosing a Wood Fill Material

Question 6 Case Study Specific Reason	Participants (#)	Question 7 General Reason	Participants (#)
Reversible/removable	5	Strength	8
Strength	5	Removability	7
Flexibility	4	Flexibility	5
Consistency	3	Ease of use	3
Aesthetics	2	Aging properties	2
Low staining	1	Compatibility with wood	2
Similar properties to wood	1	Good adhesion	2
Intimacy of join	1	Moderate to high glass transition temperature	1
Ease of application	1		
Easily distinguishable from original materials	1		
Aging qualities	1		
Use of certain solvents	1		
Time	1		
Confidence at application	1		
Material availability	1		
Cost	1		

vagueness when describing a wood fill. This is a specific wood fill that has been described in detail, and the choices are still wide ranging.

Question six asked participants to list the reasons for choosing the treatment they suggested for the case study, whereas in question seven, participants were asked to list what they believe are the most important characteristics of a wood fill. The results can be seen in table 1, listed in order of recurrence.

There is a subtle difference in asking why a conservator chose a specific material for a treatment and asking what characteristics they consider important for that type of material. It makes intuitive sense that although the answers overlap, the responses to question six are more practical, whereas the responses to question seven are more "big picture." The top four characteristics considered important by participants are the same for both questions: strength, removability, flexibility, and ease of use.

The success of the experimental method was in getting conservators to think critically and practically about how they use their empirical skills in decision making. The use of physical samples allowed for very interesting discussions afterward. The most popular choices of the four samples for use on the case study were Lascaux and fibrous cellulose powder, followed by Mowital B30H and microballoons. The final question revealed that Paraloid B72 and microballoons is quite easy to identify visually—the other three were more difficult.

When it comes to choosing wood fill materials, getting specific with the situation does not significantly change the huge variety of options. Since this is the case, what are the primary factors that drive conservation material decision making? In the following sections, quotes from the open discussion portion of the interviews are used to illustrate the most important decision-making factors.

4.1 PRACTICAL FACTORS

Six participants brought up the need to consider practical issues when choosing a conservation material, including time constraints, budget, and the future use of the object. Importantly, there is the fact that these practical considerations often limit material decision making to a familiar go-to material.

> "Sometimes the problem is the budgets are getting smaller and smaller, and certain types of adhesive I've noticed, more so to do with paper and Japanese tissue repairs, are quite expensive. So you have to weigh out the cost as well."

> "One of the things you automatically go for, like, Paraloid—I know how it works, if I don't have time to do tests like this, I know the Paraloid's going to work, I know that it's probably going to stick, I know that I can get rid of it easily. I know that I could, you know, either do the surface, like I can paint it or I can do a scrim of something else on top of it to make it more paintable. So I think it's just, when you're under pressure and you don't have that much time, that's your go to."

4.2 EASE OF USE

In the interviews, ease of use was most frequently connected with familiarity and confidence at application. Some participants felt surprised by the degree of importance they placed on familiarity and confidence when confronted with anonymous materials, and many participants felt uncomfortable discussing or choosing between the sample materials without knowing what they were.

Another surprising aspect of ease of use is appearance. Less-experienced conservators were more likely to seriously consider the appearance of the samples, whereas more-experienced conservators felt that appearance was dependent on one's skill and confidence at applying a certain material, and thus was not relevant to decision making.

> "For me, how something actually behaves when you're using it is probably, I'm almost surprised by how much I realize that matters a lot to me, is to be able to know that I can control how I apply it, that I'm not going to make a horrible mess, and that I can also get it off without making a horrible mess."

> "I think that [Paraloid B72 and] microballoons, I feel personally, blowing my own trumpet, just very confident at applying it. I've used it so often on all sorts of different types of material and I also like the fact that it's quite easy to remove during the process. So I find personally that I can create a really nice finish."

4.3 REMOVABILITY

Removability is primarily discussed by conservators who have had experience removing historic repair materials. Many participants shared anecdotes about removing old adhesives and fills, and described how it has shaped their approach to conservation in the present. Despite their apparent importance in the decision-making toolkit of conservators, these anecdotes do not supply reliability. Some participants describe finding animal glue with horror and others with relief; some rave about the reversibility properties of Paraloid B72 and others complain about removing it.

> "Because I've taken a lot of animal glue off things, and sometimes it's a real issue, having to use water instead of IMS."

> "I feel like animal glues can be really useful because they are quite good in terms of taking down."

> "I've used bulked things like Lascaux in the past, and I have sometimes found them a bit of a pain to undo. That's the advantage of something like B72. It is really easy to undo."

> *Participant*: "… the simple fact that I've had to remove B72 from coconut fibre."

> *Author*: "And how was that?"

> *P*: "Bad. Bad. So, so bad. When people think B72 is the answer, and it really isn't. . . . You've got to be able to know how to apply it to start with. How to work it and what concentration to work it at."

> *Participant*: "And it [AJK dough] does such damage because it shrinks, it rips the surface off. And it was so badly applied, it was beyond the area of the fill, so it lifts off the original surface. Nasty, nasty thing."

> *Author*: "Do you think that that's the quality of the AJK dough or just the quality of the treatment that was done, that causes the main problem?"

> *P*: (laughter) "It's both of [them]. If they'd been a bit more discrete in its use it might had had a real purpose. But it was both an inappropriate material used clumsily. It's not nice."

When the anecdotes of several conservators are collected together, it is clear that there is more to removability than the materials themselves. In reality, it is the skill and method of application and their appropriateness for the situation that make a material easy or difficult to remove. As Horie states, "There are few bad materials as such but there are many examples of inappropriate applications" (Horie 1987, 8).

4.4 FLEXIBILITY

Although participants described flexibility as an important fill characteristic during the questionnaire, during the interviews a more curious panorama emerged. Many participants described flexibility as very important in a wood material, whereas others thought it was irrelevant in this situation and could even possibly cause more damage. In fact, the participants often held completely contradictory views that could not be categorized by experience or training.

> "The other thing is that, as an organics conservator, people always say 'Oh you want a flexible material to fill wood,' and I'm thinking 'well, I'm not sure you do!'. . . Obviously in some situations it would be, if there is going to be quite a lot of movement or load-bearing, then flexibility is certainly a much more important consideration. But I otherwise don't need a flexible thing for wood."

> "I'd rather my fill to break than it to flex and something else to happen. If it flexes, it can then cause pressure points elsewhere."

> "Well I like it, it's flexible. It's gonna allow that movement. Particularly when you've got degraded or damaged wood. . . . But you do require a lot of flexibility."

4.5 TRENDS AND BIAS

The AIC's "Commentaries to the Guidelines for Practice" state that "materials must be recognized as currently accepted practice through appropriate testing and publication in peer-reviewed literature" (American Institute for Conservation 1997). Without significant scientific guidance or consensus in published currently accepted practice, conservators seem to rely on their individual experiences to guide decision making. However, this self-reliance has led to some interesting inconsistencies when it comes to material choice for wood fills, specifically with regard to removability and flexibility. As a result, it is necessary to examine the role of trends and bias. The following quotes show two instances where participants recognized their own bias during the open discussion:

> "Well that's very interesting. I would never have chosen rabbit skin glue and microballoons if I had known what it was!"

> "It does make me wonder whether I'm discounting it unfairly, I mean, especially on something that you might cover anyway, and that obviously, we would document. So we'd know."

The impact of trends and bias on the choice of conservation materials was apparent during the interviews: for example, when asked about the relationship between trends and conservation materials, one participant stated, "They are so trendy it's unbelievable." Some current trends with an impact on material decision making in object conservation practice that were discussed during the interviews include whether or not to use natural materials, the disuse of formerly popular adhesives like cellulose nitrate and polyvinyl butyral, and the popularity of Paraloid B72.

Both quotes citing bias earlier were about the use of rabbit skin glue as an option for the case study during the practical portion of the interview. Whereas some conservators were trained to consider the use of natural materials in appropriate situations, others were specifically trained to use only synthetic materials. The interviews showed that there is a lingering divide on the issue, and that it was generated during different eras and locations of training.

The once popular status of two resins came up during the interviews. The first was cellulose nitrate, which one participant claimed had a much-maligned status in conservation:

> "I use, very unfashionable, HMG cellulose nitrate adhesive. And it's very strong, and it's very reversible, and it stays where you put it. It's got immediate tack. . . . Nothing else has the same properties. And it does discolour on aging, but in most contexts that's not important. And the rest of its qualities are absolutely fine in terms of reversibility."

The other material that is no longer used frequently in the United Kingdom is polyvinyl butyral, specifically Mowital B30H. The literature hints that this material was once quite popular for use on wood (Ellis and Heginbotham 2004; Simpson and Payton 1986; Sakuno and Schniewind 1990). Yet it was not mentioned by a single conservator in the opening of the questionnaire, and six participants stated in the interviews that they had never even thought of mixing Mowital with microballoons to create a fill. At the end of the questionnaire, four participants had chosen Mowital B30H with microballoons as a fill material for use on the case study, hinting that its disuse is not a result of unfavorable properties.

The current popularity of Paraloid B72 was also a frequent topic of discussion during the interviews. Two conservators described their preference for Paraloid B72 and microballoons as being related to familiarity and lack of time, and another described using it but feeling uncomfortable that it was the "correct" option. Although Paraloid B72 is popular because of its reliable properties of usability and reversibility, conservators seem to be becoming wary that it is used too much and in inappropriate circumstances, and that students are not learning to use other materials.

> "It is one of those things that has taken over the field, and I find sometimes with students that they haven't heard of anything else other than B72."

> "I get very frustrated when I go to some of the students' presentations around the country, and ask them what resin they've used, and they use a resin just because they've been told to use it. Or, when I ask them about the properties of the resin they haven't got a clue."

5. CONCLUSION

There is a variety of conservation materials that may be successfully used on wood, and this variety is vital because there are multiple ways to successfully treat wood. Every conservator has skills and confidence at using different materials, and having a variety of materials means that a specific choice can be made based on the specific situation—for example, the need to avoid some solvents. But despite having this variety, many conservators still tend to have a go-to material that is frequently used. Additionally, much material decision making is made based on personal and anecdotal experience. Familiarity and confidence at application are powerful parts of the conservator's toolkit: however, the disparity between opinions on flexibility and removability indicate that personal experience needs to be supplemented by further research.

Fortunately, beyond encouraging further research on the subject, there is another simple solution that can be performed in each lab that can significantly help in broadening the use of conservation materials: making up a set of reference samples. Rather than doing tests for every treatment, which can be limited by a lack of time, conservators can quickly consult their own notes and the reference samples to choose one that appears the most appropriate for the situation at hand. Interview participants who had their own reference sample collections were better able to identify and comment on different characteristics they liked and disliked about the samples in the interview. Those without commented on how useful it was to see these samples made up. Students were surprised by the characteristics of materials that they had never seen in cured form. It is an easy and useful tool that can truly aid in the decision-making process.

> "I suppose what it does make me think is that I probably ought to spend some time now and again just mixing up different batches of different things. Because you don't often do this sort of thing, and you might make the choice based on the properties, and you might test a little bit to make sure it's not going to do anything crazy, but you don't do this sort of direct comparison very often."

> "This isn't a situation I've had before. So your working knowledge that you have, without having the opportunity to test all the time. You might end up, you know, not quite making the right decision. So I think having samples like this is really helpful."

The empirical skills of conservators should not be taken lightly, and the possible use of many different materials for a single task is not a cause for concern. As Caple says, "There will always be alternative views and they are an essential part of judgment. After all, if it were certain, a machine could decide rather than an educated, qualified and experienced human being" (Caple 2000, 8). In reality, without more research there is simply not enough information out there about wood fills to help conservators make well-informed decisions without relying on familiarity and personal experience. A larger issue may be that many conservators believe that their own personal experience is not sufficient to contribute to discussions on techniques and materials, and fear that others may be judgmental (Appelbaum 2007). This has led to a lack of discussion on the subject of material decision making. To achieve a less biased practice, conservators need to both think critically about their own assumptions and experience, and embrace conversations including many different experiences and techniques. A more open dialogue about material decision making could lead to a more nuanced and unprejudiced use of materials and techniques, establish what areas of conservation practice require more structured research, and create great benefits for the field as a whole.

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MATILDE RUBIO AND TIMOTHY L. LEWIS

Conservation of the Immaculate Conception at San Xavier del Bac

ABSTRACT—The 18th century polychromed and gilded wooden sculpture of the Virgin of the Immaculate Conception at San Xavier del Bac was subject to a conservation/restoration treatment. The sculpture resides in the main altar of the church San Xavier del Bac, located on the Tohono O'Odham Reservation near Tucson, Arizona. It is a living church in which the O'Odham people still attend for various celebrations throughout the year. The church is considered to be arguably the most significant historic building in Arizona. The description of the piece, the state of conservation, and the process is the object of this article.

1. INTRODUCTION/DESCRIPTION

The Virgin of the Immaculate Conception statue (fig. 1) at Mission San Xavier del Bac, known as the Immaculate, occupies a prominent position in the main altar of the church, 19 ft. from the floor level. The church is a working church situated 10 miles south of Tucson, Arizona, on the Tohono O'Odham Reservation known by the O'Odham people as Wak (fig. 2). *Wak* is an O'Odham word that means "to come in" or "to go in." As taught in O'odham history classes, Father Eusebio Kino, a Jesuit priest, visited the village of Wak in 1692 and christened it San Xavier del Bac. Construction of the current church began in 1783 and finished in 1797. This work was done by the Franciscans, Spanish, and Tohono O'odham.

The statue had been dusted and vacuumed several times at different periods of time but was never a subject of a complete conservation and restoration treatment until this present work, which was carried out from January to April 2016.

As always, the first step was to study and obtain as much information as possible. All available photographic and historical data were checked. Preliminary studies done in 2015 included chemical analysis of the paint and preparation layers and a research of the Immaculate's history and previous documentation. Cleaning and consolidation tests were also performed.

For the flesh tone (carnations), the chemical analysis and study of the surface through UV light was crucial for the identification and distinction of the original paint, as well as the over paintings that allowed for its appropriate removal.

The Immaculate is represented as a young woman standing over a half moon surrounded by a cloud and three cherubs. The sculpture is life-size, exactly 5 ft. 2 in. (158.48 cm) tall and 26 in. (66 cm) wide.

Like a traditional sculpture in Spain in the 17th century, this piece was done by two masters: the sculptor and the painter/gilder. The sculpture was achieved by joining pieces and planks of wood attached with rabbit skin glue. Straps of canvas were placed over the joints to create a stronger bond. The figure was then hollowed out from the waist down to reduce the weight and minimize cracking.

Once the sculpture was completely assembled and carved, it was prepared to be painted and gilded. This was done by covering the surface with several coats of rabbit skin glue. On several occasions, the bare wood was brushed with warm *gíscola*, which is animal glue and garlic essence.

The bottom of the statue was closed to reduce the risk of movement. This was done by adding two planks attached with glue and wood pegs.

The Immaculate and the three carved cherubs have glass eyes. The faces were cut longitudinally and carved from the back to install the glass globes. Afterward, the face was reattached to the head.

The traditional painting process begins with the application of several layers of gesso (calcium sulfate and animal glue). The areas where gold leaf and silver leaf would be applied received extra layers of bole of Armenia (iron-rich clay mixed with animal glue). For the Immaculate of San Xavier, traditional bole was substituted with a mix of earth pigments and calcium sulfate.

Traditionally, gold leaf and silver leaf were attached to the surface with animal glue. In this case and according to the chemical analysis, drying oil was used. The painting technique used in the Immaculate is oil paint, using again a drying oil as the binder for the pigments.

For the flesh tones, vermillion, white lead, and calcium carbonate were used with a technique called *encarnaciones de polimento*, which means "glossy flesh tones" (fig. 3).

The garments are profusely decorated. The exterior of the mantle was painted mixing Prussian and ultramarine blues with black and earth color, which gave it an appearance of almost black (fig. 4).

The repeated motifs in the blue mantle had nearly the same measurements, which suggest the use of a bendable pattern that

Fig. 1. General view of the sculpture before and after conservation treatment.

could follow the sculptural contours, even using it upside down or in a left and right manner.

To reproduce the gold threads of the fabric, the *estofado* technique was employed, scratching the painted surface to reveal the gold beneath. This particular way of doing *estofado* is called *rajado,* which in Spanish means "to cut." The gray tunic is

Fig. 2. Church of San Xavier del Bac. Photo taken by Donald W. Dickensheets, April 10, 1940.

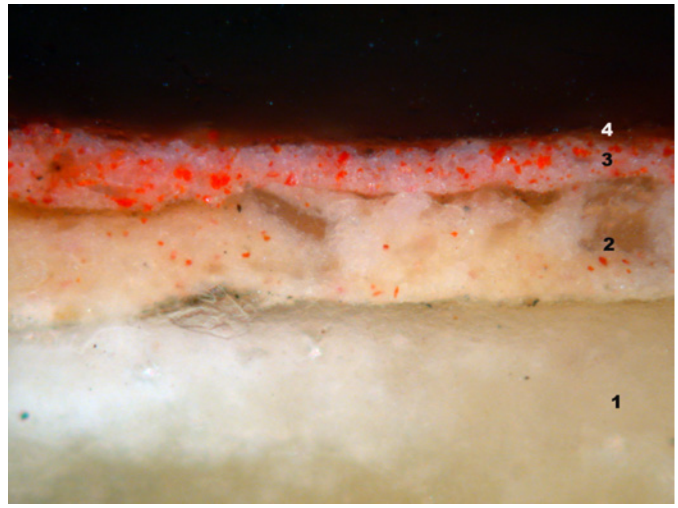

Fig. 3. Cross section seen through the microscope of a sample taken of the right cherub's chin (lens MPlan 20x/0.40). Layer number 1 is the preparation (110-250 μm), consisting in calcium sulfate and silicates. Layer number 2 is the original paint layer (50 μm), with white lead, calcium carbonate, and vermillion. Layer number 3 is the overpainting (20-40 μm), composed of vermillion, white lead, silicates, bone black, and calcium carbonate. The thin layer number 4 (0-10 μm) is an acrylic varnish. The discontinuous layer in between layers 2 and 3 is leftover original varnish, a pine resin, no thicker than 5 μm.

decorated with painted flowers and fruits, gold and silver leaf with a *rajado* background.

The motifs done with gold leaf and silver leaf are also decorated with a punch work. In the Immaculate, we can recognize at least three different tools: one to make small dots in a circular depression, the second one to create a rectangular cut impression, and the third one similar to a half-circular indentation.

2. STATE OF CONSERVATION

The statue had been precariously standing in her niche for at least 200 years. In fact, one of the major challenges during the course of the project was to bring the sculpture down from her niche, located at a height of 19 ft. from floor level, and return her without causing further damage.

To remove and lower the sculpture, a "cage" was constructed so that the sculpture was lowered safely and without causing further damage(s). Before the sculpture was removed from her niche, loose pieces of the sculpture were stabilized with Japanese rice paper and rabbit glue. Then she was wrapped with bubble wrap before being transported into the cage. The cage was made of wood with a 4 in. base and wire cables crossing over the top. The purpose of the wire cables was to tie a cord onto them to lower the sculpture down to the floor.

As the condition assessment began, it was obvious that over the years the different pieces of wood and the strips of canvas used for the joints had moved. This caused most of the cracks, which led to the loss of some paint layers.

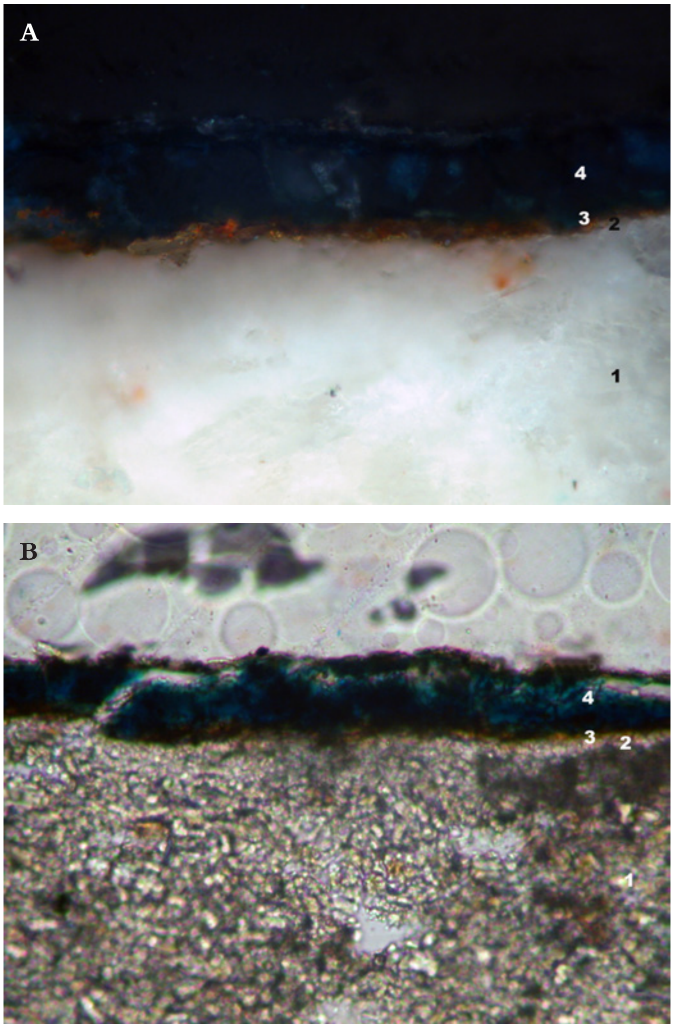

Fig. 4. Cross section seen through the microscope of a sample taken on the dark blue mantle. Layer number 1 is the preparation layer, consisting of calcium sulfate and silicates. Layer number 2 is a very thin reddish layer (0-10 µm). It is not exactly bole of Armenia but a mix of earth colors and calcium sulfate. Layer number 3 is the gold leaf (<0.5 µm), consisting of gold (92.55%), silver (4.67%), and copper (2.77%). Layer number 4 is the blue painting: Prussian blue, Ultramar blue, zinc white, bone black, and dirt umber. The image at the top (A) was taken using a lens MPlan 50x/0.75; the image at the bottom (B) was taken using a lens MPlan 20x/0.40.

Some of the damaged areas were caused by hits or mishandling of the sculpture. For example, there are slivers on the back indicating that the statue had probably fallen backward at some time. The right side of the moon was broken and reattached at the bottom, but the top part is missing.

Most likely at some time, the statue fell forward as well, breaking the hands, the left pinky finger, and the nose of the cherub on the right. The hands were reattached, but at that moment the cuffs of the tunic were repainted, covering the original gold leaf. When the pinky was reattached, slightly out of place, most of the original paint came off. This was very evident when the overpainting was removed.

At some point, the nose of the cherub was replaced with a new one made of beeswax. The wax was later eaten by an animal, almost certainly a rodent, as teeth marks can be seen.

The left glass eye of the cherub on the left and the right glass eye of the middle cherub were missing. As for the left eye of the middle cherub, its situation was so unstable that a slight touch was enough for the pieces to fall within the ocular orbit. At a closer look, pieces of the eyes were found in the eye sockets of both cherubs.

The sculpture surfaces were covered by a thick layer of dust and grime, and they were more pronounced in the back due to its inaccessibility. There were abundant mud dauber wasp nests on the entire surface, particularly in the unapproachable places. Bird droppings were also found on the head of the Immaculate.

The chemical analysis indicates the presence of an acrylic substance, used as a final varnish as well as consolidation material in an earlier restoration effort. There is also evidence of animal glues due to other restoration processes.

Most of the areas where silver leaf was used for ornament on the garments had turned a rusty brown color due to corrosion.

In a previous attempt at restoration, a thick deposit of animal glue was applied hot. It is the dash of old glue that runs from the edge of the mantle to the base, on the left of the sculpture. This caused the paint layer to rise and detach from the surface.

The remnants of an animal nest were discovered at the base of the sculpture. Some of the items found in the hole include the skeleton of a bat, two jaws of a rodent, pieces of string and cloth, an old piece of cloth with gold leaf decoration, a metal ring, watermelon and other plant seeds, and confetti.

Overall, the cohesion of the paint layers of the sculpture was fairly good, but in some areas those layers were flaking and even missing.

One of the things that caught our attention at the beginning of the project was the difference of the pictorial technique between garments and flesh tones. It was noted that the treatment of the fabrics was much more delicate and meticulous compared to that of the flesh tones. In fact, all of the flesh tones except the cherub on the left were carelessly overpainted, possibly at the beginning of the 20th century (fig. 5).

3. PROCESS OF CONSERVATION/RESTORATION

The conservation treatment approach of the Immaculate was very traditional. The choice to use natural and time-honored materials is based on using products that were similar and compatible to the original components.

A summary of the treatment products and methods includes the following. Structural consolidation includes the filling of large cracks with balsa wood and epoxy wood paste (Axon Madera). Paint layer consolidation was done by injection of rabbit skin glue. The cleaning was done in conjunction with the consolidation and vice versa.

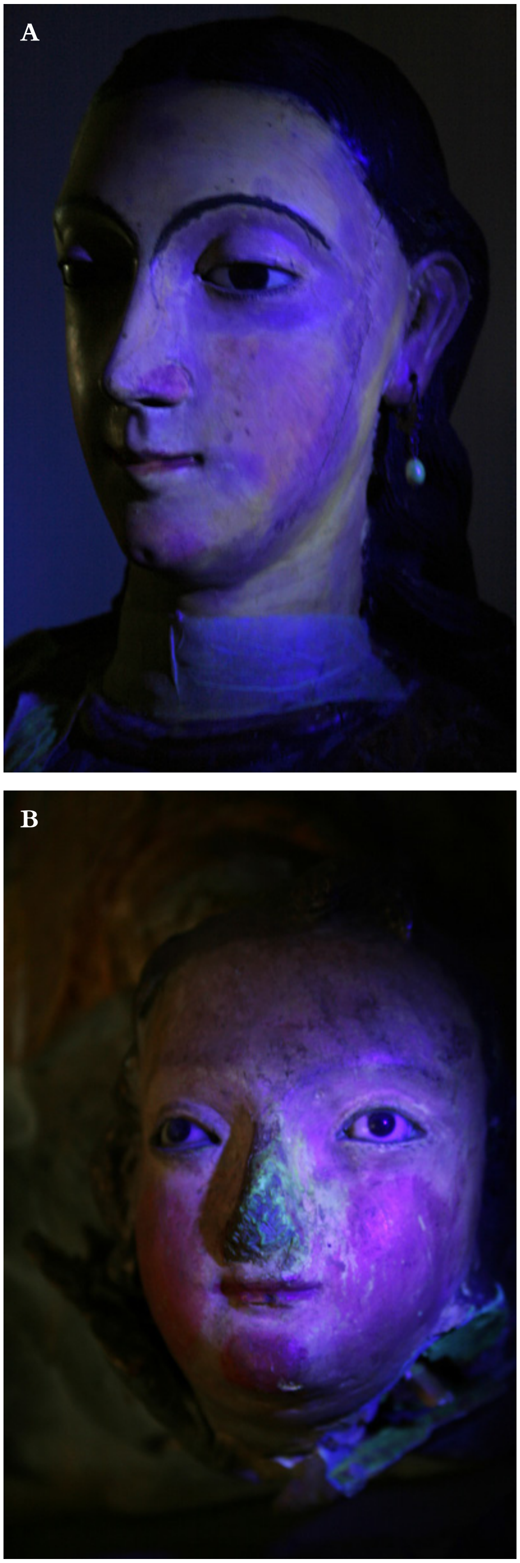

Fig. 5. (A) Detail of the Virgin's face taken with UV light. (B) Detail of the right cherub's face taken with UV light. Some of the wax that remained on the nose can be seen in yellow.

Fig. 6. Detail of the face half cleaned.

The removal of the overpainted restoration layers, mud daubers wasp nests, and other non-original substances was done using products and tools that were appropriate for each task. To remove the overpainting on the face and hands of the Immaculate (fig. 6), a paper tissue impregnated in a mix of dimethyl formamide and denatured alcohol (1:1) was applied over the surface for a period of seven minutes. After that, the area was final cleaned with the same mixture and with the help of a surgical blade. Denatured alcohol was used to neutralize the solvent.

On the cherubs, the thick layers of dust and grime were covered with a coating of Acryloid B-72 that had been applied in the 1990s.

To address this condition, the cherubs were treated with acetone to safely remove the acrylic coat. Then the dust and grime were removed with warm distilled water. The same cleaning process for the hands and face of the Immaculate was used on the middle and the right cherubs—the only ones that had been repainted.

For the cherub on the left, the eyeball pieces discovered in the left socket were extracted and cleaned. The socket was also cleaned and stabilized with the epoxy wood paste. Before the paste dried, the pieces of glass were embedded.

As for the cherub in the center, tiny pieces from the right eye were found inside the socket but not complete. Therefore, the decision was made to fill the socket with epoxy wood paste and reproduce the eye by painting it in. The left eye was so insecure that it moved while attempting to clean it, so the choice was made to remove the glass eye, fill the socket with epoxy wood paste, and set the eyeball before the paste dried.

The damaged nose of the cherub on the right was recreated using a conservation grade microcrystalline wax.

A traditional stucco mixture made with calcium sulfate and rabbit glue was used for filling losses of original stucco on the sculpture. Inpainting of the conserved areas was done using watercolors for the base layer and varnish colors (Maimeri) for the final toning. The painting technique used to distinguish the original paint layer from the conservation intervention was *tratteggio*.

For the last phase, a natural varnish was applied as a protective layer for the entire sculpture surface. *Lanfranc* dammar varnish diluted in acetone (30% varnish, 70% acetone) was applied with a brush.

The methods, materials, and techniques chosen for this conservation treatment reflect the location, environment, and living nature of the church itself. Please refer to figures 7 and 8 for samples of before-treatment and after-treatment photos.

Fig. 7. (A) Detail of the cherub on the left before conservation treatment. (B) Detail of the cherub on the left after conservation treatment.

Fig. 8. (A) Detail of the cherub on the right before conservation treatment. (B) Detail of the cherub on the right after conservation treatment.

4. PRESERVATION MEASURES

The remnants of the animal nest that were discovered in the lower hollow part of the sculpture were studied by introducing a borescope in the hole. The nest materials were cleaned out with a stiff coated wire and a special attachment to a vacuum cleaner (Nilfisk). Afterward, a piece of wood was hand carved to cover the hole. The edges around the cover were sealed with epoxy wood paste to prevent future infestations.

The statue had been resting on two rocks and two old boards when removed for this conservation treatment in 2015. The shaky base made the statue lean forward, and there was a great danger that it would fall if left uncorrected.

Photographs taken in the 1980s during the last known cleaning of the statue, shows only the front of the statue being cleaned. At that time, the back surfaces were not cleaned because the niche was too small to allow someone to reach around behind or turn the statue. It is possible that the rocks and hand-cut boards used to wedge the statue had been in place for more than 100 years. The original boards appeared to be repurposed pieces that had been used in some other construction. The San Xavier church has a long history of reusing materials whenever possible.

As part of the conservation treatment, a decision was made to have a new base built (by a professional carpenter) that would support the statue and make it able to rotate so the statue can be inspected and cleaned without the major effort to remove and lower the statue to the floor. The floor of the niche was stabilized and leveled to support the base. The supportive base itself was made of red oak wood. This is a slow-growth type of wood with straight grain and somewhat denser than other types of oak and holds glue easily.

The new base was designed to hold more than 1000 pounds; however, the Immaculate only weighs around 150 pounds. A rotating assembly (like those found in a lazy Susan turntable) was attached between the base and top board (fig. 9a). A small eyelet was attached to the top and base. A machined pin was fitted between the two eyelets and prevents the top from rotating when the pin is in place. A safety catch holds the pin in place (fig. 9b).

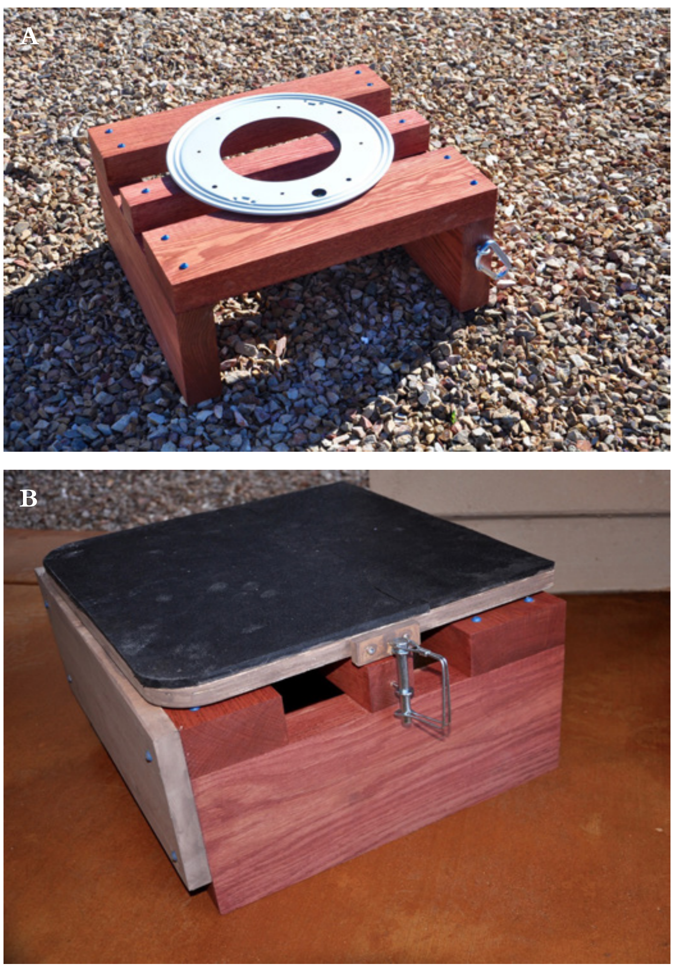

Fig. 9. (A) New base for sculpture with lazy Susan attachment. (B) New base with top and locking pin, fully assembled.

The top was made of ½-in. laminated wood board and covered with a 5-mm black synthetic mat. This is designed to hold the statue firmly in place, both on display and when being rotated for inspection or cleaning. A board was attached to the front of the base below the rotating top as a cover. The board was painted so that the base would not be visible from the ground.

5. CONCLUSION

The sculptures and decorative art of the interiors at San Xavier del Bac have been professionally conserved since 1992, and work continues today to address the needs as they are identified and can be financially addressed. The conservation treatment of the Immaculate became a high priority during a condition assessment in 2015 of the main altar. After convincing others that the conservation was urgent, the possibility for full treatment was realized. Developing a treatment that was sympathetic to the environment of a living church, on a tribal reservation, in the desert, that is a popular tourist destination, and has a harsh climate was a challenge. Traditional materials and techniques were used because experience has shown them to be the most successful.

ACKNOWLEDGMENTS

The supportive base was fabricated and donated by Craig Reid and Thomas Bilczo of Quail Creek, Green Valley, Arizona. They also constructed the cage to bring down the sculpture. The scaffolding used to bring the Immaculate down and back up again was done by Action Scaffolding, whose workers donated their time and skills to make this possible. Patronato San Xavier, a nonprofit organization, paid for the conservation work of the Immaculate. The authors would like to thank Dr. Nancy Odegaard for reading and commenting on our manuscript.

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HANY HANNA

Preservation of the Endangered Cultural Assets of the Traditional Egyptian Storytellers' Heritage and Its Instruments and Tools

ABSTRACT—The traditional Egyptian storytellers' heritage (which comes in several forms: cinematic, theatrical, and musical) is very important not only in its intangible form but also in its tools, instruments, and movable assets. The danger of losing such heritage and its assets is latent. It is rapidly disappearing under the impact of several reasons. Therefore, a project led by the author has been launched. During its first phase, surveying, reviewing, inventory, assessment, and documenting of these assets in some Egyptian museums/institutions and some museums/institutions in some other countries was done. In this article, the work conducted with complete results will be summarized.

1. INTRODUCTION

The traditional Egyptian storytellers' heritage is a very important art in its musical, theatrical, and cinematic forms. In its expressive singing, stylized speech, motion, repertoire of narratives, and mimetic gestures, it is one of the unique expressions of the rich Egyptian- performing arts tradition and folk culture. In addition to its significance as a foremost literary and musical expression, this heritage represents a repository for the spectrum of Egyptian folk history, customs, beliefs, symbolism, and traditions, not only in its intangible form but also in its instruments and movable assets.

The assets of the traditional Egyptian storytellers' heritage and its instruments and tools are very rich and have an irreplaceable value to our understanding of past and present cultures, and they require care to preserve their value for future generations. The knowledge that these assets and collections represent needs to be appreciated by the public and its collection to be a source of pride, an educational opportunity, and an attraction for cultural tourists.

The cultural assets of the traditional Egyptian storytellers' heritage and its instruments and tools are rapidly disappearing owing to competition from contemporary popular forms of entertainment such as television and radio, new sorts of musical instruments, and decreasing numbers of young people able to commit to the rigorous training process. Moreover, the lucrative Egyptian tourist industry encourages young storytellers or poets to forsake the full repertory in favor of selected brief passages performed as part of folklore shows in restaurants and hotels catering primarily to non-Arab visitors.

The danger of losing such heritage is latent. The instruments and tools, which remain a source of livelihood, have rich cultural and social meanings that are quickly disappearing under the impact of the reasons mentioned previously and under that of mass production for the tourist market. However, the collections in the national museums in Egypt seem to be poor with such cultural assets of the traditional Egyptian storytellers' heritage. Moreover, the few instruments and tools displayed in these museums provide no comprehensible understanding of the cultural wealth of this heritage. Therefore, a project led by the author has been launched in cooperation between the UNESCO Office in Cairo; Wood, Furniture, and Lacquer Working Group of the International Committee for conservation of the International Council of Museums (ICOM-CC- Wood, Furniture, and Lacquer); and the International Storytelling Center (ISC) in Jonesborough, Tennessee. During its first phase, surveying, reviewing, inventory, assessment, and documenting of the assets of the traditional Egyptian storytellers' heritage was conducted in some Egyptian museums/institutions, as well as some museums/institutions in some other countries.

This project aims to research, document, study the preservation condition, increase knowledge of the culture assets of this heritage, assess the illustration of the existing collections at national and local museums, enhance the presentation of this heritage, and improve the display for better understanding of the traditional cultural practices for the benefit of future generations that could help protect cultural diversity and strengthen multicultural identity in citizenship, and promote cultural industries in Egypt for the management of cultural assets (Hanna 2007).

2. THE TRADITIONAL EGYPTIAN STORYTELLERS' HERITAGE FORMS AND ITS INSTRUMENTS, TOOLS, AND ASSETS

There are three forms of the traditional Egyptian storytellers' heritage: the cinematic form, the theatrical form, and the musical form.

2.1 THE CINEMATIC FORM

In the cinematic form, the storytellers use a wooden box called *Sanduk El-Donia* (peep show box) for narrating the stories accompanied by images, scenes, and music (figs. 1, 2). People used to look at the pictures inside the box through some holes with a lens while the artist told the stories and changed the images within a diorama. *Sanduk El-Donia* has almost disappeared. Only two objects have been found in the surveyed Egyptian museums.

2.2 THE THEATRICAL FORM

In the theatrical form, another sort of storytellers' tool has been used; it features handicraft puppets made of wood and textile (called *Araquz* or *Qaraquz*) (figs. 3, 4). The storyteller used to hide behind a wooden and textile screen. He told or sang the story and moved the puppets in front of the audience (El-Aalemy 2002; El-Raee 2006; Hwass 2006). *Araquz* is slowly disappearing. Only four objects have been found in the surveyed Egyptian museums.

2.3 THE MUSICAL FORM

In the musical form, different types of storytelling are performed by vocalists and poets accompanied by various musical instruments made of wood, reed, and other materials.

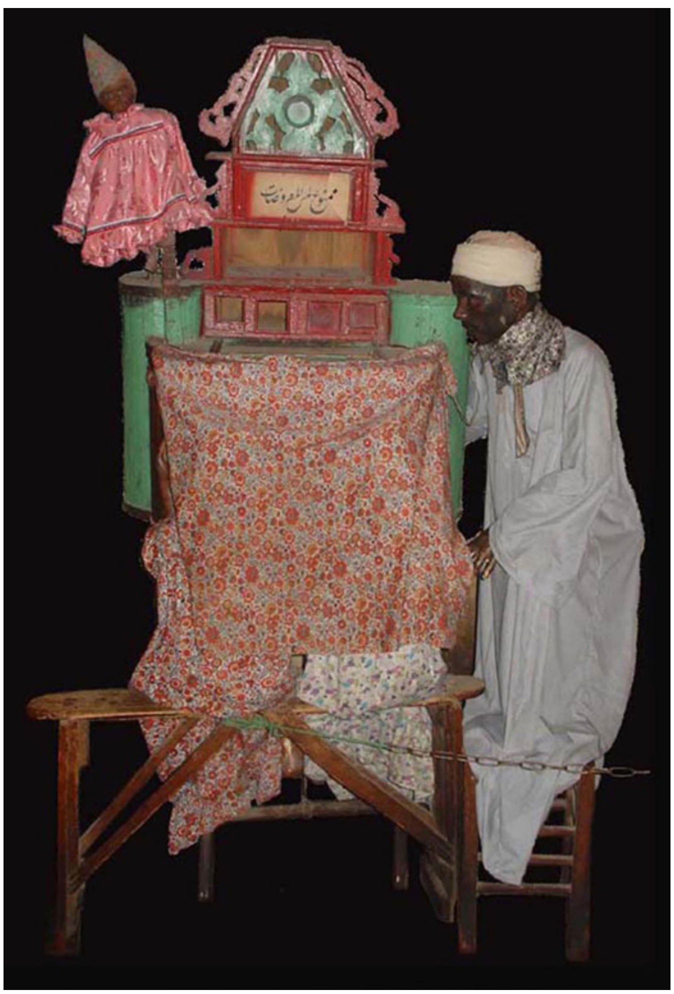


Fig. 1. *Sanduk El-Donia*, Egyptian Agricultural Museums Complex in Giza: The Scientific Collection Museum.

Fig. 2. *Sanduk El-Donia*, ethnographic museum in Cairo.

Fig. 3. *Araquz* or *Qaraquz*, ethnographic museum in Cairo.

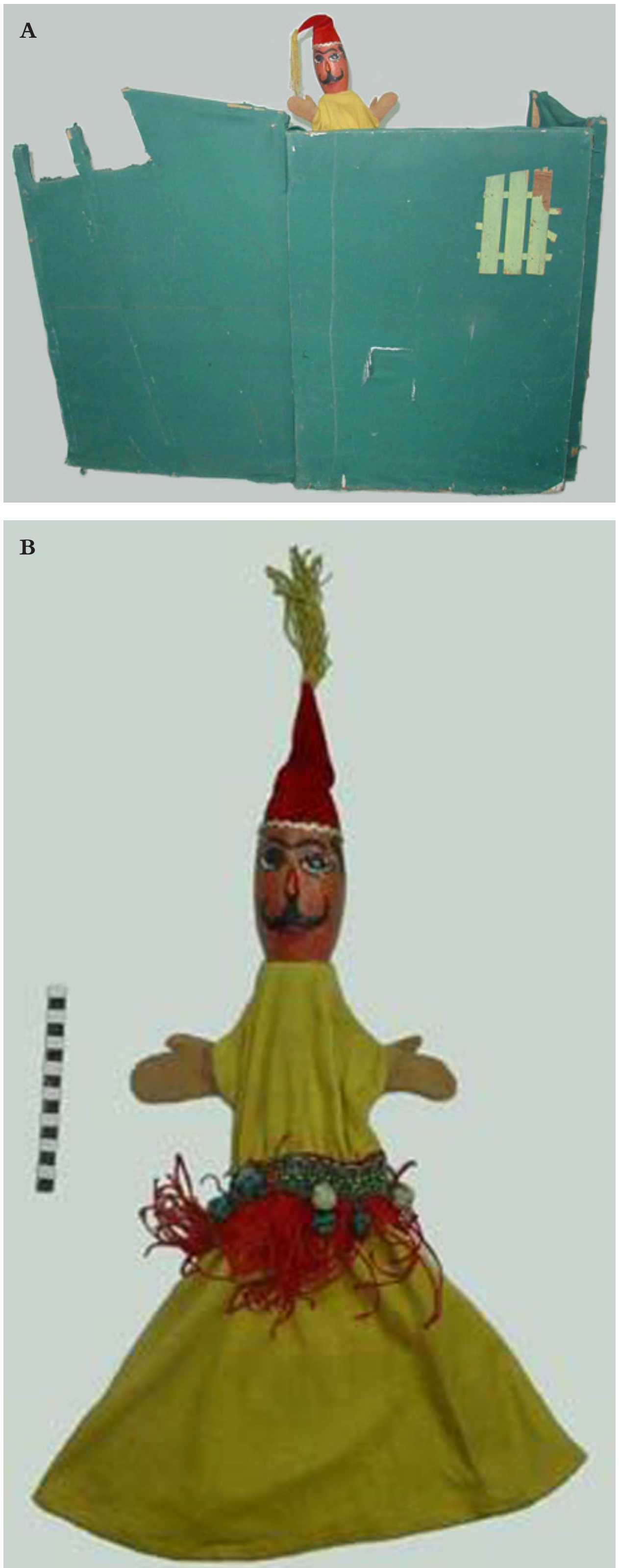


Fig. 4. *Araquz* or *Qaraquz*, and its screen. Collection of Cairo Puppet Theater in Cairo.

These include several sorts of instruments, which are discussed next.

2.3.1 The *Rababa* or Arabic Fiddle

The *Rababa* belongs to the string instruments *(chordophones)*; it is the earliest known bowed instrument. The instrument was first mentioned in the 10th century and became prominent in medieval times and later in Arab music. In medieval times, the word *Rababa* was used for any bowed instrument. The Egyptian *Rababa* usually consists of a resonating part (a membrane belly, the body of which acts as a sound box) made of wood or a coconut hard shell, http://en.wikipedia.org/wiki/Sound_boxcovered with a thin sheep- or fish-skin membrane and stretched on a long wooden straight cylindrical neck. Some instrument varieties have a spike at the bottom of the instrument to support it while being played and thus are called *spike fiddles or bowl spike fiddles*. One or more strings are stretched and run from near the base of the membrane belly along the full length of the straight neck. The strings are generally tuned to interval and stretched thanks to large pegs screwed on the upper part of the neck.

In Egypt, there are several names for the Rababa, including (Hanna 2008):

1. *Rabāba al-šā'Ir (the poet's fiddle)*. This often has a wooden rectangular-shape sound box and one string (fig. 5).
2. *Rebab el moganni (the singer's fiddle)*. This often has a wooden rectangular-shaped sound box and two strings.

Fig. 5. *Rabāba al-šā'Ir*, Museum of Folk Arts in Cairo.

3. *Goza, Kamancheh (Kamānche, Kamāncha,* or *Qyamancha)*, *Kamanja Aguz*. This often has a coconut shell round-shape sound box and two strings (fig. 6).

2.3.2 *Simsimiyya*

Simsimiyya (fig. 7) and other lyre instruments such as *Lyra* (*kinnar*) (fig. 8) *and Tanpora* (*Tanbura*) (fig. 9) belong to the string instruments. They are called *plucked instruments* and have a four-sided frame consisting of a sound box (a hollow body or sound-chest made of wood or metal). From this sound-chest are two raised wooden arms (sometimes hollow) that are bent both outward and forward. They are connected near the top by a wooden crossbar or yoke. Another small crossbar, fixed on the sound-chest, forms a bridge, which transmits the vibrations of the strings. The strings are fastened to the sound box and attached to the yoke; they run parallel to the sound table. In lyres, the strings leave the resonator at right angles to an edge and run to a crossbar that is held away from the resonator. The strings are played by plucking. Lyres are found in all shapes and sizes, but generally the sound box or resonator is bowl shaped or box shaped.

We can say that the *Lyra* (*kinnar*) can be considered the mother of *Tanpora* (*Tanbura*), which can be considered the mother of *Simsimiyya*.

These two instruments (objects)—*Rababa and Simsimiyya*—are the major musical instruments within the assets (objects) of the Egyptian storytellers' heritage.

Fig. 7. *Simsimiyya*, El-Mastaba Center for Egyptian Popular Music in Cairo.

Fig. 6. *Kamancheh*, Museum of Musical Instruments in Cairo.

Fig. 8. *Lyra* (*kinnar*), Egyptian Museum in Cairo.

Fig. 9. *Tanpora*, Museum of Folk Arts in Cairo.

2.3.3 *Darbukkah*

Darbukkah (fig. 10) belongs to the percussion instruments (*membranophones*). It is a goblet-shaped hand drum with one head (single headed) and most often is open at the bottom. Its thin, responsive drumhead and resonance help it produce a distinctively crisp sound. Goblet drums are made of ceramic, wood, or occasionally of metal. They appear in a variety of sizes. Goblet drums include instruments such as *Darbukkah* (*Darbakeh, Darbuka, Dumbelek, Derbakeh*) and *Tabl* (*Tablah, Tableh*).

2.3.4 *Riqq*

Riqq (fig. 11) belongs to the percussion instruments. It is a frame drum, which is a drum that has a drumhead diameter greater than its depth. In the frame drums, the membrane is stretched over a frame (usually made of wood), often making a wide, shallow instrument. Most often, the single drumhead is made of rawhide or man-made materials. On some frame drums, the drumhead is stretched and tacked in place. Frame drums include instruments such as *Riqq* (*Daff, Rik*, *Riq*), *Deff* (*duff*), *Bendir*, *Tambourine*, and *Mazhar*.

2.3.5 *Mizmar*

Mizmar (fig. 12) belongs to the wind instruments (*aerophones*). It has double reeds. Double-reed instruments are considered woodwinds (basically made of wood). They produce their sound by means of the vibration that occurs when a player blows through the aperture (opening) between two reeds, which are bound together. The term double reed comes from the fact that there are two pieces of cane vibrating against each other.

2.3.6 *Nay*

Nay (fig. 13) belongs to the wind instruments. It is an end-blown flute. The end-blown flute is a simple woodwind instrument where the player directs air against the end of a pipe or tube to produce sound. In this instrument, both ends of the tube are open. This flute is often made of reed (cane) or metals. End-blown flutes also include instruments such as *Kola*, *Offata*, *Salamiyyah*, *Shabab*, and *Suffara*.

2.3.7 *Arghoul*

Arghoul (*Arghul*, *Argul*) (fig. 14) belongs to the wind instruments. It has a single reed. This type of instrument is a woodwind (basically made of reed/cane) that uses only one reed (or tongue, called Risha or Kashaia in Arabic) attached to or cut out of a tube to produce sound. A single reed is a vibrating device that consists of a piece of cane bound to a mouthpiece by a ligature. The player's breath is blown between the reed and the mouthpiece, causing a vibration of the reed and thus sounding the instrument. A single-reed instrument could include one, two (double), or more pipes, but the most common is the double pipe. One pipe may be unfingered and serve as a drone, or it

Fig. 10. *Darbukkah*, Museum of Musical Instruments in Cairo.

Fig. 11. *Riqq*, Museum of Islamic Art in Cairo.

Fig. 12. *Mizmar*, Egyptian Agricultural Museums Complex in Giza: The Scientific Collection Museum.

Fig. 13. *Nay*, Museum of Folk Arts in Cairo.

Fig. 14. *Arghoul*, Museum of Folk Arts.

may be fingered the same as the other(s). Each pipe may have its own blowhole or may share a common wind way. End-blown flutes include instruments such as the double clarinet, *Doudouk*, *Kahrabaia*, *Setta-wiyyah Arabi*, *Mizmar* (*reed*), *Mizwidj*, *Mouassel*, *Orma*, *Tormay*, and *zummāra*.

Not too long ago, a 3000-year-old tomb of Egypt was uncovered on an archeological dig sponsored by the University of Cairo. During the excavation, an ancient reed *Mizmar* was discovered in the ruins. Although pictures of such musical instruments were depicted on the walls of other previously excavated tombs, this was the first incidence in history of uncovering the real object (El-Hefny 1987, 45; El-Safnawy 2000; Hanna 2008; Hollingsworth 1999; Cole & Schwartz 2007; Omran 2006; Schmidt-Jones 2004; Shabana 2006).

3. THE PROJECT (PHASE I) PROCEEDINGS AND RESULTS

Phase I of the project of preservation of the assets of the traditional Egyptian storytellers' heritage included surveying, inventory, reviewing, assessment, and documenting existing collections in some Egyptian museums/institutions, as well as some museums/institutions in some other countries.

3.1 PROCEEDINGS IN SOME EGYPTIAN MUSEUMS/INSTITUTIONS

3.1.1 Surveying, Inventory, Reviewing, and Assessment

Surveying, inventory, reviewing, and assessment of existing collections in some Egyptian museums/institutions was done to assess the representative scope, quality, and quantity of the collections and their state of conservation. Nineteen Egyptian museums/institutions in five Egyptian cities were surveyed and reviewed (table 1). In 11 surveyed museums/institutions, 394 objects were found in existing collections, including 388 musical instruments, 2 *Sanduk El-Donia*, and 4 *Araquz*.

Table 2 summarizes the quantity and different categories of the Egyptian storytellers' heritage assets (objects) in existing collections within the surveyed museums/institutions and the total number of the objects.

Table 1. Nineteen Museums/Institutions Surveyed in Egypt

Museums/Institutions	Location	Quantity of Objects Found
Objects found in the following 11 museums/institutions:		
Museum of Folk Arts	Cairo	131
Museum of Musical Instruments	Cairo	79
Egyptian Agricultural Museums Complex:	Giza	79
- The Scientific Collection Museum		29
- The Arabic Parlor Museum		49
- The Legacy Properties Museum		1
Ethnographic Museum	Cairo	58
El-Mastaba Center	Cairo	10
Egyptian Museum	Cairo	26
Museum of Islamic Art	Cairo	3
National Center for Theater, Music and Popular Arts	Cairo	7
Cairo Puppet Theater	Cairo	1
No related collection found in the following 8 museums/institutions:		
Coptic Museum	Cairo	—
El-Manial Palace Museum	Cairo	—
Gaier Anderson Museum	Cairo	—
Mohamed Abd El-Waha Museum	Cairo	—
Rokn Helwan Museum	Cairo	—
National Museum	Port Said	—
Museum of Al-Hilaliyya	Qena	—
Aswan Museum	Aswan	—

Table 2. Different Categories of Egyptian Storytellers' Heritage Assets in Existing Collections within the Surveyed Egyptian Museums/Institutions

Object Categories (Classes, Subclasses, and Names)	**Museum of Folk Arts (1.F)**	**Museum of Musical Instruments (2.MI)**	**The Egyptian Agricultural Museums complex (3.AM)**				**Ethnographic Museum (4.E)**	**El-Mastaba Center for Egyptian Popular Music (5.M)**	**Egyptian Museum (6.EM)**	**Museum of Islamic Art (7.IA)**	**Museum of the National Center for Theater, Music and Popular Arts (8.NC)**	**Cairo Puppet Theater's Collection (9.PT)**	**Total**
			All Three Museums	**The Scientific Collection (3.1.AM-SC)**	**The Arabic Parlor (3.2.AM-AP)**	**Legacy Properties (3.3.AM-LP)**							
Total quantity of objects	131	79	79	29	49	1	58	10	26	3	7	1	394
1. Musical Instruments	131	79	78	28	49	1	54	10	26	3	7	—	388
1.1. String Instruments:	13	10	16	1	14	1	7	10	2	1	—	—	59
Rababa	7	8	15	1	14	—	7	2	—	—	—	—	39
Simsimiyya	4	2	—	—	—	—	—	5	—	—	—	—	11
Lyra (*kinnar*)	—	—	—	—	—	—	—	—	2	—	—	—	2
Tanpora	2	—	1	—	—	1	—	3	—	—	—	—	6
A string instrument similar to *Rababa*	—	—	—	—	—	—	—	—	—	1	—	—	1
1.2. Percussion Instruments:	35	23	13	6	7	—	22	—	1	2	3	—	99
Baza	1	—	1	1	—	—	—	—	—	—	—	—	2
Darbukkah	8	4	—	—	—	—	3	—	—	—	—	—	15
Riqq (*Daff*)	7	5	5	—	5	—	5	—	—	2	2	—	26
Deff	10	1	1	—	1	—	2	—	—	—	—	—	14
Nakrazan	—	7	—	—	—	—	9	—	—	—	—	—	16
Nakrazan (Double)	1	—	1	1	—	—	—	—	—	—	—	—	2
Naqara	—	2	—	—	—	—	—	—	—	—	—	—	2
Nwggera	1	—	—	—	—	—	—	—	—	—	—	—	1
Tabla	1	—	1	—	1	—	2	—	1	—	1	—	6
Timpani	—	2	—	—	—	—	—	—	—	—	—	—	2
Tabla Baladi	2	1	2	2	—	—	1	—	—	—	—	—	6
Tabla Elba	1	—	—	—	—	—	—	—	—	—	—	—	1
Tabla Hukk	—	—	1	1	—	—	—	—	—	—	—	—	1
Tabla Zar	3	1	—	—	—	—	—	—	—	—	—	—	4
Tablota	—	—	1	1	—	—	—	—	—	—	—	—	1

(*continues*)

Table 2. Different Categories of Egyptian Storytellers' Heritage Assets in Existing Collections within the Surveyed Egyptian Museums/Institutions (*Continued*)

			The Egyptian Agricultural Museums complex (3.AM)										
Object Categories (Classes, Subclasses, and Names)	**Museum of Folk Arts (1.F)**	**Museum of Musical Instruments (2.MI)**	**All Three Museums**	**The Scientific Collection (3.1.AM-SC)**	**The Arabic Parlor (3.2.AM-AP)**	**Legacy Properties (3.3.AM-LP)**	**Ethnographic Museum (4.E)**	**El-Mastaba Center for Egyptian Popular Music (5.M)**	**Egyptian Museum (6.EM)**	**Museum of Islamic Art (7.IA)**	**Museum of the National Center for Theater, Music and Popular Arts (8.NC)**	**Cairo Puppet Theater's Collection (9.PT)**	**Total**
1.3. Wind Instruments	83	46	49	21	28	—	25	—	23	—	4	—	230
Arghoul	12	8	4	2	2	—	11		—	—	1	—	36
Double clarinet	—	—	—	—	—	—	—	—	2	—	—	—	2
Doudouk	—	—	1	1	—	—	—	—	—	—	—	—	1
Frefra	—	—	2	—	2	—	—	—	—	—	—	—	2
Kahrabaia	—	—	1	1	—	—	—	—	—	—	—	—	1
Khamsa-wiyyah	1	—	—	—	—	—	—	—	—	—	—	—	1
Kola	1	1	—	—	—	—	—	—	—	—	—	—	2
Mizmar (reed)	—	2	—	—	—	—	—	—	—	—	—	—	2
Mizmar (wooden)	7	8	4	4	—	—	2	—	—	—	—	—	21
Mouassel	—	—	1	1	—	—	—	—	—	—	—	—	1
Nay	16	27	24	3	21	—	12	—	21	—	2	—	102
Offata Karar	—	—	1	1	—	—	—	—	—	—	—	—	1
Okla Sihrawi	—	—	1	1	—	—	—	—	—	—	—	—	1
Orma	—	—	1	1	—	—	—	—	—	—	—	—	1
Salamiyyah	33	—	—	—	—	—	—	—	—	—	—	—	33
Setta-wiyyah	3	—	1	1	—	—	—	—	—	—	—	—	4
Shabab	—	—	3	—	3	—	—	—	—	—	—	—	3
Shababa	1	—	—	—	—	—	—	—	—	—	—	—	1
Suffara	9	—	4	4	—	—	—	—	—	—	1	—	14
Tormay	—	—	1	1	—	—	—	—	—	—	—	—	1
2. *Sanduk El-Donia* (peep show box)	—	—	1	1	—	—	1	—	—	—	—	—	2
3. *Araquz*	—	—	—	—	—	—	3	—	—	—	—	1	4

3.1.2 Assessing the Conservation Problems and Proposing the Conservation Plan

In this section, conservation problems are assessed and the preservation condition of the mentioned assets is studied in Egyptian museums/institutions, proposing the required conservation process within a general detailed comprehensive conservation plan.

3.1.2.1 Evaluating the Existing Conservation Facilities

Unfortunately, most surveyed museums within this project have peculiar designs and interior atmospheric conditions that do not provide the necessary good environment for preserving the objects. Except for the Museum of Musical Instruments, the museums' buildings need an infrastructural upgrade prior to treating the collections themselves. For example, the buildings of the Egyptian Agricultural Museums and the Ethnographic Museum show evidence of water leaking from the roof and around windows, as well as water damage in the foundations.

All collections are not stored or exhibited using current museum standards. With exception of the Museum of Musical Instruments, there are no air control systems in the museums. In some galleries, where the objects are not preserved inside show-cases, such display methods enable visitors to be in direct contact with the object, which may cause additional damage besides the bad effects of the deterioration factors. Again, object handling is a problem, as these collections are considered familiar objects and not handled as museum pieces.

It is well known that the museums' environment could cause some direct and indirect damage to objects. Quite apart from the direct damage that may result from the environmental conditions and procedures for visitation, they may also damage the objects indirectly by influencing the level of humidity, temperature, light, and pollution, raising the degree of their variation and increasing their negative effects. Worse still, the combination of the preceding factors exacerbates the damage. Examples of showcases and displays in the museums/institutions are shown in figures 15 through 21.

3.1.2.2 Conducting a Full Assessment of the State of Conservation of the Collections

Assessed collections within this project showed several signs of deterioration, damage, and decay. The different materials used in the manufacture and decoration of the objects displayed various forms of deterioration, resulting from the combined effects of environmental conditions as well as different factors of decay such as relative humidity, temperature, light, air pollution, insects, fungi, and bacteria. Environmental factors, especially moisture levels, are of a great importance to the type and rate of degradation. A variety of biodeterioration agents, such as insects and fungi, work to decompose the objects, as well as some human factors.

Fig. 15. A part of a showcase, Museum of Folk Arts in Cairo.

Fig. 16. A showcase, Museum of Musical Instruments in Cairo.

Fig. 17. A showcase, the Agricultural Museums Complex in Giza: The Scientific Collection Museum.

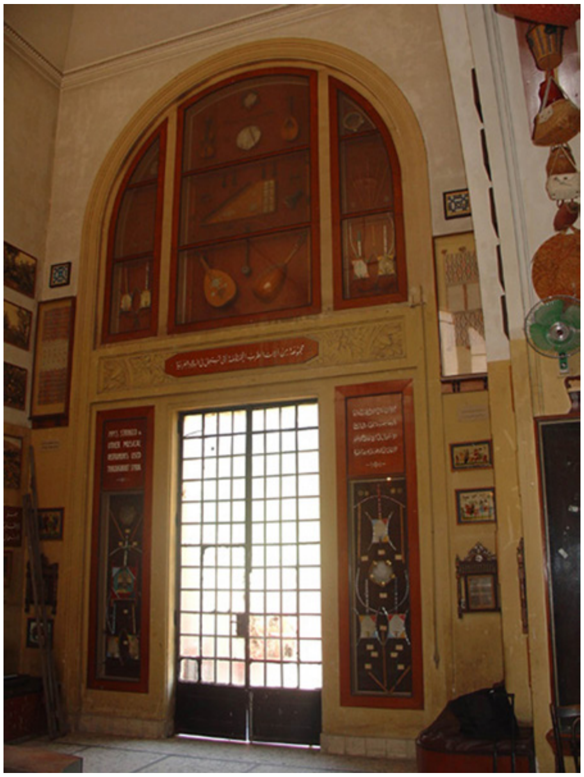


Fig. 18. Showcases, the Agricultural Museums Complex in Giza: The Arabic Parlor Museum.

Fig. 19. A showcase, ethnographic museum in Cairo.

Fig. 20. Objects displaying in El-Mastaba Center for Egyptian Popular Music in Cairo.

It seems that over the years, many problems occurred in objects as a result of basic factors of deterioration either during their use as functional objects or during storage or display in museums. Again, it is clear that the lack of conservation, interior atmospheric conditions in the museums, and visiting procedures caused additional forms of decay to wood (fig. 22), reed (fig. 23), metals (fig. 24), skin (fig. 25), fabric (fig. 26), ceramics (fig. 27), and other contents of the objects such as colors and decoration materials (fig. 28).

3.1.2.3 Determining Conservation Needs

It is important to determine general conservation needs of each collection, particularly of artifacts, and to propose the required conservation processes and upgrade the various collections within a general detailed comprehensive conservation plan to ensure the long-term future of the artifacts.

Fig. 21. Hall no. 34, Showcase E, Egyptian Museum in Cairo.

Fig. 22. Examples of damage to wood.

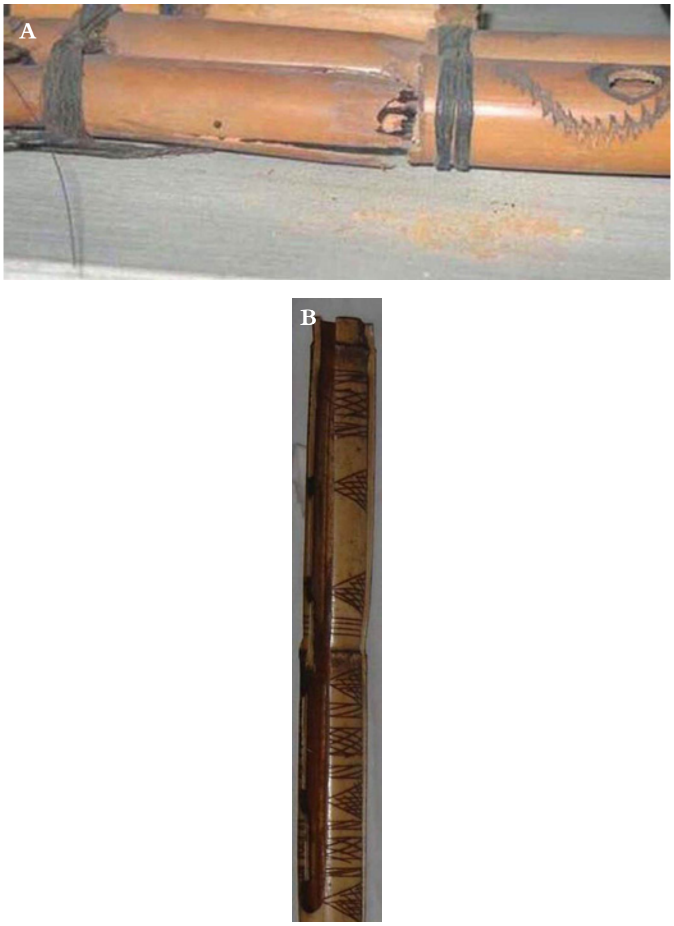


Fig. 23. Examples of damage to reed.

Fig. 24. Example of damage to metals.

3.1.3 Documentation

Gathering existing visual and textual documentation of the mentioned assets in the Egyptian museums/institutions for digitization and storage was done with detailed reports and the database.

3.1.4 General Notes on the Survey, Assessment, Inventory, and Documentation of the Egyptian Storytellers' Heritage Assets in the Egyptian Museums/Institutions

The following notes reveal results of the project, such as inventory tables, reports, and the database:

1. The Egyptian museums/institutions in which a collection of the Egyptian storytellers' heritage assets exist have been given IDs or codes consisting of one or two letters referring to one or two main words of the museum name as seen in the next entry and displayed in table 2.

2. The museums/institutions have been sorted with respect to the quality and quantity of target objects available as the following:
   - Museum of Folk Arts (1.F)
   - Museum of Musical Instruments (2.MI)

Fig. 25. Example of damage to skin.

Fig. 26. Example of damage to fabric.

Fig. 27. Example of damage to ceramics.

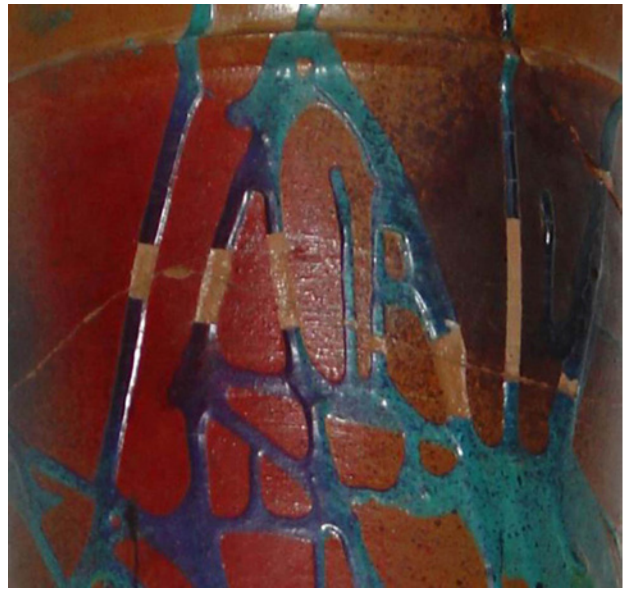


Fig. 28. Example of damage to colors and decoration materials .

- The Egyptian Agricultural Museums Complex (3.AM)
  - The Scientific Collection Museum (3.1.AM-SC)
  - The Arabic Parlor Museum (3.2.AM-AP)
  - Legacy Properties Museum (3.3.AM-LP)
- Ethnographic Museum (4.E)
- El-Mastaba Center for Egyptian Popular Music (5.M)
- Egyptian Museum (6.EM)
- Museum of Islamic Art (7.IA)
- National Center for Theater, Music and Popular Arts (8.NC)
- Cairo Puppet Theater (9.PT).

3. Information regarding the surveyed museums/institutions includes contact information (e.g., organizations or owner institutions, addresses, telephone and fax numbers, e-mail addresses, website addresses, and names of directors). Information also includes the history and a brief introduction about the museums/institutions, an overview of the museum and gallery, gallery conditions, display methods, and conservation facilities, as well as examination techniques followed for the assessment process, the number of objects in the collection, and recommendations for conservation within the museums/institutions.

4. The objects have been sorted within three categories (classes) as follows:

   1. Musical Instruments, which has three basic categories (subclasses):

   1.1. String Instruments*:* Instruments in which a vibrating string produces the sound; longer, heavier, and less tense strings produce lower pitches.

1.2. Percussion Instruments: Instruments in which the vibration of a stretched membrane (usually skins) produces the sound; heavier, less tense membranes give lower pitches. Hands or drumsticks are typically used to strike the skin.

1.3. Wind Instruments: Instruments in which a vibrating body of air produces sound; longer bodies of air produce lower pitches.

2. *Sanduk El-Donia* (peep show box).

3. *Araquz*.

5. The results depend on the level of cooperation we received from the museums/institutions and owner organizations and their staff, as well as the difficulties, which rise from the actual conditions of the display methods, such as the sort of showcases. For example, in some museums and collections, we could handle the objects directly for examination, assessment, photography, and measurement. However, in other museums, we could not handle the objects directly for the tasks because the showcases could not be opened, in which case we had to carry out all of the work through the glass of the case.
6. Some Egyptian museums/institutions included a few musical instruments that we believe are similar but may not be the sort of musical instruments that accompany the storytellers. We included them within the assessment of all related musical instruments in the museums/institutions' collections.
7. Within the assessment, we also included the following:
   A. Some objects that are at the root of some musical instruments in the museums/institutions' collections (e.g., Lyra *(kinnar)* and *Tanpora* as mother roots for *Simsimiyya*)
   B. Similar collections from countries other than Egypt (e.g., Moroccan and Japanese *Rababa*).
8. Some objects within the collections are without numbers, and therefore we assigned to those objects temporary numbers for the purpose of this survey following a serial of numbers (e.g., 1, 2, 3) with a letter or two letters (e.g., the letter "F," which refers to the word "Folk," which refers in turn to the "Museum of Folk Arts" name).
9. The information regarding the individual objects includes object number, description, and present condition. The description, for example, includes the object name, employed materials, measurements, extra information regarding its parts description, colors, decorations, and technique of manufacturing as applicable.

3.2 Proceedings in Some Museums/Institutions in Some Other Countries

3.2.1 Surveying, Inventory, and Reviewing

Surveying and reviewing the existing collections in some museums/institutions took place in countries such as the United States, Germany, Italy, the United Kingdom, Sweden, Greece, Poland, Japan, and India. The survey was done through the museums/institutions' websites, databases, and references, as well as general calls for entries and/or the direct contacts and requests to some chosen museums/institutions. Some museums/institutions included related Egyptian objects and similar instruments from countries other than Egypt, such as Sudan, Morocco, Saudi Arabia, Algeria, Turkey, Persia, India, China, and Japan.

Twenty-seven museums/institutions were surveyed: we found 126 related objects (only musical instruments) in 9 museums/institutions, and no related collections were found in 18 museums/institutions. Eleven museums/institutions were surveyed in the United States: 4 objects were found in 4 museums/institutions, and no objects were found in 7 museums/institutions. Ten museums/institutions were surveyed in Europe: 79 objects were found in 4 museums/institutions, and no objects were found in 6 museums/institutions. Six museums/institutions were surveyed in Asia: 22 objects were found in one institution, and no objects were found in 5 museums/institutions.

The surveyed museums/institutions are summarized in table 3, with numbers of found objects, which have been listed within inventory lists. The mentioned lists should not be considered as comprehensive or final lists, as they include only the objects that we succeeded to reach.

3.2.2 General Notes on the Survey, Inventory, and Review in the Museums/Institutions in some other countries

1. The results basically depended on the information available in the museums/institutions' websites, databases, and references, as well as on the level of response and cooperation we received from the museums/institutions and other organizations to our general calls for entries and/or direct contacts and requests to the chosen museums/institutions.
2. The museums/institutions' addresses and contact information, such as telephone and fax numbers, e-mail addresses, and website addresses, were mentioned as applicable and available.
3. Some museums/institutions included a few Egyptian musical instruments that we believe are similar but may not be the sort of musical instruments that would accompany storytellers; however, we included them within the inventory for the purpose of completing the assessments of all related Egyptian musical instruments in the mentioned museums/institutions.
4. We also included some objects that are the root of some musical instruments in the museums/institutions' collections.
5. We used the instruments' names given by the museums/institutions' collections, and we also connected them with our given code numbers belonging to their subclasses.
6. Some objects in the collections were without numbers, or we were not able to obtain the numbers. In such cases, no numbers were mentioned within the inventory.

Table 3. One Hundred Twenty-six Objects Were Found in Existing Collections in Nine Surveyed Museums/Institutions

	Total			
Museums/Institutions	**1. Musical Instruments**	**1.1. String**	**1.2. Percussion**	**1.3. Wind**
Total quantity of objects	126	21	32	73
1. Museums/Institutions in the United States:	25	03	03	19
Museum of Fine Arts, Boston, MA	14	03	01	10
Dayton C. Miller Flute Collection, Library of Congress, Music Division, Washington, DC	07	—	—	07
Grinnell College Music Instrument Collection, Grinnell, IA	03	—	01	02
National Music Museum, Vermillion, SD	01	—	01	—
Kenneth G. Fiske Museum of the Claremont Colleges, Claremont, CA	—	—	—	—
Buechel Memorial Lakota Museum, St. Francis, SD	—	—	—	—
The Mathers Museum of World Cultures, Bloomington, IN	—	—	—	—
Maxwell Museum of Anthropology—Instruments of the World, Albuquerque, NM	—	—	—	—
Metropolitan Museum of Art, New York, NY	—	—	—	—
Washington University Collection, Washington, DC	—	—	—	—
Yale University, Collection of Musical Instruments, New Haven, CT	—	—	—	—
2. Museums/Institutions in Europe:	79	17	28	34
Edinburgh University Collection of Historic Musical Instruments, Reid Concert Hall. Museum of Instruments, Edinburgh, UK	12	02	04	06
Horniman Museum, London, UK	46	09	16	21
Germanisches National museum, Nürnberg, Germany	12	03	02	07
Museo Nazionale degli Strumenti Musicali, Rome, Italy	09	03	06	—
National Museum Liverpool, Liverpool, England	—	—	—	—
International Slavery Museum, Liverpool, England	—	—	—	—
Musikinstrumentenmuseum Markneukirchen, Markneukirchen, Germany	—	—	—	—
Museum of Popular Instruments, Athens, Greece	—	—	—	—
"Musikmuseet"—The Stockholm Music Museum, Stockholm, Sweden	—	—	—	—
The Museum of Musical Instruments (Muzeum Instrumentów Muzycznych), Poznań, Poland	—	—	—	—
3. Museums/Institutions in Asia:	22	01	01	20
Tokyo National University of Fine Arts and Music Collection, Tokyo, Japan	22	01	01	20
Museum of Musical Instruments, Osaka College of Music, Osaka, Japan	—	—	—	—
Museum of Music, Kunitachi College of Music, Gaakkigaku Shiryokan, Tokyo, Japan	—	—	—	—
Orissa State Museum, Orissa, India	—	—	—	—
The National Museum, New Delhi, India	—	—	—	—
University of Calcutta, Fine Arts, Music and Home Science Collection, West Bengal, India	—	—	—	—

7. The description of the objects includes all available information mentioned by the museums/institutions, such as the object name, employed materials, measurements, extra information regarding its parts description, provenance, ownership history, digital ID, and object condition, as applicable and available.
8. Some objects had digital images available on the museums/institutions' websites and databases, but images were not available for others.

3.3 THE PROJECT (PHASE I) OUTCOME AND RECOMMENDATIONS

3.3.1 Writing Full Reports

Writing full reports on the results included surveying, reviewing, assessment, and documentation, including the following:

1. A general introducing report included a summary of the project (Phase I) proceedings.
2. A detailed report included surveying, reviewing, assessment, recording, and documentation conducted on the existing collections in some Egyptian museums/institutions with an inventory of the objects. This included individual objects' photos, description, and condition, including all gathered, recorded, and documented information regarding the objects, with introduction information regarding the host museums/institutions.
3. A detailed report included a survey conducted on the existing collections in some museums/institutions in some other countries, including all gathered, recorded, and documented information regarding the objects, which are available on the museums/institutions' websites and databases, and so forth, with introduction information regarding the host museums/institutions. This report did not include any photos for the objects because of copyright regulations.

3.3.2 The Conservation Plan

A general detailed conservation plan for the objects and an upgrade to host museums/institutions were created. This conservation plan was based on standards, guidelines, recommendations, and notes for the different components of the conservation process from several points of view and according to numerous considerations and factors, giving examples of conservation works, techniques, and materials.

In general, several conservation treatments were needed for the objects, including cleaning; treating dry objects such as dry wood and softening dry skin; treating warped objects; treating metal corrosion and repairing and fixing breakages; restoring cracks, holes, gaps, lost pieces and the lost parts; consolidation of weakened parts; and isolation and coating of the object surfaces. Thus, individual attention should be given for every object to be treated using different/several techniques according to the object's condition.

It is highly recommended to set separate conservation projects for each museum. This will be the next step for another stage within future developments of the project. It is also necessary to set a conservation laboratory and workshop in each museum.

The standards, guidelines, recommendations, and notes given within this conservation plan could be followed in preparing and applying the conservation projects, as well as within any future plans for development of the mentioned museums. In the beginning of the conservation plan, it is necessary to discuss factors and signs of deterioration, damage, and decay, which have been summarized in general, then by type of object and at last by materials of fabrication. Again, some testing and analysis methods are mentioned in brief.

The plan also deals with definitions, guidelines, standards, recommendations, and notes for conservation of musical instruments and storytellers' objects, as functional objects and as museum objects, with brief identifications for the several types and components of conservation treatments. Some notes are given on the materials, followed by recommendations and notes for conservation treatment by material of fabrication, such as wood, reed, skin products, bone, ivory, synthetic organic materials paper, leather, textile, metals, ceramics, glass and coatings such as pigment, paint, lacquer, or varnish, oil or wax, glaze, plating, and patina, as well as recommendations and notes for conservation treatment by type of instrument.

Some recommendations and methods concerning the general care of musical instrument and storytellers' objects collections, such as supporting for display and storage, handling, and transport were discussed. The plan also concerns recommendations and methods for regulating access to the objects in public collections, such as initial conditions of access, general protection from damage, measurements examination, reproduction of instruments, performance use, and dissemination of information.

Again, there are needs for environmental control and management. For example, centralized environment controls should be installed to reduce atmospheric pollution and to maintain a constant environment. Additionally, light levels in all museums were too high for these light-sensitive collections. An integrated pest management program should be instituted as well. Strategies and recommendations for environmental control and management of environmental factors, such as RH, temperature, lighting, air quality, and pest monitoring and control, were discussed as well. In all museums, although mitigating infestations is a priority, treating infested objects and replacing them in cases and galleries with untreated objects could be followed.

Training the staff in museum standards and practices is needed in all museums at differing levels. Collections management, collections care, and artifact handling courses would benefit all staff, from directors to curators, cleaning staff, and guards.

Again, as noted in the collections surveyed, only a few collections were documented, so documentation and cataloging are needed as well.

Table 4. Contents of the Storytellers' Museums Table within the Egyptian Storytellers' Heritage Database

1. Storytellers' Museums Table This table includes 29 fields, which secure the full record for a museum/institution's information either for the present time or for future updates. Fields include the following:			
• **Digital Record Management (1 Field):**			
Institution/Museum ID (the key field for this table)			
• **Institution/Museum Management (6 Fields):**			
Institution/Museum Name	Organization	Country	City
Address and Contact Information	General Director		
• **Institution/Museum Description (11 Fields):**			
History and Brief Introduction	Overview of Museum and Gallery		
Gallery Conditions	Display Methods	Museum Web Picture	Image (up to 6 image fields)
• **Institution/Museum Conservation (5 Fields):**			
Conservation Facilities	General Notes Regarding Assessment and Documentation		
Conservation Recommendations	Conservation Requirements	Housekeeping Tasks	
• **General (2 Fields):**			
General Comments	Bibliography		
• **Recording Management (4 Fields):**			
Editor of Record	First Registration Date	Last Update	Comments

Finally, general principles and methods for documentation of objects and collections, such as registration, accession numbers, object files, security, cataloging, documentation of conservation treatment, and automated resources, were tackled.

3.3.3 Designing a Database with Web Pages

Under the name *Egyptian Storytellers' Heritage*, a database for existing collections of assets (objects) of the Egyptian storytellers' heritage in Egyptian museums/institutions with basic information, such as their history, description, and photographs, was specifically designed. The database consists of two basic tables (including a storytellers' museums table and a storytellers' objects table) and forms (models), query, reports, and data web pages, to facilitate access and realize the maximum benefit of the Egyptian storytellers' heritage database.

The two basic tables are shown in tables 4 and 5. They have been connected with a relation as a head (storytellers' museums table) to many (storytellers' objects table) through the institution/museum ID fields in both tables. This connection/relation allows for access to all objects of every institution/museum from the storytellers' museums table. We can extract reports, models, and web pages for one or all objects and museums. All are digital and printable. An example of a model for a museum extracted from the database is shown in figure 29, and an example of a model for an object extracted from the database is shown in figure 30.

3.3.4 Publishing a Short Brochure

A 34-page color brochure summarizing the project of preservation of the endangered cultural assets of the traditional Egyptian storyteller's heritage and its instruments and tools—Phase I was published. (Hanna, 2007)

3.3.5 Defining Future Development for Further Phases and Activities of the Project

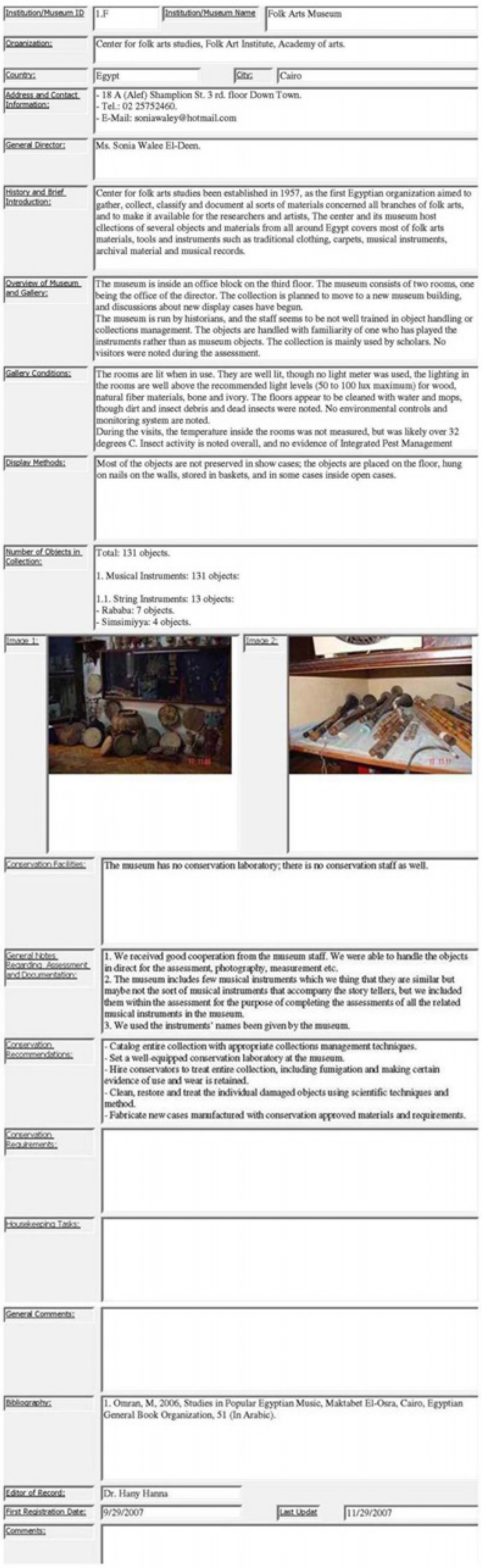
If further funding is made available, there are several possibilities for further phases of the project to be undertaken including the following:

1. It is of vital importance for the safekeeping of this invaluable heritage that suitable efforts be made to set separated conservation projects for every individual museum with all suggestions mentioned within the conservation plan. This will be the next step for another stage within future developments of the project.
2. It is very important to conduct a survey and research of assets of instruments and tools of traditional Egyptian storytellers' heritage outside the museums to enrich the collections. Again, in the future, it will also be possible to conduct further surveys and inventories for any new collection, as well as any updates to the present ones. The designed database will be continuously used for this purpose.

Table 5. Contents of the Storytellers' Objects Table within the Egyptian Storytellers' Heritage Database

2. Storytellers' Objects Table This table includes 56 fields, which secure the full record for an object's information either for the present time or for future updates. Fields include the following:				
• **Digital Record Management (2 Fields):**				
Object Record ID (the key field for this table)	Object Digital ID			
• **Object Management (12 Fields):**				
Country	City			
Institution/Museum	Owner Institution	Institution/Museum ID		
Object Number	International Inventory Number			
Acquisition Date	Acquisition Method	Provenance		
Hall/Room	Showcase			
• **Object Description (25 Fields):**				
Object Web Picture	Full Image	Details Images (up to 6 image fields)		
Class	Subclass	Family/Type	Name	Others' Names
Materials	Technique			
Length (cm)	Height (cm)	Width (cm)	Depth (cm)	
Diameter (cm)	Accessories' Dimensions (cm)	Weight (g)		
Description	Inscriptions	Object's History		
• **Object's Conservation (11 Fields):**				
Present Condition	Conservation Need	Illustrations	Drawings	
Experimental Works	Testing and Analyses Works	Cleaning Works	Treatment Works	
Restoration Works	Preservation Recommendation	Housekeeping Tasks		
• **General (2 Fields):**				
General Comments	Bibliography			
• **Recording Management (4 Fields):**				
Editor of Record	First Registration Date	Last Update	Comments	

3. It is also important to establish a protocol for cataloging and studying this heritage at the national, regional, and international levels. A printed detailed catalog for the mentioned assets will be very useful to have at hand.
4. It would be best to serve this heritage by a technical partnership between museums in Egypt, the United States, the United Kingdom, Germany, Japan, and other countries, allowing data and digitized images to be shared around the world. In the long term, this project might enable artifacts that have never been shown outside their home countries to be loaned to museums overseas so that in the future this project could be developed to lead to the establishment of such technical partnerships and experts' exchange schemes between these museums in Egypt and some museums and universities specialized in the subject in the United States (and any other suggested countries). This exchange should enable foreign experts to participate in the conservation effort and provide training courses for Egyptian experts in various required fields for conservation of the mentioned objects. This would strengthen the national and local capacities for their long-term conservation.
5. It is also very important to carry out a comparative study between these cultural assets in Egypt and in other countries, as well as research and gather information on similar cultural assets in some chosen countries.
6. It is very important to design and establish a specific comprehensive website for the cultural assets of traditional Egyptian storytellers' heritage and its instruments and tools over the world, with basic information, such as their history, the nature of their collection, and a description, with the assets' categories, photographs, and figures.



Institution/Museum ID: 1.F
Institution/Museum Name: Folk Arts Museum
Organization: Center for folk arts studies, Folk Art Institute, Academy of arts.
Country: Egypt
City: Cairo
Address and Contact Information:
- 18 A (Alef) Shamplion St. 3 rd. floor Down Town.
- Tel.: 02 25752460.
- E-Mail: soniawaley@hotmail.com

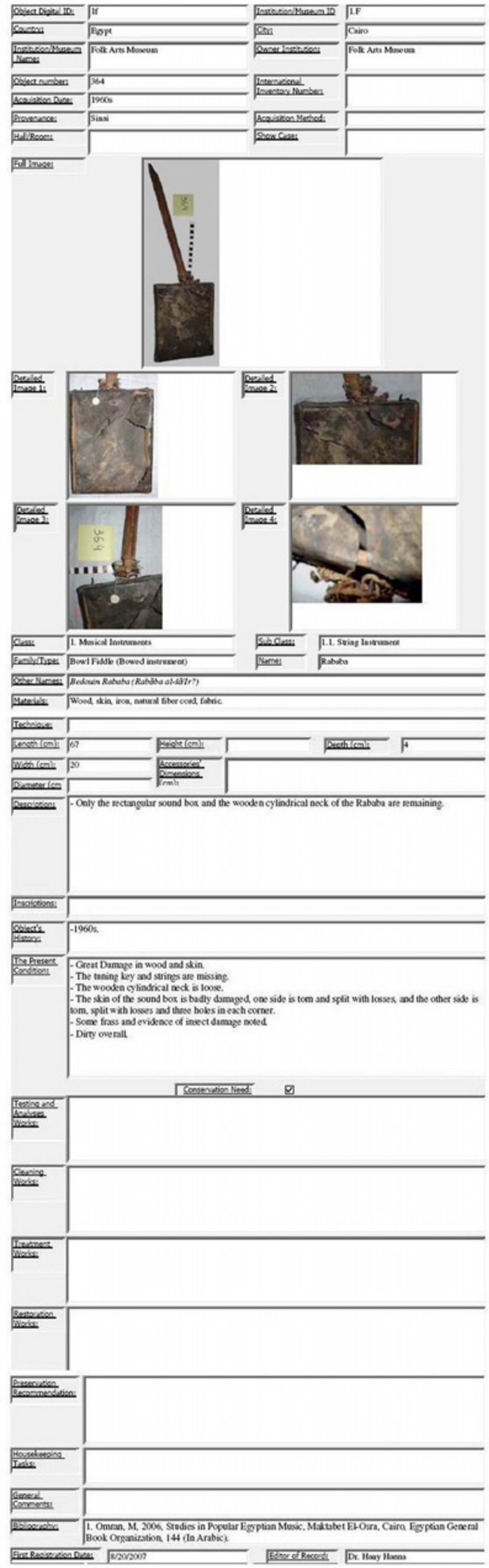
General Director: Ms. Sonia Walee El-Deen.
History and Brief Introduction: Center for folk arts studies been established in 1957, as the first Egyptian organization aimed to gather, collect, classify and document al sorts of materials concerned all branches of folk arts, and to make it available for the researchers and artists, The center and its museum host cllections of several objects and materials from all around Egypt covers most of folk arts materials, tools and instruments such as traditional clothing, carpets, musical instruments, archival material and musical records.
Overview of Museum and Gallery: The museum is inside an office block on the third floor. The museum consists of two rooms, one being the office of the director. The collection is planned to move to a new museum building, and discussions about new display cases have begun.
The museum is run by historians, and the staff seems to be not well trained in object handling or collections management. The objects are handled with familiarity of one who has played the instruments rather than as museum objects. The collection is mainly used by scholars. No visitors were noted during the assessment.
Gallery Conditions: The rooms are lit when in use. They are well lit, though no light meter was used, the lighting in the rooms are well above the recommended light levels (50 to 100 lux maximum) for wood, natural fiber materials, bone and ivory. The floors appear to be cleaned with water and mops, though dirt and insect debris and dead insects were noted. No environmental controls and monitoring system are noted.
During the visits, the temperature inside the rooms was not measured, but was likely over 32 degrees C. Insect activity is noted overall, and no evidence of Integrated Pest Management
Display Methods: Most of the objects are not preserved in show cases; the objects are placed on the floor, hung on nails on the walls, stored in baskets, and in some cases inside open cases.
Number of Objects in Collection: Total: 131 objects.
1. Musical Instruments: 131 objects:
1.1. String Instruments: 13 objects:
- Rababa: 7 objects.
- Simsimiyya: 4 objects.

Image 1:
Image 2:
Conservation Facilities: The museum has no conservation laboratory; there is no conservation staff as well.
General Notes Regarding Assessment and Documentation:
1. We received good cooperation from the museum staff. We were able to handle the objects in direct for the assessment, photography, measurement etc.
2. The museum includes few musical instruments which we thing that they are similar but maybe not the sort of musical instruments that accompany the story tellers, but we included them within the assessment for the purpose of completing the assessments of all the related musical instruments in the museum.
3. We used the instruments' names been given by the museum.

Conservation Recommendations:
- Catalog entire collection with appropriate collections management techniques.
- Set a well-equipped conservation laboratory at the museum.
- Hire conservators to treat entire collection, including fumigation and making certain evidence of use and wear is retained.
- Clean, restore and treat the individual damaged objects using scientific techniques and method.
- Fabricate new cases manufactured with conservation approved materials and requirements.

Conservation Requirements:
Housekeeping Tasks:
General Comments:
Bibliography: 1. Omran, M, 2006, Studies in Popular Egyptian Music, Maktabet El-Osra, Cairo, Egyptian General Book Organization, 51 (In Arabic).
Editor of Record: Dr. Hany Hanna
First Registration Date: 9/29/2007
Last Updat: 11/29/2007
Comments:

Fig. 29. Example of a model for a museum extracted from the database.



Object Digital ID: If
Institution/Museum ID: 1.F
Country: Egypt
City: Cairo
Institution/Museum Name: Folk Arts Museum
Owner Institution: Folk Arts Museum
Object number: 364
International Inventory Number:
Acquisition Date: 1960s
Provenance: Sinai
Acquisition Method:
Hall/Room:
Show Case:
Full Image:
Detailed Image 1:
Detailed Image 2:
Detailed Image 3:
Detailed Image 4:
Class: 1. Musical Instruments
Sub Class: 1.1. String Instrument
Family/Type: Bowl Fiddle (Bowed instrument)
Name: Rababa
Other Names: *Bedouin Rababa (Rabāba al-šāʿir?)*
Materials: Wood, skin, iron, natural fiber cord, fabric.
Technique:
Length (cm): 67
Height (cm):
Depth (cm): 4
Width (cm): 20
Accessories' Dimensions (cm):
Diameter (cm
Description: - Only the rectangular sound box and the wooden cylindrical neck of the Rababa are remaining.
Inscriptions:
Object's History: -1960s.
The Present Condition:
- Great Damage in wood and skin.
- The tuning key and strings are missing.
- The wooden cylindrical neck is loose.
- The skin of the sound box is badly damaged, one side is torn and split with losses, and the other side is torn, split with losses and three holes in each corner.
- Some frass and evidence of insect damage noted.
- Dirty overall.

Conservation Need: ☑
Testing and Analyses Works:
Cleaning Works:
Treatment Works:
Restoration Works:
Preservation Recommendation:
Housekeeping Tasks:
General Comments:
Bibliography: 1. Omran, M, 2006, Studies in Popular Egyptian Music, Maktabet El-Osra, Cairo, Egyptian General Book Organization, 144 (In Arabic).
First Registration Date: 8/20/2007
Editor of Record: Dr. Hany Hanna

Fig. 30. Example of a model for an object extracted from the database.

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ELIZABETH PEIRCE

Old Meets New: Consolidation Techniques

ABSTRACT—As Chinese export lacquer degrades, it becomes increasingly more sensitive to staining by polar solvents. This is a particular problem when trying to consolidate the lifting and cracking surfaces on export pieces. Adhesives bound in an aqueous solution, such as fish or hide glue, run the risk of damaging the lacquer surface, although they are more compatible with the ground. The author developed a system using silicone solvents as a barrier layer during consolidation to protect the lacquer while still using aqueous adhesives, maintaining high compatibility while minimizing the risk of damage.

1. INTRODUCTION

1.1 LACQUER MANUFACTURE AND DEGRADATION

Lacquered pieces are made from the sap of the Anicardiaceae family of trees, which are closely related to poison sumac or poison ivy. There are three main types of lacquer: *Toxicodendron verniciflluum,* providing urushi or qi lacquer to Japan, China, and Korea; *Toxicodendron succedaneum* for laccol lacquer in Vietnam and Taiwan; and *Gluta usitata* for thitsi lacquer in Burma and Thailand (Getty 2010; Schilling et al. 2014). Each sap has its own working properties that affect the manipulation of the material for final production. The Getty Conservation Institute has performed extensive research into identifying different additives through their Recent Advancements in the Characterization of Asian Lacquer program.

Lacquer polymerizes when exposed to both heat and humidity, creating a hard, shiny, insoluble surface (McSharry et al. 2007; Webb 2000). Lacquer for the domestic market was made with more care to properly cure the layers between applications; however, export lacquer artisans who were working to meet the increasing demands of the Western market did not have the time necessary to produce the same high-quality product. Instead, several shortcuts were taken to lessen the production time, including using protein-based binders such as pigs' blood for the ground instead of lacquer and applying thicker layers of lacquer to build up the surface quickly (Getty 2010; Heginbotham and Schilling 2011; Milklin-Kniefacz et al. 2014). Although export pieces may still have a very fine appearance when new, they are inherently more susceptible to degradation over time due to the shortened production period (Petisca et al. 2011).

As lacquer is exposed to light and fluctuations in RH, it begins to degrade. Frequently, export lacquer suffers from multiple, closely spaced, parallel cracks across the surface. These cracks are caused by a combination of stresses, both from the shrinkage and expansion of the wooden core and the tension that forms in the lacquer itself as it cures (Schellmann 2011; Webb 2000). These cracks will lift and curl, eventually leading to loss of material. Light damage causes the lacquer surface to degrade, creating microcracks in the surface that causes a matte, dull appearance (Von Stein 2012; Webb 2000; Yamashita and Rivers 2011). The degradation has more than an aesthetic alteration: the lacquer surface becomes friable, sensitive to polar solvents, and sensitive to physical abrasion (Webb 2000; Webb, pers. comm.). In some instances, a varnish layer would be applied to resaturate the matte surface and restore the gloss.

1.2 LACQUER CONSERVATION AT WINTERTHUR

Export lacquer can be found in almost any collection. Winterthur alone has 33 pieces of lacquerware, ranging from small fan boxes to sewing tables to larger case furniture and screens. Although there had been isolated treatments focusing on individual pieces in the past, there had not been a comprehensive survey of the lacquer collection in many years. In 2012, a survey of the lacquer was conducted, and it was felt that this collection as a whole was at the greatest risk if conservation intervention was not undertaken (Auffret, Matsen, and Petisca 2014). The survey was used as part of a grant application to the Institute for Museum and Library Services (IMLS), which was awarded in 2013. The two-year IMLS grant provided funding to complete three main objectives: to educate staff and students about lacquer conservation, to treat six objects in the collection, and to perform and share research on the material composition of lacquer pieces (Institute of Museum and Library Services 2017). Knowing that lacquer conservation requires specialized training, the grant also provided funding to hire lacquer conservation specialist João Petisca to treat objects and train staff in lacquer conservation.

2. LACQUER SCREEN

2.1 HISTORY AND CONSTRUCTION

One of the six pieces to be treated during the IMLS grant campaign was a six-paneled screen, seen in figure 1 in situ in the China Trade Room. Located on the third floor of the museum, the China Trade Room focuses on Chinese export lacquer,

Fig. 1. Chinese export lacquer screen 2004.0040.002 seen in situ in the China Trade Room at Winterthur. Photo courtesy of Jim Schneck, Winterthur Museum.

displaying 11 of Winterthur's 33 pieces of Chinese export lacquer. The screen was donated to the museum in 2004 at the bequest of Mrs. Violet Thoron, descendent of William Ward of Salem, Massachusetts. It was most likely given to Ward by his brother-in-law, Captain William Grey, who was an important New England shipowner and importer of Chinese export lacquerware (Auffret et al. 2014). The provenance dates the piece to the first quarter of the 19th century.

The six-paneled screen is decorated with two-toned gold designs (fig. 2). Each panel has a central scene depicting birds and small trees on the front, and birds with bamboo on the back. The front of the screen has a wide, elaborate border depicting typical Chinese iconography—bats, butterflies, spiders, paper scrolls, fans, and flowers. Each panel measures 211.8 x 54.6 x 2.54 cm (83.4 x 21.5 x 1 in.). The panels have a "breadboard" construction—three long, wide boards with vertical grain capped at the top and bottom with narrower, horizontal boards. The top rail has been mitered to join with the outer panels, whereas the bottom rail sits squarely in between the feet. The vertical boards are held together with wooden dowels, whereas the top and bottoms have been fixed in place with long, straight nails (fig. 3). Wood identification performed on a small sample shows that the screen is made of Chinese swamp cypress (*Glyptostrobus pensilis*), a tree native to southeastern China (Alden, pers. comm.). The cross section seen in figure 4 shows four layers: two coarse ground layers separated by an interleafing layer, most likely paper, and two layers of lacquer. Pyrolysis gas chromatography/mass spectrometry analysis performed by the Scientific Research and Analytical Lab at Winterthur determined that there is a protein binder in the ground, the lower lacquer layer is made with laccol, and the upper lacquer layer is urushi.

Fig. 2. Overall image of screen 2004.0030.002 before treatment. Courtesy of Jim Schneck, Winterthur Museum.

2.2 CONDITION

Overall the screen was in fairly good condition, particularly when compared to other examples in the collection. However,

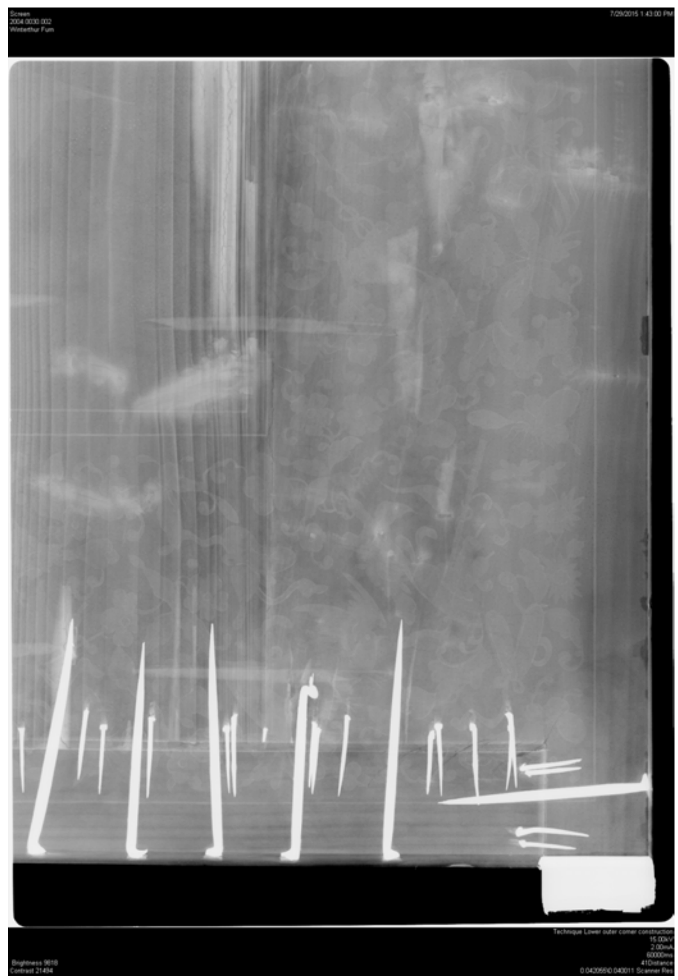

Fig. 3. X-radiograph of one of the panels of screen 2004.0030.002. The long nails used to attaché to top and bottom boards can be seen, as well as the wooden dowels that peg the vertical boards together. Courtesy of the Winterthur Museum.

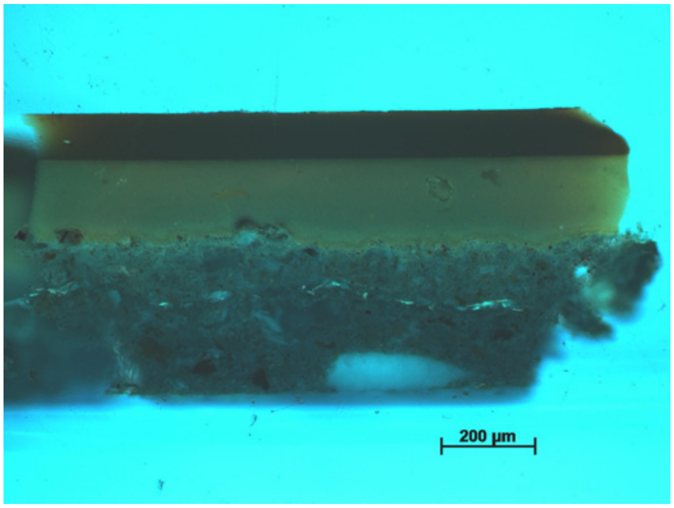

Fig. 4. Cross section depicting layer structure of screen 2004.0030.002. The cross section is illuminated under UV405 to better highlight the layers. Courtesy of Catherine Matsen, Winterthur Museum.

there were several large vertical cracks that coincide with the joins of the vertical boards, most likely caused by the shrinkage of the substrate. Numerous horizontal cracks had formed across the surfaces of the lacquer, particularly concentrated along the edges of the face of the panels and along the vertical cracks. Many of these cracks were severely lifting, leading to breakage and loss of material. Losses were particularly concentrated on the outside edges of the two outermost panels, where improper handling has caused extensive damage (fig. 5).

There were multiple fingerprints along the edges of the faces of all panels. On multiple panels, there are splashes and smears of an unknown substance on the surface, both on the fronts and the backs of the panels. Additionally, there is evidence of previous restoration campaigns on several panels, some of which are more stable than others. There are two types of repairs: a thick, hard, supportive fill placed within curled and cracked areas, and a thinner black paint or varnish that was applied to losses without bulking. There appears to be an additional coating on the sides of the panels and near the hinges that fluoresce a pale green-white under UV light.

3. TREATMENT

3.1 ORIGINAL TECHNIQUE

Until this point, all other lacquer coated objects during this campaign had been consolidated in the same way. First, a mixture of water and ethanol was injected beneath the lifting flakes to soften the protein binder in the ground (Umney and Rivers 2003). The flake was then covered with a sheet of silicone release Mylar, followed by a sewn baggie filled with steel shot. The baggie had been placed on a hot plate on low and heated until it felt warm against the inside of the wrist. This combination of

Fig. 5. Detail of damage and loss on the edge of screen 2004.0030.002. Courtesy of Jim Schneck, Winterthur Museum.

Fig. 6. Bain marie made of a modified mason jar with a copper tube set into the center of the lid. The mason jar was filled with water then placed into water in a standard glue pot. Courtesy of the Winterthur Museum.

Fig. 7. Author Liz Peirce clamping using the Shimbari table. Courtesy of the Winterthur Museum.

moisture, warmth, and gentle pressure helped to relax the flake down flat. The setup was left for several minutes to allow the flake to fully relax.

Hide glue of 192 g was chosen as the consolidant for its compatibility with the protein ground, quick tacking time, and strength. It was both strong enough to hold the flake down while still weak enough to release before causing other areas of the lacquer to crack should further movement occur. Additionally, the long-term aging properties should be similar to those of the ground, maintaining its resolubility and retreatability over the years. The hide glue was warmed in a specially designed bain marie (fig. 6) that heated the glue without having it be in contact with water. The adhesive was injected beneath the lifting flake, which was then pumped to evenly distribute the glue. Any excess adhesive or "squeeze-out" was wiped from the surface using a dampened poly(vinyl alcohol) (PVOH) sponge.

Silicone-release Mylar was placed over the flake, followed by a warmed silicone rubber pad and block. The warmed rubber pad helped keep the hide glue slightly fluid to allow the flake to lie flat and acted as a cushion between the block and the lacquer surface. The setup was clamped using a modified Shimbari technique to apply even downward pressure (fig. 7).

This method had been successful in all prior executions. However, one of the main differences between previous treatments and the China Trade screen was the presence of a varnish layer. Varnish layers would frequently be applied to degraded lacquer surfaces to restore luster and gloss. Although these varnishes are problematic—they darken and crack over time, and potentially become insoluble and irreversible as they age—they do act as a barrier layer that protects the surface of the lacquer from the consolidation process. The six-panel screen, although no longer highly glossy, had not been varnished in its history. Preliminary spot tests did show that the lacquer was sensitive to both water and ethanol, but this was expected based on normal degradation of lacquer. Theoretically, with careful application, the pre-established technique could have been successful. However, on the second area to be consolidated, when the

Fig. 8. Humidification chambers. Courtesy of the Winterthur Museum.

warmed baggie was removed, the lacquer surface beneath had solubilized, leaving a disfigured melted-looking surface. The first thought was that the damage was caused by human error, assuming that too much of the ethanol:water mixture had been injected beneath the surface. Another area was tested, this time being extremely careful to only inject a few drops of the mixture. However, the same issue occurred. It is believed that the combination of the injected water and ethanol with the warmth from the steel shot baggie created a microenvironment, causing the water and ethanol to condense on the surface. At this point, treatment stopped and the technique was reassessed, both with regard to how to properly relax the flakes and whether proteinaceous adhesives should be used.

3.2 NEW TECHNIQUE

3.2.1 Humidification

The risk of continuing to inject liquid solvents beneath the surface of the lacquer was considered too great, leading to different softening tests. The first attempt involved placing the same warmed baggies onto the surface of the lacquer with the aim that heat can help soften protein adhesives and the lacquer itself (Webb 2000). This technique was effective in areas that were barely lifted but was unsuccessful on areas with more severe lifting. Prolonged exposure was avoided due to the concern that excessive heat could cause irreversible color changes to the lacquer (Webb 2000). A different solution was required.

Marianne Webb very kindly shared her humidification technique that uses localized humidification chambers placed on the lacquer surface. Three chambers were made—one round and two rectangular (fig. 8). The rectangular chambers were best for long cracks in the surface and were made of Vivak—a clear thermoplastic sheet that can be easily bent and shaped. The transparency of the Vivak provided good visual access to assess whether there were any unexpected reactions on the surface of the screen. The round chamber was best for small areas of lifting lacquer and was made of two heavy duty stackable plastic cups with the bottoms removed. For both systems, a piece of cotton cloth was wetted and wrung out until just damp, then placed over the top of each chamber. The cloth was clamped in place either with a rubber band or was sandwiched between the two cups, taking extreme care to ensure that the cloth did not touch the lacquer surface in any way. This technique locally raised the RH on the surface of the lacquer, permitting the ground to gradually soften and relax. Once the flakes were pliable, they would be dry clamped flat to help set the shape.

3.2.2 Adhesive Selection

The second challenge was to evaluate the adhesive selection. There had been several issues with the hot hide glue. Excess adhesive that squeezed out onto the surface during consolidation left stains and the quick gel time for the glue made working with the adhesive in a syringe difficult. The syringe had to frequently be reheated during consolidation, as the adhesive gelled inside the needle before it could be injected beneath the flake. Additionally, the hide glue was highly viscous, requiring a larger needle size to accommodate the viscosity. The larger needle made injection into small or barely lifting areas potentially dangerous, as the insertion of the needle could cause lifting areas to break off.

Synthetic adhesives were also considered, including Paraloid B-72, Plextol B500, and Lascaux Medium for Consolidation. All three had been previously used in other consolidation treatments (Chase et al. 1988; Webb 2000; Webb, pers. comm.). A 1:1 Plextol B500:Lascaux Medium for Consolidation mixture was tested by wicking it beneath the surface of the crack. However, the combination was found to not only be too weak to hold the flakes flat but also left an oddly shiny surface around the edge of the crack where it had been wicked in. B-72 was considered but ultimately was rejected for several reasons. Most importantly, there was a desire to maintain consistency between treatments in this campaign, and using B-72 or other synthetics rather than a protein adhesive limited treatment options in the future.

Protein adhesives were revisited, eventually leading to the selection of Art Colle fish glue, a highly refined fish glue from France. It was selected for its strength, good working properties, and compatibility with the ground. Because fish glue is liquid at room temperature, the adhesive did not need to be heated to maintain fluidity. The lower viscosity of the fish glue also meant that a smaller needle could be used. However, because the adhesive was still transported in water, a barrier coating or masking layer needed to be applied to protect the surface from excess adhesive during consolidation.

3.2.3 Barrier Layer

There were several factors that needed to be considered to determine the best material for this application. The barrier layer needed to flow into the microcracks of the lacquer to properly protect the surface from adhesive. However, applying a varnish layer, such as Paraloid B-72 or Laropal A81, was not desired (2004.0030.001 Treatment Report 2016; Arslanoglu and Learner 2001; Coueignoux 2011). The application of a varnish layer would have altered the gloss of the surface, and complete removal of the localized varnish would have been very difficult. Instead, the barrier needed to evaporate completely while still providing coverage. Additionally, the barrier ideally should be

Fig. 9. Detail showing area before treatment (A), application of silicone solvent (B), clamping (C), and after treatment (D). Courtesy of the Winterthur Museum.

nonpolar, creating an oil-on-water effect that would help propel any excess adhesive on top of the barrier and away from the lacquer.

Richard Wolbers had suggested the use of silicone solvents as a barrier during varnish reduction for the cleaning of the companion piece to the screen, a kneehole desk donated to the museum in the same gift. The silicone solvent had been applied to flood the surface while a cleaning gel was worked into the varnish layer to slowly reduce the coating. It was thought that the solvents may be used in a similar capacity on the screen. Because the screen was not varnished, tests were performed in discreet areas to see if either D4 or D5 left any tide lines as it evaporated. No tide lines were found, and the surface appeared unchanged. There had been concern about the full evaporation of the solvents from the microcracks in the surface; however, research into the complete evaporation of the solvent has been promising (Stavroudis 2012; Sullivan, Brogdon-Grantham, and Tiara 2014). A 1:1 combination of D4:D5 was used for its optimal working time, allowing approximately 45 minutes before the solution fully evaporated.

3.3 RESULTS

The chambers were placed over the desired area and left until the flakes could be flexed without breaking. The cloths were rewetted as necessary. Once the flakes were relaxed, a 1:1 ratio of D4:D5 silicone solvent was liberally applied to the surface (fig. 9). Art Colle fish glue was then injected beneath the surface, and the flake was pumped to distribute the adhesive evenly. Any excess at this point was wiped with a lightly damp PVOH sponge. The surface was then blotted with a Kim wipe, and more of the silicone solvent was applied. This step was performed to ensure that no excess adhesive or water was left behind, and that there was a continuous coating of the silicone solvent. A layer of silicone-release Mylar followed by a silicone rubber pad and wood block were placed on top of the area to be consolidated. The setup was then clamped, tightened, and immediately released. All of the layers were removed, and the area was checked for any squeeze-out. Any excess adhesive was wiped with the PVOH sponge, blotted with a Kim wipe, and more solvent was applied. The setup was clamped again and left for 15 minutes, then the process was repeated again until no excess adhesive was found. The clamps were then left on for 2 days to allow the fish glue to fully set.

4. CONCLUSION

Overall, the technique was highly successful. It was most effective on the smaller areas of delamination that could be consolidated in one session. The long cracks were more challenging, as they needed to be worked in small sections to successfully secure the lacquer, and it took longer to humidify the larger surface area. The long cracks also tended to be the areas that were the most severely lifted, which made it more difficult to estimate how much adhesive was beneath the flake, leading to more squeeze-out and repeated clamping and unclamping of the system. However, the silicone solvent significantly reduced the risk of staining on the lacquer surface. The solvent is easy to control, staying where it is brushed without wicking under the flakes. It evaporated without leaving tide lines and had a working time that allowed for repeated manipulation of the surface. It is hoped that this technique could be used in other scenarios when consolidation is potentially damaging to the sensitive lacquer surface.

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SOURCES OF MATERIALS

ArteColle Fish Glue (refined clear fish glue from France)
Source unknown

Ethanol, Plextol B500, polyvinyl alcohol sponges, silicone release Mylar
TALAS
330 Morgan Ave.
Brooklyn, NY 11211
212-219-0770
http://talasonline.com

Exel hypodermic needles, 25G x 1-1/2 in. x 0.5 x 38 mm & 22G x 1-1/2 in. x .07 x 38 mm
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WEI KAO, KATE DUFFY, HIROMI KINOSHITA, PEGGY OLLEY, AND BEHROOZ SALIMNEJAD

Conservation and Analysis of a Pair of Qing Dynasty Lacquer Clothes Wardrobes in the Collection of the Philadelphia Museum of Art

ABSTRACT—A pair of Qing dynasty (1644–1911) lacquer clothes wardrobes (1940-7-1a--c, 2a--c) is a highlight of the Chinese art collection in the Philadelphia Museum of Art. Each of the wardrobes consists of lower and upper cabinets with gilt lacquer decoration of dragon and lotuses appropriate for furniture made for the nobility. Due to years of use as display cases, the wardrobes required conservation treatment. The project afforded an opportunity for a technical investigation of the materials.
The results of the analyses on both wardrobes suggest that the current surface decorations on the two wardrobes represent an attempt to unify upper and lower cabinets.

1. INTRODUCTION

A highlight of the Chinese art collection in the Philadelphia Museum of Art (PMA) is a pair of Qing dynasty (1644–1911) lacquer clothes wardrobes (1940-7-1a--c, 2a--c). In consultation with a curator from the museum's East Asian art department, the wardrobes were examined by conservation staff in preparation for the reinstallation of the Chinese permanent galleries. At the same time, a technical analysis with the museum's conservation scientists was pursued. The examination and analysis supported an evaluation of materials and assessment of the wardrobes' condition for treatment planning and provided an opportunity to contribute data regarding the lacquer materials to a collaborative lacquer database for the conservation field. Wardrobe 1940-7-2a--c was the primary object of investigation, as it needed the greatest amount of treatment, whereas wardrobe 1940-7-1a--c was examined for comparative purposes as necessary while remaining on display in the galleries.

2. DESCRIPTION OF OBJECTS

Compound wardrobes such as the ones at PMA are called *sijian gui* (四件櫃) in Chinese, or "four-part wardrobes." Each wardrobe consists of a large lower cabinet with a matching smaller cabinet situated on top (fig. 1). An overall design of five-clawed dragons suggests use by Chinese nobility. Each pair of doors has four hinges and a large escutcheon with two pulls and lock receptacles. The upper cabinets are secured with a large imperial lock and key decorated with five-clawed dragons chasing a flaming "jewel." Perhaps the most impressive feature of the wardrobes is their size—each measures more than 9 ft. tall.

3. HISTORY

Based on the museum's records in the registrar's department, the pair of wardrobes was purchased in 1940 from Mr. Owen F. Roberts, a stockbroker and art collector who lived at 825 Fifth Avenue in New York City (Gray 2005). The provenance before Roberts is unknown. Roberts inherited a fairly large fortune from his late wife's estate in 1912 (*New York Times* 1913). He collected other Chinese works of art, including jades, pottery, agate, crystal carvings, snuff bottles, embroideries, and other textiles, some of which he sold at auction in 1928 at the American Art Galleries, New York.

When the Asian wing of the PMA opened in 1940, the pair was featured and functioned as display cases for Chinese porcelains (fig. 2). Around that time, the wardrobes were wired for lighting and the interiors of the lower cabinets were modified with fabric-covered Masonite. The same fabric is present on another pair of large lacquer wardrobes (1939-18-1a--c, 2a--c) in the museum's collection, suggesting that the modifications were done by the museum.

Plain wood and lacquered compound wardrobes like the two discussed in this article were found in the mansions of the upper-class elite and nobility during the late Ming (1368–1644) and Qing (1644–1911) dynasties. The lower cabinets were fitted with shelves and drawers designed to store fine garments such as robes which were folded flat. Hats, smaller items, and less-used clothing were kept in the upper cabinets and accessed using a ladder (Handler 1993, 23). The wardrobes would have been secured with large metal locks.

Dominating the entire design surfaces of the museum's wardrobes are groups of five-clawed dragons amid lotus scrolls. The dragon is an ancient symbol of creation that was thought to induce rain. It later became an emblem of the emperor—its imagery associated with imperial power and authority. From the 14th century onward, rules were implemented for dragon imagery: five-clawed dragons were reserved for the emperor and his immediate family (although this rule was not always followed).

Fig. 1. Pair of compound wardrobes: 1940-7-1a--c is on the left, and 1940-7-2a--c is on the right. Note that each wardrobe consists of a large lower cabinet and a small cabinet on top. Artist/maker unknown, Qing dynasty (1644–1911), lacquered wood with painted and gilt decoration, brass fittings; 290.2 × 143.5 × 66.8 cm. Purchased with the Bloomfield Moore Fund, 1940. 1940-7-1a--c, 2a--c.

Compound wardrobes were placed in both private and public spaces of a household. Based on the imperial dragon design of the museum's wardrobes and their large size, they are appropriately interpreted in the museum's 17th century Reception Hall

Fig. 2. Photograph of the Reception Hall taken in 1940 at the opening of the new PMA Asian wing. Note that one of the wardrobes, with its interior modifications for use as a display cabinet, is seen in the back. Photographer Alfred Eisenstaedt ©Time Life Magazine.

from the Palace of Duke Zhao, a public space where the noble family conducted official activities.

4. METHODOLOGY

The first step in the technical study was visual examination with a stereomicroscope, followed by nondestructive analysis using UV light, x-ray radiography, infrared reflectography (IRR), and handheld XRF examinations. Samples were then taken with a scalpel and examined under low magnification. Half of each sample was cast in Bioplastic resin, cured, sectioned, and polished for examination by visible and fluorescent light microscopies (VLM and FLM). The uncast portion of each sample was separated into discrete layers for analysis by Fourier transform infrared (MFTIR) microspectroscopy and pyrolysis gas chromatography mass spectrometry (Py-GCMS) using a procedure described by the Getty Conservation Institute. A UV light was used to discriminate the various lacquer layers.

5. INITIAL EXAMINATION

5.1 STRUCTURE

As described earlier, each wardrobe comprises a large lower cabinet with a smaller cabinet situated on top. Each cabinet has one pair of doors that open outward from the center. The wardrobes are constructed with a soft wood. To further examine the structures, the fabric-covered Masonite was removed from the lower cabinets. X-rays were taken but did not resolve questions about the joinery.

The lower cabinets are constructed using panels, interior rails, stiles, and cross battens with mortise and tenon joinery. The panels on the sides and lower front are flush mounted to the interior frame. The rear panel is resting in grooves on the rear rails and stiles. The door panels are flush mounted to the surface of a frame, which is constructed using mortise and tenon joinery and a cross batten.

Although the construction of upper and lower cabinets is similar, there are some variations. For instance, on the upper cabinet the back panel is flush with the rails and stiles, whereas on the lower cabinet the back panel is set into grooves (fig. 3). In addition, comparison of the battens from the upper and lower cabinets revealed several differences. The battens on the upper cabinets are bigger and more square than the lower cabinets. In addition, three mortises were found on the third batten of the lower cabinets (fig. 4). Research into similar cabinets found that the mortises may be from multiple drawers that are missing in the museum's wardrobes (e.g., see one of a pair of massive Huali compound cabinets, Late Qing Dynasty Lot 1007, Sotheby's New York, September 17, 2016).

Overall, the structure is relatively sound and stable on both wardrobes. There are many nail holes in the interior and some associated exterior surface damage due to the addition of the Masonite. Wardrobe 1940-7-2a--c has a large crack on the proper right side at the upper corner of the lower cabinet. It is unclear how and when the damage occurred. Additionally, the

Fig. 3. Reverse of upper and lower cabinets on wardrobe 1940-7-2a--c. Note that the back panel on the upper cabinet is flush with the rails and stiles, whereas the back panel on the lower cabinet is set into grooves.

back panel has shrunk, causing gaps where it meets the stiles. This gap does not affect the overall stability of the wardrobe.

5.2 HARDWARE

Each wardrobe has eight sets of hinges, as well as two large escutcheons (each with two pulls and lock receptacles). The upper cabinets are secured with a large lock and key. Elemental analysis by XRF of the hinges, escutcheon, and lock revealed copper (Cu) and zinc (Zn) indicative of brass hardware. The hinges are surface mounted and secured with six conical-headed pins. The octagonal foliated rimmed hinge and lock plates are incised with sinewy dragons amid clouds against a punched ground. The two pulls of the lock plate and two lock receptacles are decorated with stylized *shou* (壽, "longevity") characters (fig. 5). Overall, the style of the dragon design (different dragons

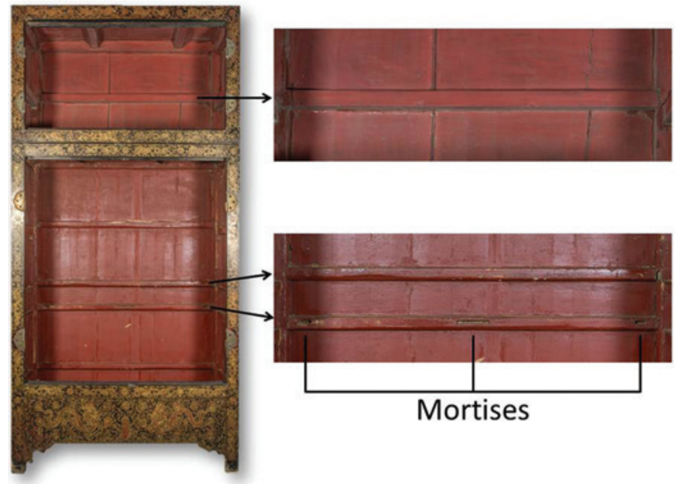

Fig. 4. Interior of upper and lower cabinets on wardrobe 1940-7-1a--c. Note that the battens on the upper cabinet are bigger and more square than the lower cabinet. In addition, there are three mortises on the third batten that may correspond to now-missing drawers.

Fig. 5. Brass lock plate showing dragon design and pull with *shou* (longevity) character.

are depicted during different periods) and the material of the hardware (brass is more commonly used during the Qing rather than *pak tong* [copper, zinc, nickel alloy] during the Ming dynasty) (Zhu 1987, 83; Hu 1995) suggests a possible mid-Qing dynasty (1644–1911) dating.

Each upper cabinet has a large lock with a key. The lower cabinets originally would have had locks as well. Each lock is heavily cast in high relief with a pair of five-clawed dragons confronting a flaming "jewel" on each side. Six characters cast on the edge of the lock read *Da Qing Qianlong nian zhi* (大清乾隆年製), which translates to "made in the year of Qianlong of the Great Qing" (fig. 6). This mark indicates that the locks were made by imperial command during the reign of the Qianlong emperor (1736–1795). In addition, each lock has a mark incised on its side that corresponds with the same mark on the key: *yi* (乙) on 1970-4-2c (fig. 6) and *ding* (丁) on 1970-4-1c. *Yi* and *ding* are the second and fourth of the Ten Heavenly Stems (甲, 乙, 丙, 丁, 戊, 己, 庚, 辛, 壬, 癸), which together with the Twelve Earthly Branches form China's traditional calendrical and counting system. The Ten Heavenly Stems also are used as numbering system with *yi* (乙) corresponding to the number 2 and *ding* (丁) to 4. Hypothetically, the two missing locks may have had the inscription *jia* (甲) corresponding to the number 1 and *bing* (丙) corresponding to 3.

5.3 SURFACE

The surface was examined overall in normal and UV light. The decorative layers were further examined using a stereomicroscope. Mercury (Hg) and gold (Au) were detected by XRF, implying vermilion (HgS) pigment and a gilt decoration.

Several types of preparatory layers with coarse fibers, paper, and/or coarse grounds are visible above the wooden substrate in

Fig. 6. Six characters cast on the edge of the lock, read *Da Qing Qianlong nian zhi* (大清乾隆年製), which translates to "made in the year of Qianlong of the Great Qing." In addition, the lock has a mark (*yi* [乙]) in intaglio, which corresponds to the same mark on the key. Lock and key, Qing dynasty (1644–1911), Qianlong period (1736–1795), brass; lock 8.9 × 28.73 × 3.5 cm. Purchased with the Bloomfield Moore Fund, 1940-7-2c.

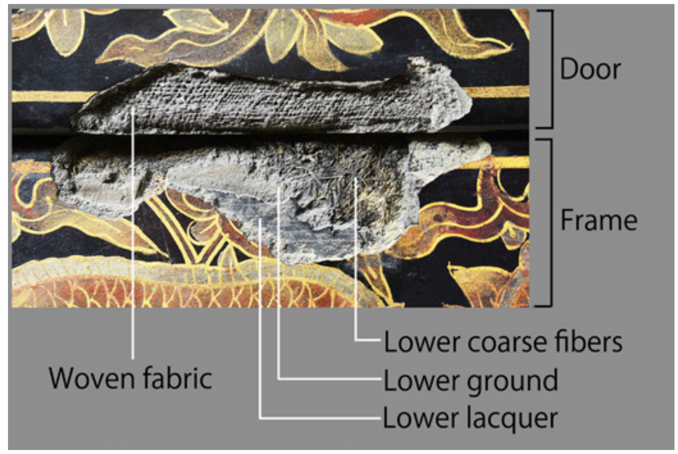

Fig. 7. Detail of area of loss in the upper cabinet. Note that lower layers, including fibers, ground, and lacquer, are visible. Also note that woven fabric, used in the preparatory layers, is visible on the door.

areas of loss on wardrobe 1940-7-2a--c. Figure 7 shows a woven fabric found as a preparatory layer on the doors, whereas rough/coarse plant fibers were applied over the wooden substrate along the exterior of the frame. Also seen in figure 7 is a lower decorative scheme situated beneath the current presentation surface; it consists of fibers, ground, and lacquer. Interestingly, handwritten characters were discovered on paper that was part of the lower cabinet's preparatory layers. IRR on several detached fragments made some of the characters more visible (fig. 8). These characters, Wáng (王), Shī (師), Fū (夫), and Yú (於), can be read, although in isolation their meaning cannot be determined.

Prior to treatment, the surface was in fair condition. Due to the movement of the wooden substrate, the surface showed minor tenting and cracking throughout. The edges and corners had the greatest extent of losses. There is some loss in the raised gilt decoration, revealing a red layer underneath. In addition, there is an overall, uneven, and dull surface coating, which was identified as wax (possibly beeswax) by MFTIR.

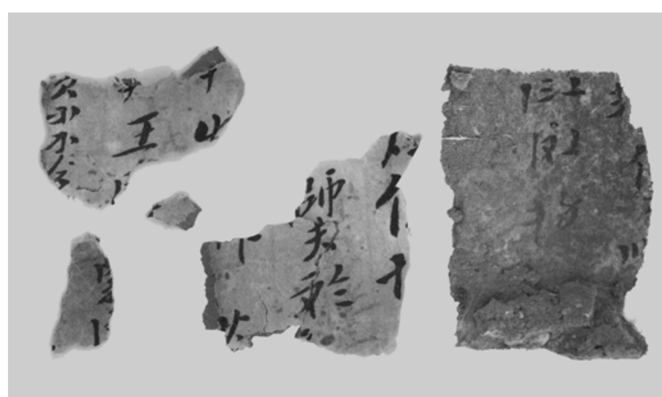

Fig. 8. IRR image of fragments from the interior of the lower cabinet shows characters written on the paper used in the preparatory layers.

6. CROSS-SECTION AND BINDING MEDIA ANALYSIS BY PY-GCMS

6.1 WARDROBE 1940-7-2A--C

Thirty-five cross sections were produced for wardrobe 1940-7-2a--c, representing the exterior and the interior decorations of both the upper and lower cabinets. In general, two decorative schemes were identified on the upper cabinet. In contrast, only one decorative scheme was found on the lower cabinet. These decorative schemes are depicted in cross sections with accompanying schematics in figures 9, 11, and 12.

6.1.1 Upper Cabinet

Although there are slight differences in stratigraphy, in general, the first decorative scheme on both the interior and exterior of the upper cabinet begins with a coarse ground, followed by paper fibers, a black ground, and then the decorative layers. The second decorative scheme was executed directly above the first decorative scheme.

6.1.1.1 Interior

The first decorative scheme on the interior of the upper cabinet, in general, begins with the preparatory layers (a coarse gray ground above the wood substrate, layer of paper fibers, and black finer ground), which are followed by the decorative lacquer layers, one pigmented with yellow (arsenic) and the other with red (mercury) (fig. 9). Media analysis was applied to the black finer ground and decorative layers. The black ground is bound mainly with a proteinaceous material, as suggested by the amino acids identified by Py-GCMS. For absolute identification of the protein(s), further testing with liquid chromatography is needed.

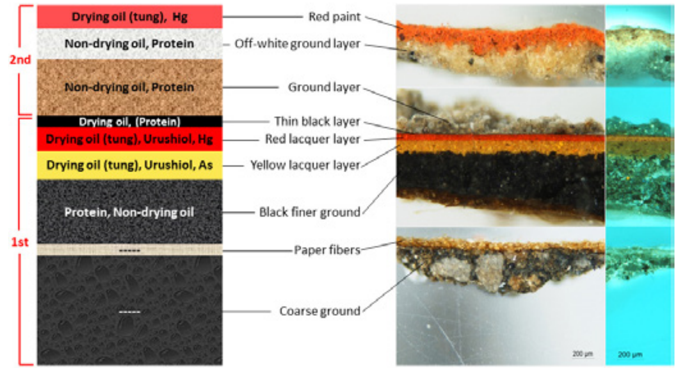

Fig. 9. Stratigraphy of the interior surface of the upper cabinet of wardrobe 1940-7-2a--c. Left: Represented as a schematic labeled with media results by Py-GCMS. Middle: Layer designations. Right: Sample cross section with visible and UV excitation, respectively. Two decorative schemes are evident.

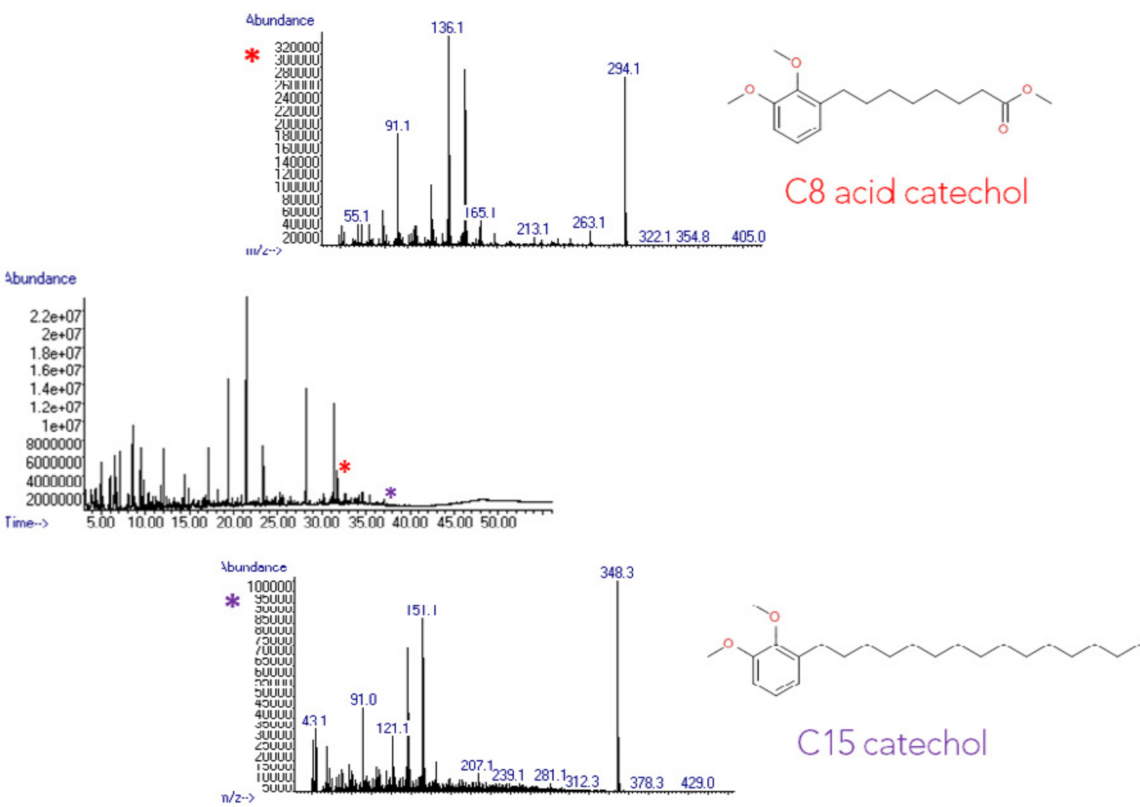

Fig. 10. Mass spectra of the two key biomarkers in urushiol, C8 acid catechol (top) and C15 catechol (bottom) detected in the lacquer layers of wardrobe 1940-7-2a--c. Their corresponding peaks are marked on the total ion chromatogram (middle).

The yellow and red lacquer layers are bound with urushiol as determined by the presence of two key biomarkers: C8 acid catechol and C15 catechol (fig. 10). Drying oil was also identified in each lacquer layer. The oil was tentatively identified as tung oil based on the level of nonanoic acid, 9-(o-propylphenyl)-, methyl ester, which was nearly 50% of the adjoining methyl stearate peak in the total ion chromatogram (not shown). Above the yellow and red lacquer layers is a thin black layer containing drying oil and an unidentified proteinaceous material; urushiol was not identified in this layer.

A second decorative scheme was applied directly above the first decorative scheme (fig. 9). The preparation layer is a thick ground layer bound with nondrying oil and an unidentified proteinaceous material. Above is an off-white ground layer bound with similar materials. The uppermost decorative layer contains a red paint bound with a drying oil, probably tung oil. Urushiol was not identified in this layer.

6.1.1.2 Exterior

Samples taken from the exterior of the upper cabinet also exhibit two decorative schemes (fig. 11) with preparatory layers similar to those on the interior of the upper cabinet. Cracks visible in the first scheme suggest that some time elapsed before the second decorative scheme was applied. In the first scheme, the two decorative layers contain lacquer. Binding media analysis with Py-GCMS identified drying oil, urushiol, proteinaceous material, and low levels of carbohydrates in both lacquer layers.

In the second decorative scheme, the two decorative layers are bound with urushiol, low levels of proteinaceous material, and oil (drying and nondrying, respectively). Above the lacquer layers is a red layer; the sample analyzed from this layer contained oil and paraffin wax. These materials may result from the surface treatment layer that is visible above the lacquer layers.

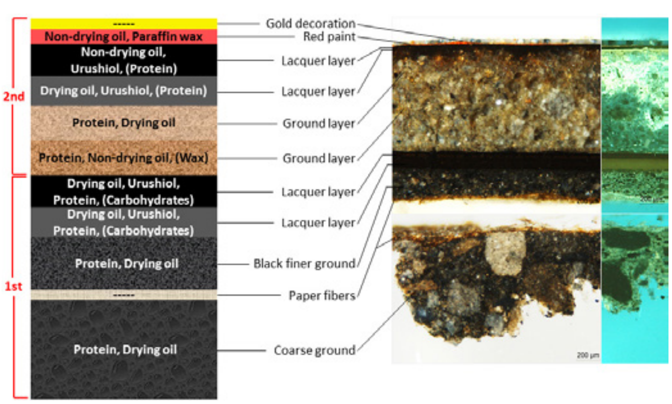

Fig. 11. Stratigraphy of the exterior surface of the upper cabinet of wardrobe 1940-7-2a--c. Left: Represented as a schematic labeled with media results by Py-GCMS. Middle: Layer designations. Right: Sample cross section with visible and UV excitation, respectively. Two decorative schemes are evident.

6.1.2 Lower Cabinet

In contrast to the upper cabinet, only one decorative scheme was evident on the lower cabinet.

6.1.2.1 Interior

Examination of the interior of the lower cabinet revealed a layer of paper above the wood substrate, followed by two thick ground layers and then a thinly applied red decorative layer (not shown). The binders for both grounds contain drying oil and proteinaceous material, whereas the uppermost decorative layer is paint bound with drying oil. There is a thin, discontinuous layer of beeswax on the surface of the cabinet, probably applied to buff or saturate the surface.

6.1.2.2 Exterior

Examination of the exterior of the lower cabinet also revealed one decorative scheme (fig. 12). Above the wood substrate is a layer of coarse fibers followed by two thick, brown ground layers. The lowest ground layer is bound with proteinaceous material, nondrying oil, and paraffin wax (the origin of the paraffin wax is unknown). The second ground layer is also bound with nondrying oil, proteinaceous material, and wax. Above are two decorative lacquer layers containing urushiol. Drying oil was detected in the lower of these two layers and nondrying oil in the upper. The final/uppermost, red decorative layer contains drying oil, urushiol, beeswax, proteinaceous material, and several aleuritic acid-related compounds indicative of shellac. The shellac and beeswax likely represent surface enrichments applied during the object's lifetime.

6.2 WARDROBE 1940-7-1a--c

Although the study focused mainly on wardrobe 1940-7-2a--c, six samples from wardrobe 1940-7-1a--c were analyzed for comparative purposes. Examination of cross section samples also revealed two decorative schemes (not shown) with the

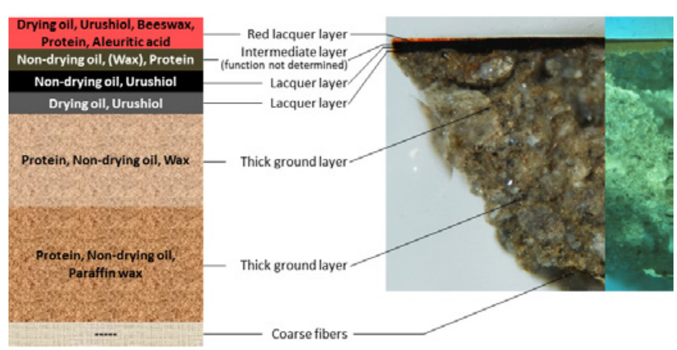

Fig. 12. Stratigraphy of the exterior surface of the lower cabinet of wardrobe 1940-7-2a--c. Left: Represented as a schematic labeled with media results by Py-GCMS. Middle: Layer designations. Right: Sample cross section with visible and UV excitation, respectively. Only one decorative scheme exists on the lower cabinet in contrast to the two schemes on the upper cabinet.

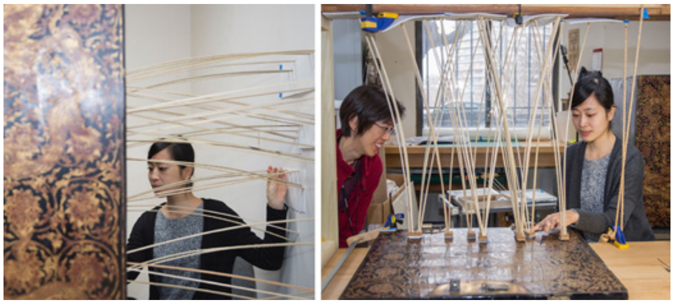

Fig. 13. Left: Conservator Wei Kao consolidating the surface of wardrobe 1940-7-2a--c using the *shimbari* technique. The wall was used for clamping the surface of the cabinets. Right: Kao uses a frame to clamp the surface of the shelves and doors while curator Hiromi Kinoshita observes.

stratigraphy of the exterior of the upper cabinet mimicking the stratigraphy of the exterior of the upper cabinet on wardrobe 1940-7-2a--c. Media analysis of the lacquer layers detected mixtures of urushiol and drying oil; the latter tentatively identified as tung oil.

7. CONSERVATION TREATMENT

The treatment focused on stabilizing the surface and structure. Cleaning and consolidation tests were carried out on wardrobe 1940-7-2a--c in preparation for the surface treatment. Cleaning tests also were performed on wardrobe 1940-7-1a--c to ensure consistent results for its later treatment. Once the appropriate cleaning and consolidation methods were determined, treatment began on wardrobe 1940-7-2a--c. In areas of flaking and tenting, isinglass was injected and then clamped using the *shimbari* technique, which uses flexible sticks to provide clamping pressure. A frame was used for clamping on the shelves and doors, whereas the wall was used for clamping the case. The entire consolidation process took six months (fig. 13).

For the treatment of the structural damage on the proper right side of the lower cabinet, two cauls, fabricated from Plexiglas and plywood, were used on the top corners to protect the lacquer surface from damage, as well as to provide even pressure when clamped. Due to the clear Plexiglas, the surface was visible to the conservators during the clamping process. The area first was dry clamped using long clamps. After the joint went back into plane, liquid fish glue was injected for consolidation and then clamped again for several days until secured.

At the time of this publication, the treatment is still ongoing and may include continued surface cleaning, cleaning of the metal hardware, fabrication of new sabots (metal feet), and compensation in certain areas of loss.

8. DISCUSSION

Combined examination and analysis has allowed a more complete understanding of the wardrobes to emerge. The decorative surfaces of the upper and lower cabinets on both wardrobes currently have a unified appearance. Based on the results of this study, it is clear that the upper cabinets have an earlier decorative scheme that is not present on the lower ones, indicating a different history. However, the two upper cabinets have a similar stratigraphy implying a shared history. Although the original surface pattern of the earlier scheme has not been discerned, minute remnants of gold suggest that the earlier scheme included gilded decoration. The discovery of the two decorative schemes on the upper cabinets is not surprising in the context that furniture, like architecture, often was restored and redecorated.

The style of decoration on the current surface may also give additional clues about the wardrobes. The PMA wardrobes have been compared to a single gilt black lacquer wardrobe with very similar design housed in the Musée Guimet, Paris (illustrated in Garner 1979, 196 and in Cescinsky 1922, pl. X), which dates to the Ming dynasty, Wanli period (1573–1620). Closer examination and stylistic comparison between the PMA and Guimet's dragon and lotus design, however, suggests that the PMA decoration is unlikely to date to the Ming period but rather is in Ming style. For example, the PMA dragon has a more sinewy body and a rounder head and is less ferocious looking than the Guimet dragon, which is more typical of dragons depicted in the middle to later Qing dynasty (1644–1911). During the Qing dynasty, paying tribute to the past through recreating objects and earlier styles, or *archaizing*, was popular.

Knowledge of the decorative materials provides clues about the history of the wardrobes as well. The identification of urushiol in the decorative layers is consistent with lacquer sap sourced in China rather than other parts of Asia. It also is interesting to note that paint—not lacquer—was applied to the current interior surfaces of the upper and lower cabinets. Perhaps this choice was based on economy. The presence of paraffin wax in the lowest ground layers of the second scheme is a curiosity that invites further exploration. Paraffin wax was first refined in the West during the mid-19th century; however, further investigation by the authors on the history and use of paraffin wax in China is needed to interpret its presence in the grounds (Warth 1956, 401). If the paraffin wax is an intentional constituent of the binder rather than an artifact of a treatment, its detection may aid in establishing an earliest possible date for the application of the second scheme. Technical analysis of both wardrobes continues.

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APPENDIX A. ANALYTICAL DETAILS

VLM and FLM

Samples for VLM and FLM were embedded in Bio-Plastic polyester/styrene resin (Ward's Natural Science). Once cured the resin cubes were polished to reveal the layered stratigraphy. The cross-section samples were examined in both visible and UV light using a Leitz Laborlux S microscope equipped for epi-illumination in UV light. A Leitz D filter cube was used (355–425-nm excitation, 460-nm suppression filter) and a 100-W mercury source. Fiber optics were used for visible light. Samples were photographed using a Nikon Digital Sight Ds-5M camera with Nikon Eclipse Net image capture software.

MFTIR

Representative portions of each sample were mounted on a diamond window and rolled flat for analysis by MFTIR. The data were collected in transmission mode between 4000 and 600 cm^{-1} at 4 cm^{-1} resolution and 200 scans per spectrum using a Thermo Nicolet Continuum microscope equipped with an MCT-A detector attached to a Nexus 670 spectrometer and processed using Happ-Genzel apodization.

Py-GCMS

Samples were weighed on the micro-balance and the weight recorded. A sample then was placed in a Frontier Lab stainless steel sample cup, treated with 1.5 μL tetramethylammonium hydroxide (TMAH) (2.5 wt. % in water) and warmed on the top of the GC for approximately 3 minutes. The sample cup was inserted into a Frontier Py-2020iS pyrolyzer attached to an Agilent 7890B GC/5977A MS and pyrolyzed at 600°C. The resulting products were separated using a HP-5MS UI column (30m, 0.25mm id, 0.25μm film) with helium carrier gas at a flow rate of 1 ml/min and an average velocity of 36.3 cm/sec. The inlet split ratio was 10:1 with a 10 ml/min split flow. The GC inlet was 320°C and the oven was programmed as follows: 40°C for 0.5 minutes, raised 6°C/min to 320°C and held isothermally for 9 minutes. The solvent delay was 2.5 minutes and the total run time 62 minutes. The MS was run in the EI (70 eV) scan mode (m/z 35-600) with the interface at 320°C, source at 230°C and quad at 150°C. Data were collected and processed using Agilent MassHunter (v. B.07.02.1936) and AMDIS (v. 2.72) software.

XRF

The areas were examined by non-destructive XRF utilizing a hand held Bruker Tracer series instrument operating at 40 kilovolts (Kv) and 11.4 microamps (μa). The x-ray beam was not filtered for this examination. The analysis was not performed under vacuum. Samples were collected for 60 seconds.

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NINA OLSSON AND SUZANA RADIVOJEVIC

Aimee Spencer Gorham's Wood Marquetry of the Pacific Northwest

ABSTRACT—The article discusses the technical aspects and conservation treatment of the Works Progress Administration marquetry mural titled *Send Us Forth to be Builders of a Better World*, created in 1938 by Aimee Gorham. The mural is considered in the context of artist's *opus* and her access to innovative, engineered wood materials manufactured in the Pacific Northwest. The article highlights the unique nature of Spencer Gorham's work, which combined the ancient technique of wood marquetry with the newest, cutting-edge industrial wood products of the era, mechanical presses, and industrial furniture coatings.

1. INTRODUCTION

The abundance of old growth forests of the Pacific Northwest seemed limitless in the early 20th century, and they provided the raw materials for the creation of a flourishing wood products industry. It was in this forested and highly industrialized backdrop in Portland, Oregon, that Aimee Spencer Gorham produced an extensive series of large-scale wood marquetry murals under the Works Progress Administration (WPA) from 1936 on. Gorham revived the Italian Renaissance craft of figurative marquetry for the decoration of numerous educational and cultural/recreational architectural spaces buildings in Oregon during the New Deal era, and beyond into the 1960s for religious and commercial spaces.

In 2015, efforts began for conservation of Gorham's 1938 mural *Send Us Forth to be Builders of a Better World*, the first since its installation, and the first technical examination and treatment of a Gorham marquetry mural. The mural, measuring 128 sq. ft., was custom designed for the entrance foyer of Chapman Elementary School in Portland. In preparation for and during the course of treatment, examination and research into the materials and technique of the murals have provided insights into the artist's working methods that embraced the regional veneration of wood, the historic aspects of the craft of marquetry, and modern technological advances in tools and manufacturing that resulted in unique and unprecedented works.

2. BACKGROUND

2.1 HISTORICAL CONTEXT: 20TH CENTURY CURRENTS IN DECORATIVE AND FINE ARTS IN THE PACIFIC NORTHWEST

Aimee Spencer was 22 years old when the City of Portland mounted the ambitious Lewis and Clark Centennial Exposition in 1905. The World's Fair achieved the intended result of promoting Portland, previously known as Stumptown, to emerge as the "Rose City." The natural beauty of the setting, surrounded by old growth forests, was featured in the fair ground design, as were regional wood products (Kriesman and Mason 2007). The expo highlighted the virtues of local handmade craft, as well as the wonders of recent advances in industrial products, due to the immense economic benefits that the timber industry had brought to the city. One of the most prominent features of the exposition was the Forestry Building, constructed with colossal old growth trunks in the style of an oversized log cabin (fig. 1). Its rustic hand-built character was to codify the regional vernacular of a strong connection between art, architecture, and the forest. Architects, artists, and craftsmen were inspired to celebrate the territory's beauty of pristine timberlands by creating with native wood materials.

Riding the success of this grand civic venture, the local arts and crafts movement was also nascent. Julia Hoffman opened School the Metal Work in 1907 in a repurposed building from the fair, which offered the first art classes in the city, and in the same year she founded the Arts and Crafts Society of Portland (today the Oregon College of Art and Craft). In 1909, the Portland Art Museum opened the Museum Art School, with traditional fine arts classes offered mostly to female students.

Simultaneously, the women's suffrage movement was growing, and the two milieus of women's rights activists and the artistic circles were quite meshed. Two aspirational figures dominated the cultural overlap: the writer Abigail Scott Duniway, who was crucial in passing the women's suffrage amendment in 1912, and C. E. S. Wood, lawyer, advocate, painter, and activist, who represented these interconnected spheres more than any other. Wood served as conduit to several high-profile East Coast artists such as J. Alden Weir, Albert Pinkham Ryder, Childe Hassam, and Olin Warner, which elevated the cultural landscape of the city (Bullock 2004). It was in this context that Spencer Gorham came of age.

Not to be understated was the immense influence that the WPA had on Gorham in the 1930s, which represented a period of intense artistic evolution for the artist, not only within the context of her own opus but also in connection to the wider landscape of artistic production at Timberline Lodge. Timberline Lodge was the crown jewel of Northwest New Deal projects

Fig. 1. Left: Interior view of 1905 Lewis and Clark Exposition Forestry Building. Library of Congress. Right: Image of two women on the mezzanine of the Forestry Building. Courtesy of City of Portland Archives.

and the principal beneficiary of the budget for Region 6 (AK, WA, OR, ID, MT), which empowered the project manager, Margery Hoffman Smith, to commission textiles, wood, ironwork, paintings, and works on paper for the highly designed interior from the leading artists and craftsmen in the region (Munro 2009). At Timberline, Gorham connected with Ray Neufer and his crew of furniture makers, with whom she continued to collaborate to produce her marquetry designs through the 1960s (Allen 2017).

2.2 BIOGRAPHY: AIMEE SPENCER GORHAM

Aimee Spencer (1883-1973) was born in St. Paul, Minnesota and moved to Portland at age 15. After briefly attending the Museum Art School, Spencer transferred to Brooklyn to attend the Pratt Institute between 1910 and 1913. There she thrived in an environment where distinctions between the fine and decorative arts were quite fluid. It is probable that she was also exposed to the explosive modern art scene in Manhattan, seeing, for example, the Armory Show in 1913. Duchamp's *Nude Descending a Staircase* traveled to Portland in the same year.

Soon after her return, Spencer was selected to show a painting at the San Francisco Panama Pacific International Exposition of 1915. The setting for the exhibition was within the Oregon Building, which again was created as literally a temple of timber. Her painting titled *Sand Dunes* was shown in a gallery called *The Art Room* (Lundberg 2000). Allen Eaton, then professor at the new Allied Arts and Architecture School at the University of Oregon, who would later come to be known as the Dean of American Craft, curated the room. More than 600 works were on view in an environment built entirely from materials native to Oregon, such as madrone wood chairs, caned furniture made with Oregon willow, glass lighting, paintings, books, and prints. Included in the room were examples of inlaid wood on a guitar and cello, made by the early Oregon pioneer W. R. McCord, which provided a direct inspiration to Gorham on the beauty and possibilities of marquetry.

Following a short-lived marriage, in the mid-1920s Gorham became a single mother with two children and worked to support her young family as a designer and craftswoman of stained glass for the successful and influential Povey Brothers Glass Company, known as the Tiffany of the West Coast. During her time at Povey, and later under the new ownership of W.P. Fuller & Company, Gorham created glass windows for the principal architects of the area on major commissions, such as the Temple Beth Israel (1929).

From 1930 to 1934, she attended summer workshops at the University of Oregon taught by Viennese Secession architect Eugene Steinhof (student of Josef Hoffman), who had been formed in the culture of the opulent decorative surface treatments so characteristic of the Secession.

In 1934, under the Public Works of Art Project, Gorham was commissioned to produce a carved relief of Abigail Scott Duniway. She remained quite active during the later New Deal Arts Projects and produced as many as 25 wood marquetry works, 16 alone for Portland Public Schools. The first marquetry commission was in 1936, for the mural *Ali Baba and the Forty Thieves*, from the Arabian Nights Entertainment (fig. 2). Exotic

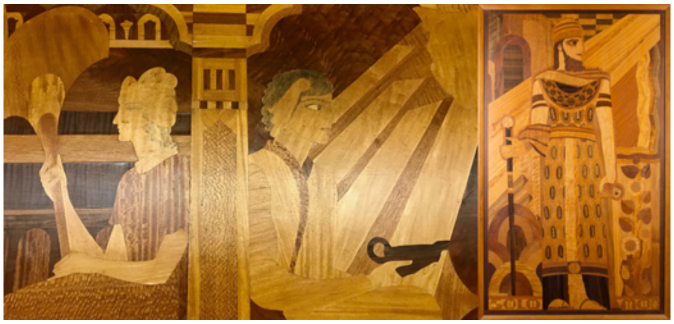

Fig. 2. Left: Detail of A. Gorham's first marquetry mural, *Ali Baba and the Forty Thieves*, from the Arabian Nights' Entertainment, 1936, mural 84 x 234 cm, bottom panels 207 x 16.5 cm, Courtesy of Nina Olsson. Right: A. Gorham, *Solomon*, 1937, 156 x 95 cm. Courtesy of Portland Art Museum.

and figured veneers were used to emulate the effects of drapery, chiaroscuro shading, and even perspective. Blue and green tints and other painted effects were used to further enhance and embellish the amber tonal range of the veneers. Another mural at the school, *Swans*, was described as being rendered in "soft wood tones," indicating diverse methods of finishing and coating of the surfaces. Gorham makes use of an epithet that will become a recurring method of giving a title to her murals: "Square thyself for use. A stone that may fit in the wall is not left in the way."

Gorham produced a second Orientalist subject in the 1937 work titled *Solomon* for the Curry County Regional Art Center, today in the collection of the Portland Art Museum (fig. 2). The small panel is designed with opulent use of pattern and exotic veneers reminiscent of the style of the Viennese Secession.

Gorham is perhaps best known for her two works at Timberline Lodge (fig. 3). *Coyotes* from 1937, and *Mountain Lions* from 1937 to 1938, are located in the observatories of the main lobby of the lodge. In 1938, two colossal murals, *The Forest—Nature's Great Gift to Mankind* and *Only God Can Make a Tree*, were created for the Oregon State University (OSU) School of Forestry, each one measuring 12 x 18 ft. Each of the panels bears an inlaid band with the name of various indigenous wood species.

Fig. 3. Left: A. Gorham, *Coyotes*, 1937, 106 x 152 cm. Right: Interior view of West Observatory of main lobby at Timberline Lodge with A. Gorham, *Mountain Lions*, 1937-1938, 106 x 152 cm. Courtesy of Aaron Johanson.

Under New Deal programs, Gorham produced numerous murals for Portland Public Schools, including the 1938 mural *Send Us Forth to be Builders of a Better World* for Chapman Elementary in Northwest Portland under the WPA Federal Arts Project. The mural is composed of four panels that surround a double door in the entrance foyer, and the mural surface may be divided into three compositional areas (fig. 4). Wide horizontal bands of alternating veneers in the background visually unify the four panels into a single mural. The aspirational title of the work is further developed in the subject matter of the lower panels that portray two students with symbols of peace and resourcefulness set among the flora and fauna of the Pacific Northwest (fig. 5). The lower left panel depicts a girl standing barefoot on a small mound with unfurling fern fronds, a flowering tree, and a flowering iris. The girl wears a dress and supports a white dove that perches on her proper left arm. The lower right panel depicts a boy standing on a mound with crocus, trillium, and a fruit-bearing tree. The boy wears pants, shoes, and a shirt, and holds a wheel in his hands. Across the entire width of the upper section of the mural are stylized images of corn, an eagle in the lowered position, and a central image of a conifer within a semicircular frame above the title epithet (fig. 6). As was often the case for WPA works destined for schools, the iconography and materials were devised with a didactic purpose to inspire young students to be industrious, live in harmony with nature, and appreciate the natural resources and beauty of the region.

2.3 Historical Development of Wood Products

The Pacific Northwest was the major center of the wood products industry at the turn of the century. In addition to erecting the Forestry Building as the largest log building at the time, the timber industry also sought to showcase new innovative industrial concepts and products as part of the 1905 centennial celebration of the Lewis and Clark Expedition. For the occasion, first softwood plywood, a simple three-ply panel made with

Fig. 4. Dimensions of the mural panels on plywood.

Fig. 5. Left and right lower panels of A. Gorham, *Send Us Forth to be Builders of a Better World*, 1938, 305 x 531 cm, after treatment, prior to installation.

Douglas fir and animal glues was fabricated by Portland Manufacturing Company and exhibited in the Forestry Building, where it was seen by half a million visitors during the expo and was retained as a permanent exhibit (Cour 1955). Following this success, furniture manufacturing markets opened the door to plywood panels, and over the next 25 years, developments in the rotary veneer manufacturing and adhesive technologies allowed for the expansion of plywood production from interior-grade decorative panels to structural building components suitable for exterior applications. By the 1930s, the softwood plywood industry was well established in Washington and Oregon, and included at least 15 independent small-size plywood mills, which came together in 1933 to form a nonprofit trade association—the Douglas Fir Plywood Association (DFPA). The DFPA will take on a pivotal role in developing plywood markets through nationwide promotion, providing assistance with product quality monitoring, and effective promulgation of first industry standards (Cour 1955). Steady technological developments around improving water resistance of animal and vegetable glues, and the introduction of waterproof phenol formaldehyde wood adhesives in 1935, greatly expanded the versatility of plywood products and the number of architectural applications. At the time when Gorham was creating wood marquetry murals, plywood was becoming utilitarian and ubiquitous building material as exemplified by speculative "Plywood Houses" designed in Portland by

Fig. 6. Detail of center top section of the mural.

a prominent Northwest modern architect, and Gorham's contemporary, John Yeon.

Mass production in the region that extended to other wood products, such as doors and furniture, created a demand for interior-grade plywood finished with decorative face veneers. In the 1930s, some 70 different wood species were readily available, and up to 200 were offered by the wood veneer manufacturers and suppliers in the region. Most decorative veneer stock was cut locally from valuable high-quality logs of exotic hardwoods imported from the world's forests. Irresponsible logging practices and the lack of regulated industry and markets have since resulted in an endangered status of numerous tree species, which are now protected and subject to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) international trade regulations. Among wood species used for inlay veneers in the Chapman mural, bubinga (*Guibourtia* spp.) has been included on CITES listing as of January 2017 (CITES 2017). Veneers of several other wood species are not commercially available, such as Queensland maple (*Flindersia brayleyana*), which is in a short supply due to World Heritage listing of North Queensland rainforests.

3. TREATMENT OBJECTIVES

3.1 MATERIAL RESEARCH

The 2016 conservation treatment of *Send Us Forth to be Builders of a Better World* constitutes the first technical examination of a marquetry work by Gorham, and therefore further investigation of the work from a technical perspective became a core objective of the project to gain an understanding of Gorham's process, both technical and artistic, and the materials she employed. Study and identification of the substrate support, research into the creative process, and the identification of the wood veneer species and the original adhesives and coatings were compiled into a technical profile of Gorham's work that accompanied the report on the current condition of the mural.

3.1.1 Plywood

Objectives

In all of her wood marquetry murals, Gorham used Douglas fir plywood as a panel backing and support. This configuration provided adequate material compatibility between the marquetry veneers and the plywood veneers, and structural and dimensional panel attributes that will allow Gorham to expand the scale and size of traditional wood marquetry. A brochure for one of her later murals for the U.S. National Bank's Lakeview branch in Oregon describes the mural as "one of the largest of its type in the world" ("A creation in marquetry" 1963) (fig. 7).

Methods

The plywood panels were examined visually for the wood species and panel configuration, and the measurements were taken in situ during restoration.

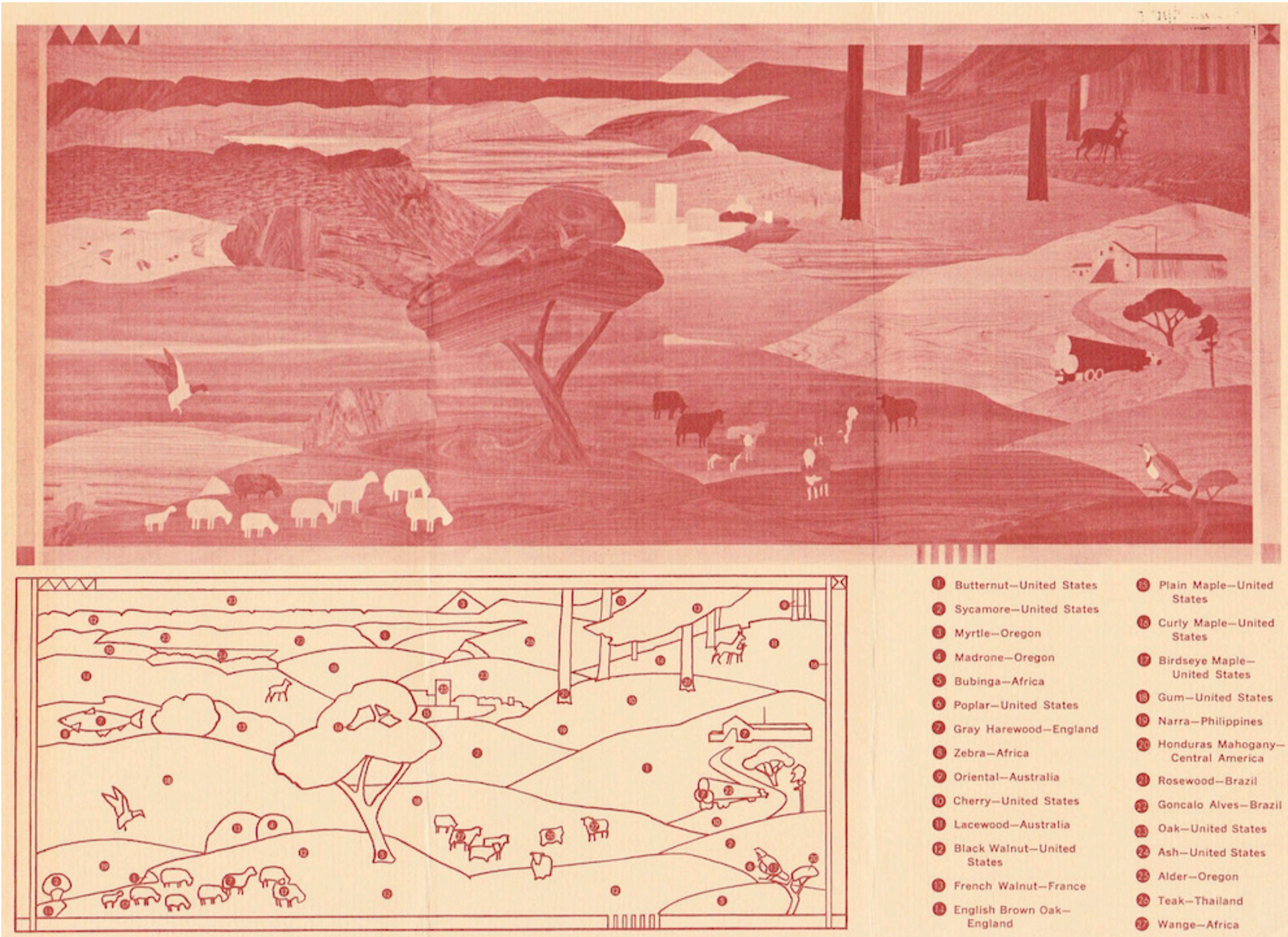

Fig. 7. Marquetry mural for the U.S. National Bank's Lakeview branch, Oregon, by Aimee Spencer Gorham, 1963, 183 x 427 cm, with map of 27 wood species used in inlay veneers.

Fig. 8. Backsides of two side marquetry panels showing Douglas fir plywood.

Results

Plywood used as a backing and a marquetry support for all panels is Douglas fir plywood (fig. 8). Panels are of ¾ in. thickness and composed of two individual ⅜-in. three-ply laminations measuring 3/32 in. for face veneers and 9/16 in. for the core (fig. 9). Seams visible on the backsides of the panels (fig. 8) suggest a possibility that two laminations were glued together to increase the size of the panels, since the minimum sizes of 66 x 86 in. for the lower modules and 34 x 106 in. for the upper modules, respectively, exceed the maximum standard Douglas fir plywood sizes of 48 x 96 in. Two panels are pressed together either in a single press cycle or in two separate press cycles. Glue appears to be water-resistant casein or advanced soybean-based glue. The stamp present on the back of one of the panels (fig. 10) confirms inspection or certification by the DFPA, suggesting that the panel production conformed to an early industry standard from either 1936 (DFPA 1936) or 1938 (DFPA 1938). The plywood grade appears to be AA per 1938 standard, which

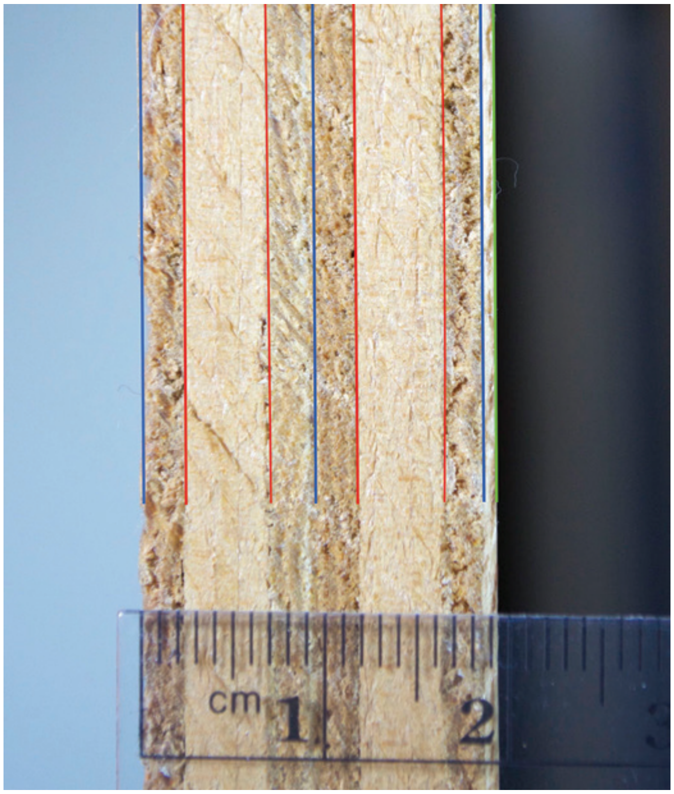

Fig. 9. Cross section of the plywood support showing two three-ply plywood panels (blue lines), marked face plies (red lines), and the inlay veneer layer (green line).

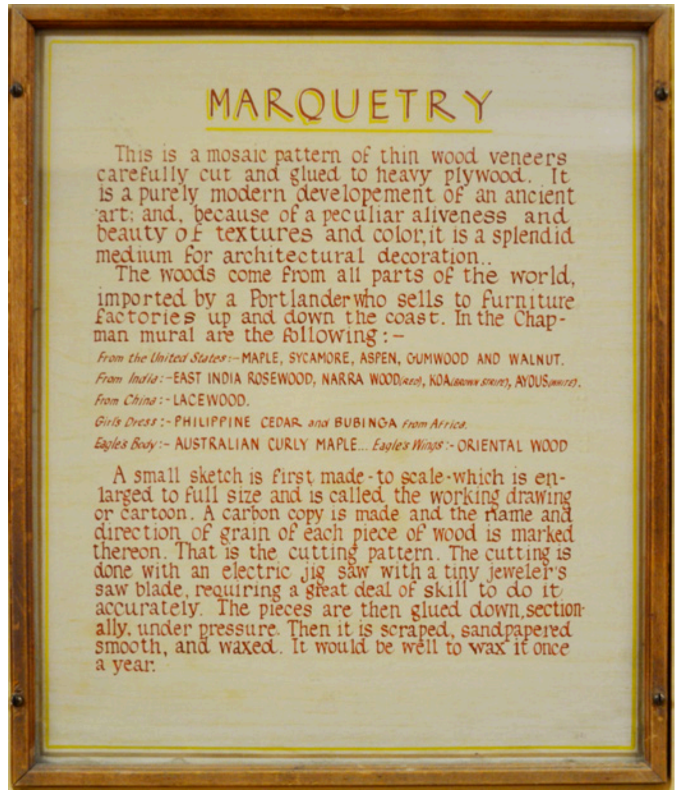

Fig. 11. Image of the original plaque created by Gorham for the Chapman Elementary School marquetry mural describing the creative process and documenting wood species and their origin.

would correspond to N (natural, clear) at present (S. Zylkowski, pers. comm., October 16, 2016).

3.1.2 Gorham's Artistic Process

A small plaque mounted on the wall adjacent to the mural by Gorham in 1938, with the header "Marquetry," describes the technique used as a "splendid medium for architectural decoration" (fig. 11). Yet she also characterizes her own work as a "purely modern development of an ancient art" and goes on to describe her artistic process. Her approach began quite traditionally, creating first a sketch, which was then enlarged to a full-scale cartoon. From the cartoon, a copy was created as a cutting pattern, including annotation on the type of veneer, and indications of the direction of the grain to best exploit the figurative qualities. A pair of ink preliminary sketches for *The Forest* murals at OSU provides evidence of her manner of visualization of the veneer wood grain directions and colors during her initial composition. Gorham used an extensive selection of domestic and exotic wood veneers, usually between 20 and 30 distinct species per mural, to achieve remarkably varied effects of chroma, grain, and chatoyance. Highly figured veneers were used to great effect to emulate waves in the figure's hair (fig. 12), feathers, atmospheric effects, and dewy iridescence of plant surfaces. She notes that the diverse origins of the veneers she used, and that they were acquired by a local import company that distributed to the entire West Coast.

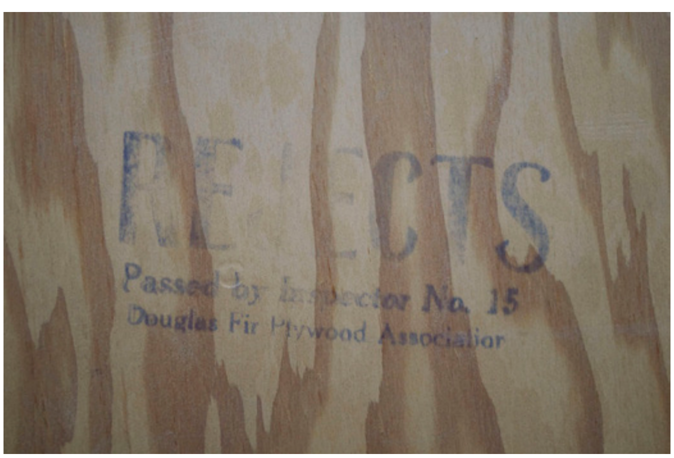

Fig. 10. DFPA product inspection stamp; an early example of plywood inspection and certification.

It is interesting to note that Gorham states that the veneer contours were cut not with a conventional coping saw but with an electric jigsaw. With exception to scattered gaps that arrive at 1.5 mm maximum width, the veneer joins are generally quite

Fig. 12. Details of lower right panel, showing chatoyance of veneers made evident with change in directional light.

precise. Gorham used modern cellophane and Scotch tape to position the veneer pieces prior to adhesion to the plywood substrate (Laroff 2013). The pieces were laminated in a large, custom-made press manufactured by fellow marquetry artist Jerome Selinger (Munro 2009). Gorham also describes that the veneered surfaces were then scraped, smoothed, sanded, and finished.

3.1.3 Wood Species Identification

Objectives

Identification of wood species and mapping of marquetry veneers was done to enable exact specification of wood species for future repairs of veneers and to facilitate the understanding Gorham's artistic expression.

Methods

Standard microscopic wood identification techniques were not readily applicable for marquetry veneers because of the small thickness of veneers that precludes examination of the anatomical features of wood in the cross section and, in most instances, tangential section. The available sampling surface on the faces of the veneers was predominantly radial and presented only limited opportunities for extraction of thin sections due to sensitivity of veneer surfaces to destructive sampling. Wood identification was, as a result, based on the combination of several analytical approaches: the use of archival documentation available about the mural, macroscopic investigation, and light microscopy of thin sections that were collected from the panels.

A list of 14 veneer wood species documented by Gorham on the original plaque that accompanied the Chapman mural provided invaluable preliminary information about wood species used in panels. Listed wood species comprise maple, sycamore, aspen, gumwood, and walnut (from the United States); East India Rosewood, narra wood (red), koa (brown stripe), and aydus (white) (from India); lacewood (from China); Philippine

Fig. 13. Oriental wood—Queensland walnut (*Endiandra palmerstonii*)—used in Eagle's wings. Australian curly maple—Queensland maple (*Flindersia brayleyana*)—used in Eagle's body.

Fig. 14. Sampling location for collection of thin section from the veneer for microscopic wood wood identification. Flat-cut oak veneer provides radial section for microscopic investigation.

cedar and bubinga (from Africa) in the girl's dress, and Australian curly maple in Eagle's body; and oriental wood in Eagle's wings (figs. 11, 13). Vouched reference wood samples of all listed wood species were used for comparative macroscopic identification based on the unaided eye and low (10x) magnification.

Thin sections for microscopic examination were collected directly from the surfaces of veneers in the "girl" panel from seven inconspicuous locations (fig. 14). Samples were extracted using sharp razor blade by removing and discarding the top layer of wood and obtaining a 2 x 2 mm sample from the cleaned surface. Thin sections were stained with safranin and mounted on permanent microscopic slides for microscopic examination.

Results

The veneers used in the marquetry panels comprise approximately 16 wood species, including domestic hardwoods and numerous species of exotic hardwoods that were widely used in the furniture manufacturing and were readily available in Portland in the 1930s. A complete inventory of wood species that includes names supplied by Gorham, and common and scientific names, is presented in Appendix 1. In addition to all wood species listed by Gorham, white oak and butternut were respectively identified as the veneers in the green and orange background stripes of the mural.

Wood species identification data were integrated into color-coded maps that were subsequently incorporated in the Chapman interpretation panels (Appendix 2).

3.1.4 Coatings Identification

Objectives

Surface coatings were identified to inform cleaning protocols and gain understanding of the artistic process. Results were compared to recorded and anecdotal information about Gorham's use of traditional and modern industrial coating materials.

Methods

Gorham states in the original wall plaque that her final finish is a wax coating. Yet other sources have suggested her use of Fuller "Nitrokote," a nitrocellulose furniture coating manufactured by W.P. Fuller and Company (Ball 2004). Gorham worked in the stained glass department of Fuller and may have been familiar with their products (Laroff 2013).

Visual examination and photo-documentation of UVt fluorescence of the mural surface was conducted. The characteristic orange fluorescence of shellac was identified along the external edges of the panels, dispersed in a bleed pattern that was readily visible in areas that had been hidden/masked by the perimeter-molding frame, indicating that the surface coatings were applied after installation.

Four samples of the coating were taken for FTIR analysis. The findings revealed spectral features that are consistent with varied amounts of wax and natural resin, possibly amber resin or seedlac (Appendix 3). One sample had spectral features that may indicate the presence of nitrocellulose, but the findings are inconclusive.

3.1.5 Condition

Despite the mural's prominent location in the entrance foyer of the school, the marquetry mural had languished in neglect. Close to 80 years of accumulated age, wear, accidental damage, vandalism, and inopportune custodial maintenance had compromised the condition of the delicate surface, which not only obscured the quality of the mural and its glowing figural effects of the wood grains but also threatened its long-term

Fig. 15. Details in raking light of lower left panel prior to treatment. Left: Vandalism that marred the veneer surface with deep scratches. Right: Delaminated and lifting veneer.

preservation. The high traffic and fluctuating environmental conditions of the mural location had severely impacted the veneer adhesion. Extensive delamination of the veneer from the substrate was identified during examination (fig. 15), with visible points of lifting of the veneer edges and blind delamination identified through surface percussion. Lifting had resulted in several losses of the veneer from opportunistic vandalism. The structural stability of the plywood substrates has allowed the mural panels to remain quite planar despite the unstable environmental conditions in which they have been housed.

Perhaps most disfiguring was the devastating vandalism present in the form of graffiti, which primarily affected the bottom panels (fig. 15). Scratches of various depths were at times oriented cross grain and therefore created frayed and open fibers that were subjected to inopportune remedial local application of wood stains. The entire surface was covered with surface grime and also coated with a polyurethane finish that had become darkened and opaque with time. Further damage to the surface coatings was caused by the repeated use of tape to attach posted announcements to the mural surface, which, when later removed, resulted in a "strappo" of the coatings.

4. CONSERVATION TREATMENT

4.1 OBJECTIVES

An interdisciplinary group of architectural, objects, wood panel, and painting conservators collaborated on the project. The scope of treatment was to stabilize and repair the damaged veneer, thin or remove the aged and opaque surface coatings, and improve visual legibility of the image with the application of a new surface coating and retouching. Due to the logistical needs for the veneer repair and necessary solvent use, the murals were temporarily removed from their location and transported to the laboratory for treatment.

4.1.1 Consolidation

A custom support structure was positioned below the panels, which was connected with lateral clamps to a sliding mobile bridge across the width of the panels. The bridge served as a housing for mobile sections, clamped into place and fitted with threaded rods that would allow targeted pressure to be applied to delamination points on virtually all areas of the panels. The support and mobile bridge is an adaptation of the systems used for wood panel support treatment (fig. 16).

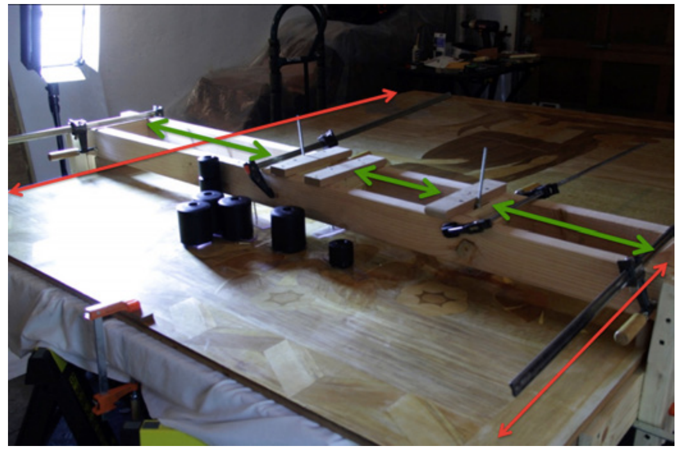

Fig. 16. Image of custom support structure with mobile sliding bridge to position for targeted pressure during consolidation of lifted veneer.

A 20% hide glue solution was used for consolidation of the veneer, heated to 37°C. Prior to injection of the glue, isopropanol was injected to improve migration and flow of the glue. Pressure was sustained during the drying process.

4.1.2 Testing and Surface Cleaning

Treatment involved surface cleaning and the removal of various inopportune coatings, including a polyurethane varnish applied during the 1980s that had darkened and obfuscated the lively grain of the wood veneers. The cleaning protocol was formulated to conserve the original shellac and wax coatings. Once the surface had been stabilized, it was possible to proceed with surface cleaning.

Testing was conducted to determine the solubility parameters and the most effective mode of solvent application: free solvent solutions, methylcellulose, and carbopol gel. Because of the varied porosity and hardness of the wood species, surface cleaning was conducted on isolated veneer areas, applying solvents and removing the materials following the wood grain. Benzyl alcohol and acetone gel (Wolbers' polyurethane gel) was applied on top of a rayon tissue on selected areas and capped with mylar while it was left to dwell for three to four minutes. The polyurethane coating crizzled on the surface, the bulk remaining adhered to the rayon tissue. Remaining residues were mechanically removed with a spatula, then cleared with acetone and followed by odorless mineral spirits. Scratch sites required further localized cleaning since the polyurethane coating had penetrated

Fig. 17. Detail before and after images of lower left panel with mitigation of disfiguring vandalism through fill and retouching.

Fig. 18. Left: Detail before and after images of the lower right panel with mitigation of darkened scratches. Right: Detail of use of mica powders to retouch darkened scratch.

into the flayed wood grain. The surface, after cleaning, retained the original durable wax surface with a brushy relief. Although the benzyl alcohol partially removed the cloudy appearance of the substrate shellac, it remained in part microfissured, requiring further saturation through coating to improve transparency.

4.1.3 Protective Coating

As a protective surface coating, a 25% solution of Laropol A81 (in 5:4 Gamsol:Xylenes) was applied by brush while the work was horizontal. A final spray coating of Regalrez 1094 (20% in Gamsol) with the HALS Tinuvin 292 was applied following restoration.

4.1.4 Restoration

The deepest scratches and narrow gaps between veneer sections were filled to provide a continuous surface. For some areas, a custom-made pigmented wax resin was made with Regalrez 1094, Cosmolloid 80H, and dry pigments. For areas where the veneers were in the darker tonal range, the natural transparency and dark warm tone of beeswax and colophony (relining wax resin mix) was more visually effective (fig. 17).

Where some of the scratches retained a darkened appearance, inpainting was used to mitigate the disturbing linear graphic effects. Due to the highly reflective, almost metallic effect of some of the chatoyance in the wood grain, reflective mica powders were bound in Laropol A81 (50%) (fig. 18). Gamblin conservation colors were also used to improve the chromatic continuity of the coatings, utilizing the transparent earth colors to glaze areas where the coatings had been stripped off with adhesive tape.

4.1.5 Dissemination

Interpretive panels with biographical information about the artist, historical context, iconography, and technical information were designed to inform and enhance the original didactic purpose of the murals, and to foster appreciation of the murals for K-5 students of Chapman and their community. A teaching curriculum and kit is currently being developed for use in the years to come.

5. CONCLUSION

The project to conserve the wood marquetry mural *Send Us Forth to be Builders of a Better World* became a significant opportunity to bring attention to the unique work of Gorham as a product of her place and time. Research of the materials provided the first technical profile of the artist's work, revealing interesting connections to the deep regional connection to the old growth forests as a source of inspiration and an economic resource, and also to the rapidly evolving wood products industry of the time.

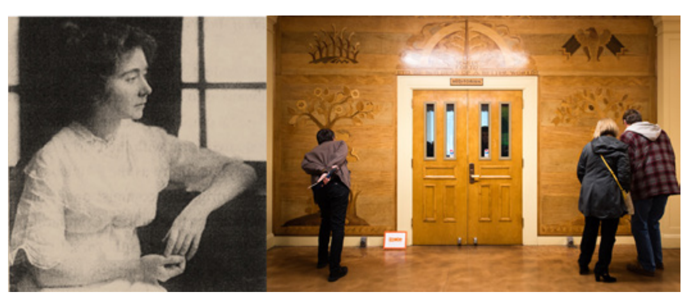

Fig. 19. Left: Aimee Spencer Gorham, ca. 1910. Oregon Historical Society. Right: Visitors at the public unveiling, December 1, 2016. Courtesy of Portland Public Schools.

Gorham's work appears on the surface to adopt the arts and crafts' ideal of handwork, which elsewhere was often a form of reaction against industrialization. In contrast, Gorham embraced industrially produced plywood as a substrate, exploited the industrially peeled and cut veneers that were locally available thanks to the booming furniture industry, used an electric jigsaw and an industrial press, and may have incorporated mass-manufactured nitrocellulose lacquer coatings, resulting, in her own words, in "a purely modern development of an ancient art; and, because of a peculiar aliveness and beauty of texture and color, it is a splendid medium for architectural decoration." (Gorham n.d.)

The conservation effort also provided the opportunity to bring together an interdisciplinary group of researchers and conservators, who applied methods customarily used in the fields of painting and wood panel conservation and wood science to a wood architectural object to achieve the optimal final result.

Art historians have recognized the mural as significant not only for the quality of the composition itself but also as the work of an early independent Oregon woman artist, active in the nexus of creative energy that took place under New Deal projects at Timberline Lodge and in Portland. The impact of that period of intense creative innovation on the local art scene extended long beyond the end of the federal relief programs. With the restoration of the panels and installation of the interpretive panels in the school, Chapman students are engaging with the history and meaning of the work, preserving the historic context, and advancing its original didactic purpose. Art historians, historians, Gorham family members, community members, and even marquetry craftsmen were present for the unveiling, where discussion of the project has inspired new investigation into Gorham's work and further commitment to preserve the WPA marquetry works in other schools and all Oregon cultural heritage for future generations (fig. 19).

APPENDIX 1. WOOD SPECIES IDENTIFICATION

Table A1. Inventory of wood species in marquetry veneers including species documented by Aimee Spencer Gorham

Common name	**Latin name**	**Native range**	**Name used by Aimee Gorham**
Sweetgum, Redgum, Sapgum	*Liquidambar styraciflua*	Eastern North America, Central America	Gumwood
Hard maple, Sugar maple	*Acer saccharum*	North America	Maple
Sycamore, American plane	*Platanus occidentalis*	North America	Sycamore
Quaking aspen	*Populus tremuloides*	North America	Aspen
Black walnut	*Juglans nigra*	Eastern North America	Walnut
Indian rosewood	*Dalbergia latifolia*	India, Sri Lanka, and Indonesia	East Indian rosewood
Amboyna (burl)	*Pterocarpus indicus*	Southeast Asia	Narra
Hawaiian koa	*Acacia koa*	Hawaii	Koa
Ayous, Obeche	*Triplochiton scleroxylon*	Tropical West Africa	Ayous
Brazilian lacewood	*Panopsis* spp.	South America	Lacewood*
Northern silky oak, Australian lacewood	*Cardwellia sublimis*	Queensland, Australia	
Australian red cedar, Toona	*Toona ciliata*	Southern Asia and Australia	Philippine cedar
Kevazingo, Bubinga	*Guibourtia* spp.	Equatorial Africa	Bubinga
Queensland maple	*Flindersia brayleyana*	Northern Queensland (Australia)	Australian curly maple
Queensland walnut	*Endiandra palmerstonii*	Northern Queensland (Australia)	Orientalwood
White oak	*Quercus* spp.	Europe, North America	not listed
Butternut, White walnut	*Juglans cinerea*	Northern Queensland (Australia)	not listed

*Lacewood speciation was inconclusive between Australian lacewood (*Cardwellia sublimis*) and Brazilian lacewood (*Panopsis* spp.).

APPENDIX 2. MAPPING OF WOOD SPECIES AND INTERPRETIVE PANELS

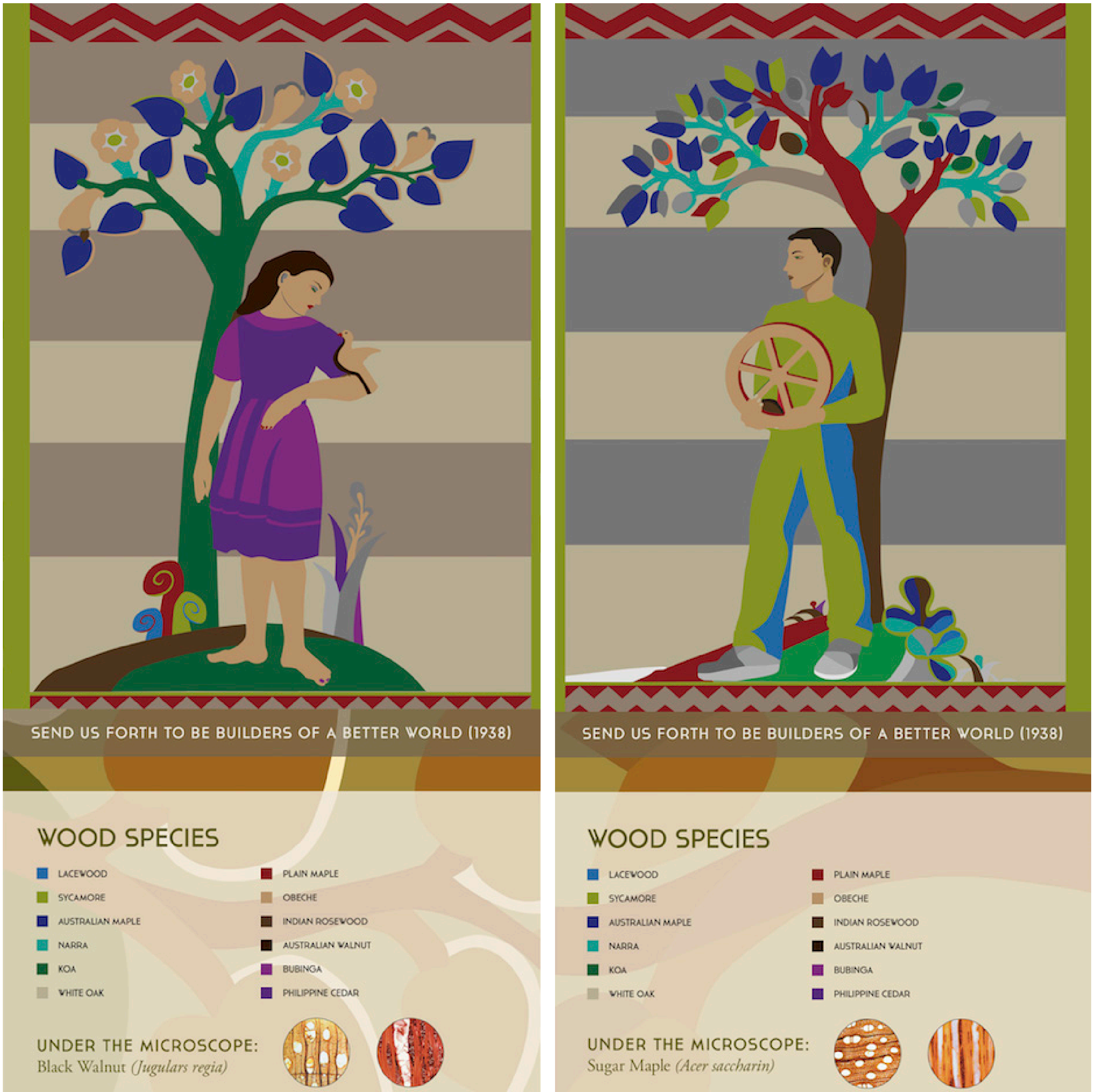

Fig. A1. Details from the two interpretive panels mounted next to the conserved mural at Chapman Elementary School, Portland, Oregon.

APPENDIX 3. FTIR ANALYSIS OF COATING SAMPLES

Dr. Tami Lasseter Clare
The Regional Laboratory for the Science of Cultural Heritage Conservation, Portland State University.

INSTRUMENTATION

FTIR Analysis. A Thermo Scientific iS 10 infrared spectrometer with a Nicolet Continuµm FT-IR microscope and a 250 µm MCT detector was used to acquire IR spectra from 4000-650 cm^{-1} with 4 cm^{-1} resolution with Omnic software. Data was transformed using an N-B strong apodization function and Mertz phase correction. Scrapings of varnish were provided for analysis, and once in the laboratory they were handled using nitrile-gloved hands and stainless steel tweezers. A stainless steel scalpel was used to remove a smaller sample for analysis, using a stereomicroscope for visual magnification. Samples were then pressed to flatness by a stainless steel roller on a diamond slide before spectral acquisition in transmission mode for 32 scans.

DATA AND RESULTS

A summary of findings is shown in the following table. Comparative identification of spectral features was conducted using the IRUG database, in reference to Price and Pretzel (2009).

Sample Number	Physical Description	Composition as Determined by FTIR
1	Transparent	*Major*: Wax *Minor*: Natural resin
2	Transparent	*Major*: Wax *Minor*: Natural resin and carbohydrate fibers
3	Transparent	*Major*: Natural resin *Minor*: Wax
4	Transparent and amber	*Mixture*: Includes natural resin and other components that may be carbohydrate fibers or nitrocellulose and urethane

The following images show FTIR analysis of four samples of coating from Aimee Gorham, *Send Us Forth to be Builders of a Better World*, 1938.

Sample 1: Primarily wax with some natural varnish

- Contains wax with spectral features consistent of a microcrystalline wax such as beeswax.
- Spectral features are consistent with a natural resin such as amber varnish and Dammar. Spectral features are associated with shellacs

FTIR analysis of coating in sample 1 from Aimee Gorham, *Send Us Forth to be Builders of a Better World*, 1938

Sample 2: Primarily wax with some natural varnish and fibers

- Contains wax with spectral features consistent with a microcrystalline wax such as beeswax.
- One area of the sample also contained traces of a natural carbohydrate fiber, such as flax.
- Like sample 1, there is also some varnish present, although wax is the primary component.

FTIR analysis of coating in sample 2 from Aimee Gorham, *Send Us Forth to be Builders of a Better World*, 1938

Sample 3: Primarily natural resin varnish with trace amounts of a wax

- Contains a natural resin, such as seedlac.
- It also contained traces of wax.

FTIR analysis of coating in sample 3 from Aimee Gorham, *Send Us Forth to be Builders of a Better World*, 1938

Sample 4: Mixture

- Contains natural fibers, such as jute, that could be instead from the wood substrate.
- Also contained traces of wax or varnish. Due to the overwhelming presence of natural fibers, it cannot be determined whether additional varnish is present.
- If there is nitrocellulose present, this sample is the most likely to contain it, although due to the spectral complexity in the key regions where nitrocellulose shows signature peaks, its presence could not be confirmed. A reference spectrum of nitrocellulose is provided to demonstrate the overlapping features between it, the sample, and the jute fiber reference spectrum. If nitrocellulose is present, it is not a major component of the sample.
- This sample may also contain a urethane alkyd varnish, yet similarly to the case of nitrocellulose, the region showing key urethane features is complex in this sample.

FTIR analysis of coating in sample 4 from Aimee Gorham, *Send Us Forth to be Builders of a Better World*, 1938

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JENNIFER SCHNITKER AND MANU FREDERICKX

Treatment of the Appleton Organ at the Metropolitan Museum of Art

ABSTRACT—The Appleton organ at the Metropolitan Museum of Art is a rare example of early American organ building. After 35 years on the museum's sunlit balcony, the mahogany casework had faded and the 1980s restoration beeswax finish had partially opacified. Testing revealed that removal of this finish was feasible with ethanol poultices, which improved the wood's appearance. Using photographic and physical evidence of the original color, the organ was recoated with thinly applied acrylic paints pigmented with transparent iron oxides. Top coats of Paraloid B-72 doped with zinc oxide were used to reduce incident UV radiation on the wooden substrate.

1. BACKGROUND

The Metropolitan Museum of Art's pipe organ (fig. 1), made by Thomas Appleton, stands 16 ft. tall and has 836 pipes, making it by organ standards modest in size and musical scope (Hughes 1983). The best indication of its manufacture date is an inscription found on the interior, which reads "Maid in 1830" (fig. 2).

Thomas Appleton was a Boston-based cabinetmaker who turned to a career in organ building and developed considerable renown for his fine craftsmanship, use of high-quality materials, and the musical qualities of his instruments (Thomas Appleton 2017). The mahogany Greek revival case and its tonal design reflect British models of the late 18th century, often imported to North America during this period (Owen 1979, 39). By the first quarter of the 19th century, however, America saw a reduction in the number of instruments being imported from England and growing prowess among American instrument builders. Further, there was growing acceptance of music in church services and greater demand for church organs such as this one (Owen 1979, 40).

There are few surviving Appleton organs. There are fewer still that have not been significantly altered to remain viable as musical compositions grew in their sonic and technical demands. Thomas Appleton's career stretched from about 1805 to well into the latter part of the 19th century (Thomas Appleton 2017). His records list 40 organs being constructed or commissioned solely during the period between 1820 and 1833 (Ochse 1975). In comparison, the total number of Appleton organs known in the Organ Historical Society database is 34 (Appleton 2017). Many of these were only ever known by a single historical source, and many others have fallen off the map. Those that do survive, as well as drawings attributed to him, attest that he worked within a stylistic vernacular that changed little over his lifetime. The three instruments advertised as from 1823 are each described as having a "handsome or elegant case, carved ornaments, and gilt front pipes" (Organs 1823) (fig. 3). Comparison with early 19th century organs by London builder Thomas Elliot, for example, reveals how English organ design influenced American organ builders, including Thomas Appleton (Owen 1979, 526)

In addition to its rarity, the Met's instrument survives in a nearly unaltered state. It is thought to have started its life installed in South Church in Hartford, Connecticut (Owen 1983). By the mid-19th century, the changing tide of musical tastes

Fig 1. Pipe organ, Thomas Appleton, Boston, 1830, 16 ft. x 9 ft. 9 in. x 9 ft. 9 in. Metropolitan Museum of Art (1982.59.1).

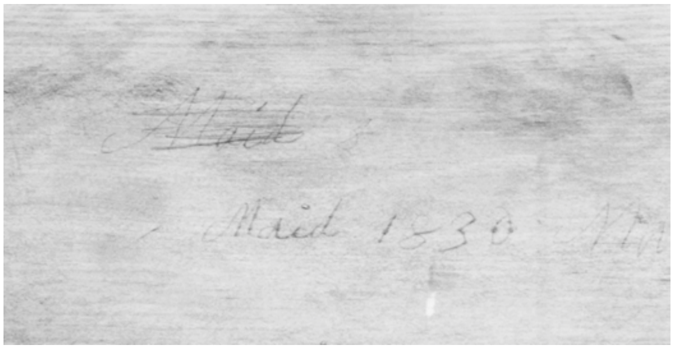
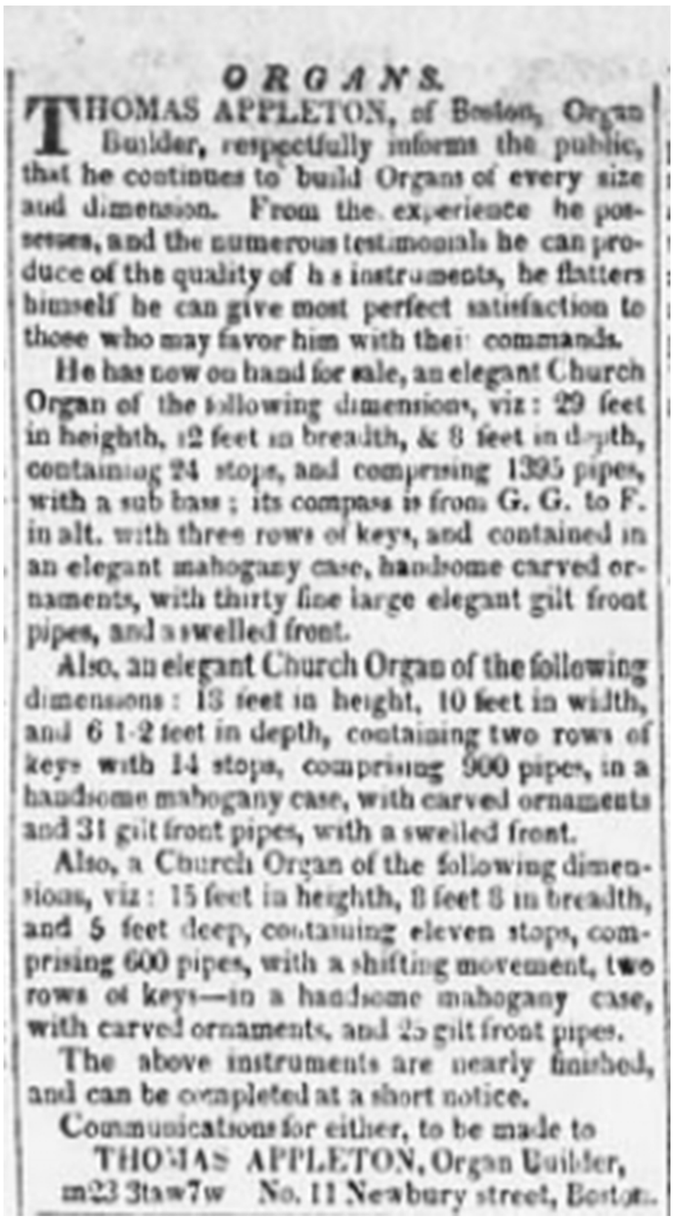


Fig. 2. Graphite inscription on interior of organ casework. Viewed under infrared reflectography.



ORGANS.

THOMAS APPLETON, of Boston, Organ Builder, respectfully informs the public, that he continues to build Organs of every size and dimension. From the experience he possesses, and the numerous testimonials he can produce of the quality of his instruments, he flatters himself he can give most perfect satisfaction to those who may favor him with their commands.

He has now on hand for sale, an elegant Church Organ of the following dimensions, viz: 29 feet in heighth, 12 feet in breadth, & 8 feet in depth, containing 24 stops, and comprising 1395 pipes, with a sub base; its compass is from G. G. to F. in alt. with three rows of keys, and contained in an elegant mahogany case, handsome carved ornaments, with thirty fine large elegant gilt front pipes, and a swelled front.

Also, an elegant Church Organ of the following dimensions: 13 feet in height, 10 feet in width, and 6 1-2 feet in depth, containing two rows of keys with 14 stops, comprising 900 pipes, in a handsome mahogany case, with carved ornaments and 31 gilt front pipes, with a swelled front.

Also, a Church Organ of the following dimensions, viz: 15 feet in heighth, 8 feet 8 in breadth, and 5 feet deep, containing eleven stops, comprising 600 pipes, with a shifting movement, two rows of keys—in a handsome mahogany case, with carved ornaments, and 25 gilt front pipes.

The above instruments are nearly finished, and can be completed at a short notice.

Communications for either, to be made to

THOMAS APPLETON, Organ Builder,

m23 3taw7w No. 11 Newbury street, Boston.

Fig. 3. Advertisement by Appleton in the *Evening Post*, 1823.

dictated use of larger, more powerful organs (Organ 2017), and the Appleton was replaced less than 25 years later in 1854 (Hughes, 1983). It surfaced again in the 1880s, at which time builder Emmons Howard undertook a campaign of work and expanded the pedal compass to 27 notes from its original 18 (Hughes 1983). Luckily, this was Howard's most significant alteration, which makes the Met's instrument a tremendous source of information about early American organ building and musical practice.

Howard then installed the organ in a small church near Wilkes-Barre, Pennsylvania, where it was used until the middle of the 20th century (Hughes 1983). As was common for the time, the organ fell into disuse in favor of an electronic organ, which would not have required either the maintenance or laborious hand pumping of the Appleton organ. The Appleton was serendipitously rediscovered in 1980 and brought to the attention of then Met curator Laurence Libin.

2. CONDITION AND TREATMENT IN 1980

Luckily, the organ remained in the church, a paramount example of how benign neglect can serve to save and preserve important cultural heritage. During its neglected years, the ceiling was dropped around it, as seen in figure 4, and a plywood façade was nailed to the front and sides to better blend into the surrounding décor. The façade and organ were painted white and red-brown to further incorporate the instrument into its architectural surround.

It was acquired by the Met and brought to New York-based restorer Lawrence Trupiano for restoration. The 1980s restoration is recorded as being "relatively straightforward" (Trupiano and Laufman 1983). Metal pipes were washed free of dust, and wooden components were cleaned with hot, moist cheesecloth or steel wool. Cracks were filled, missing veneer was replaced, and chip losses to wooden components were repaired. The reservoir and feeder bellows were releathered, as were ribs and corner gussets. Pipes were straightened, and damaged areas were replaced with new lead alloy soldered in place. Missing ivory decorations on the stop knobs were replicated based on the two remaining ones, and moldings to the central cornice were replaced based on another Appleton model. The windchest, which is at the heart of the instrument, was largely untouched but for cleaning and lubrication of the sliders (Trupiano and Laufman 1983).

Arguably the most intrusive part of the 1980s restoration occurred to the casework. To remove the 20th century paint, the mahogany was hand scraped down to bare wood, thus removing most of the original finish. It was then refinished with a layer of shellac and hand-rubbed beeswax (Trupiano and Laufman 1983).

3. THE ORGAN AS PLAYING INSTRUMENT

The type of work conducted by Trupiano allowed for the organ to be utilized as one of a select number of playing instruments in our collection. According to Libin, it was played as much as

Fig. 4. The Met's Appleton organ as discovered in 1980 in Sacred Heart Church, Plains, Pennsylvania.

weekly in its earlier years and now is played a few times a year for audiences that range from departmental donors to museum visitors. The organ lends a tangible presence to the Equestrian Court over which it presides and for many visitors has been their first introduction to the musical instrument collection of the Met.

Caretakers of functional objects will always be confronted with the question of whether a given artifact should be utilized as originally intended. This is the case especially for musical instruments, whose intended function is to create an art form about which so many individuals are passionate.

For organs in particular, it is critical to understand that their survival often depends on their ability to be used as playing instruments. The physical space burden imposed by pipe organs is generally restrictive to private collectors or museums. Organs will more often move to other churches and occasionally to university music programs, both venues that all but require use. The Appleton organ also survives in part because it could be made playable without extensive restoration and the sound heard would be the most Appleton in character due to its limited alterations. Indeed, the church in which the Appleton was found has since been demolished, and there is no way of guaranteeing that had it remained there its significance would have been recognized in time to save it.

Thirty-five years after its installation at the Met, the Appleton organ had developed condition issues impacting both playing components and the casework. The recent multiyear closure of the Musical Instrument galleries for renovation presented an ideal opportunity to evaluate, extensively document, and arrange for treatment of the organ. In February 2016, the organ was partially disassembled as a component of this renovation project.

The mechanism of any instrument bears the deteriorating effects of playing, and keeping an instrument playable requires a commitment to regular maintenance so that small issues do not snowball into larger, more damaging ones. To treat the mechanism of the Appleton organ, the Met again contracted Trupiano, the restorer who installed the organ in the 1980s and who has been tuning and maintaining the instrument since.

4. CONDITION AND TREATMENT OF MECHANICAL COMPONENTS

Copious dust produced by the galleries' 1970s-era carpeting had accumulated in the pipes. Dust creates problems with sound production of all pipes but especially in reed pipes. Whereas

Fig. 5. Part of the mahogany case showing the original color in an area protected from light by a decorative element and the faded color in unprotected areas.

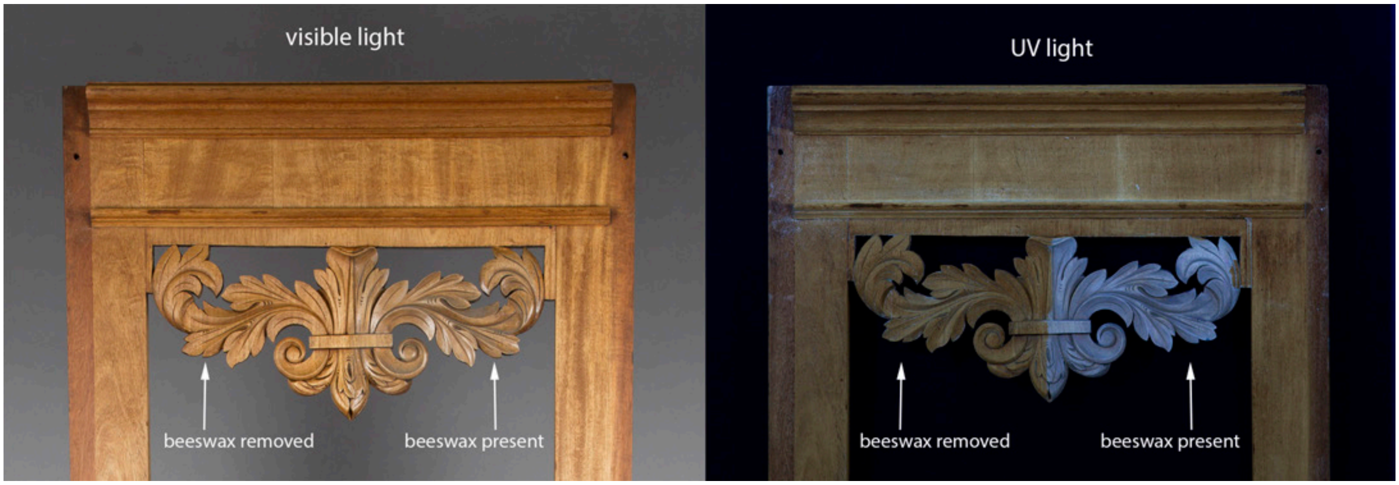


Fig. 6. Part of the mahogany case showing the restoration coating of beeswax in normal light and UV light.

common flue pipes do not rely on any moving components to produce sound, reed pipes have a vibrating brass tongue that is responsible for the timbre that allows them to imitate oboes, for instance. The sound is influenced by dust impinging on this mechanical action, and further the reeds in the Appleton had deformed after numerous tunings. The wooden wedges used to hold them in place were also extremely aged and fragile. To combat these issues, Trupiano cleaned the pipes and contracted a reed pipe expert to address the damaged reeds and tune them. The wooden wedges were replaced, and the originals were retained by the museum.

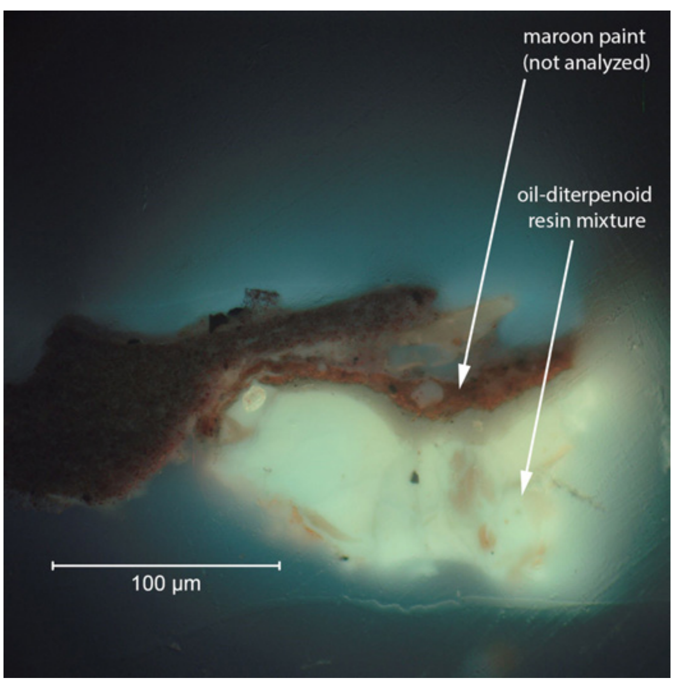


Fig. 7. Cross section of a sample containing the original oil resin varnish, analyzed with ATR-FTIR.

The leather gaskets on the pallets inside the windchest had deteriorated, causing air leaks and unwanted noise when the organ was played. These may have been original, and thus it was critical that they be carefully documented before removal, delicately removed, and afterward preserved by the museum. Removal of materials such as these from instruments is not a decision that can be undertaken lightly, and yet it is often a choice that one must contend with when conserving musical instruments. In this case, careful removal would allow the instrument to play and further enable better preservation of this historical material. This was deemed preferential to retiring the organ from its playing life, at which point the leathers would continue to deteriorate in their inaccessible location. Treating the leather in situ would be challenging on several fronts. Reversibility of interventions such as consolidation would be limited, and changes to the mechanical properties of these components directly influence how the organ functions.

Finally, the restoration flap valves inside the bellows and air reservoir had warped and buckled, causing air leaks that made it virtually impossible to maintain constant air pressure or use all of the organ's pipe registers. Although initially the organ was only partially disassembled, ultimately it required full disassembly to allow Trupiano the necessary access to replace the valves and for the authors to address the condition issues of its mahogany case.

5. CONDITION AND TREATMENT OF THE CASE

Due to direct sunlight entering through the windows on the east and west sides of the galleries, the mahogany casework had faded from the typical dark, rich color to a pale blonde. In uppermost areas, it was even gray tinged. Parts of the case that were protected from incident light by removable elements revealed the extent of cumulative light damage (fig. 5). This fading clearly presented a significant change to the aesthetic of the instrument, and the irreversible depletion of colorants within the wood was a concern to both conservators and curators.

Fig. 8. Part of the mahogany case before (left) and after (right) treatment.

Initial mechanical and solvent testing revealed that the gray color and dull appearance of portions of the wood was mainly due to the degradation of the beeswax finish applied during the 1982 restoration campaign. The wax had turned semi-opaque and had trapped dust from the carpet covering the gallery floors. Selective removal in test areas revealed the beautiful cross grain of the mahogany obscured by the degraded wax.

Removal of the beeswax coating was desirable, and after initial solvent testing this was achieved through application of ethanol-moistened cotton wool poultices to the wooden surface. The wax was so degraded that its chemical and mechanical properties had been altered. A combination of crazing and presumably increased polarity of the wax allowed the solvent to soften it and penetrate to the underlying shellac, thus allowing easily removal (fig. 6). Traces of original finish in areas too low to have been accessed by the scraper during restoration were sampled and analyzed using attenuated total reflectance Fourier transform infrared reflectometry (ATR-FTIR). It was found that under the 20th century paint, there was an oil-diterpenoid resin mixture indicating an oil resin varnish (fig. 7). This information not only revealed the builder's materials and methods but also gave an indication of how the original surface finish would have looked.

Any conservation treatment of the case obviously would need to address the source of the damage: the amount of light coming into the gallery. When the organ was installed, there were no UV filters on the gallery windows; however, they were installed within a few years. New Madico CL-400-EXSR filters were applied in 2010, although they do little to reduce the visible light penetrating the glass. According to the specifications provided by the manufacturer, these filters transmit 90% of the visible light and filter out 99% of the UV light. Their performance is guaranteed for five years after installation, and it is to be expected that the film's filtering capacities have diminished since their installation (Boye, Preusser, and Schaeffer 2011).

Fig. 9. The Appleton organ reassembled after treatment.

In situ light readings taken with an Elsec 764 Environmental Monitor in January 2016 show visible light levels up to 29,000 lux in a direct sunbeam with UV levels of 27 μW/lumen. Compared to the generally accepted guidelines of maximum 25 μW/lumen, this reading is not egregious; however, it is of course relative to the number of incident lumens (Tétreault 2016). A longer study of light exposure in the gallery was conducted measuring light intensity every 15 minutes with a HOBO U12-012 data logger for an eight-month period. Based on these measurements, the total light exposure was estimated to be around 3,635,000 lux hours/year. This correlates to a constant day and night exposure at 415 lux or almost three times the generally accepted maximum level of illumination for wooden objects of 150 lux (Michalski 2016).

Although applying neutral density filters or scrims to the windows would be an effective way of protecting the wood from further light damage, it requires the planning and coordination among many departments within the museum. With many demands on time and resources, a project such as this must be scheduled years in advance. This lead time needed to be considered in any treatment plans, which led to investigation into the possibility of applying a coating that would at the same time restore the color of the case and protect it from further light damage.

Synthetically produced transparent iron oxides are known to have excellent lightfastness properties and are additionally reported to be strong absorbers of UV radiation (Wright and McKenna 2000). They are used in paints, coatings, and plastics and differ from opaque iron oxides principally in terms of particle size and shape. They are available from Golden Artist Colors Inc. as High Flow Acrylics in a limited range of colors: transparent red iron oxide; transparent yellow iron oxide; and transparent brown iron oxide, which is a mixture of transparent red and carbon black. Although these could be mixed to produce an orange-brown earth tone, a true red-purple colorant was necessary to mimic the original color of the mahogany. Based on the results from accelerated aging tests performed by Golden Paints, a quinacridone violet was selected for this purpose (Jackson 2017).

The use of High Flow Acrylics enabled the application of very thin coats, achieved by brushing paint on and then mostly wiping it off with Kimwipe tissues. This allowed for the gradual buildup of the desired color. This method was preferred over application with a spray gun due to the challenges of attaining an even coating on the intricate carving and molding present.

UV-Vis spectroscopy of the transparent iron oxide High Flow Acrylics applied to quartz slides showed that they indeed act as excellent UV absorbers, filtering out virtually all UV radiation and thus protecting the wooden substrate (see Appendix 1). However, the challenging light situation and the predicted time prior to retreatment of the windows prompted exploration into the use of a UV-inhibiting top coat to limit exposure of the quinacridone violet.

The use of zinc oxide and titanium dioxide nanoparticles as UV absorbers in transparent coatings has been explored by various studies and was found to be effective in the photostabilization of wood (Blanchard and Blanchet 2011; Silverman 2016). Although the use of organic UV absorbers and hindered-amine light stabilizers (HALS) is well documented in conservation coatings, they deplete over time and have a shorter life span than available metal oxide absorbers.

Experiments were carried out with the use of Paraloid B-72 doped with zinc oxide nanoparticles. Zinc oxide was preferred to titanium dioxide, as it is more absorbent in the UV-A range that penetrates typical window glass. Another benefit of the zinc oxide is that it is more optically transparent at a given concentration, indicating that more coats could be applied if needed. Paraloid B-72 was chosen because of its excellent stability and reversibility (Feller, Curran, and Bailie 1981).

The UV-blocking capacity of a coating modified with zinc oxide nanoparticles largely depends on the quality of the dispersion. Predispersed nanoparticles of zinc oxide are available in a limited number of solvents, and for this treatment NanoArc 40-nm zinc oxide dispersed in propylene glycol methyl ether was used. This solvent was chosen because of its compatibility with xylenes and toluene, both solvents that allow spraying Paraloid B-72 to the appropriate surface sheen. According to the manufacturer, the nanoparticles can be added up to 4%, proportional to resin weight, before film-forming properties are compromised (Kozick 2017).

UV-Vis spectroscopy was used to determine the specific wavelengths filtered, what concentration of zinc oxide was needed to have an effective coating, and how many coats should be applied. SEM was used on samples sprayed onto carbon stubs as a means of checking the dispersion and the degree of potential agglomeration occurring.

It was found that 9 to 10 coats of 10% Paraloid B-72 with 4% w/w zinc oxide in xylenes applied with a spray gun gave the best results. It avoided the milkiness that results from too thick a coating, effectively reduced UV radiation by about 50% (see Appendix 2), and had the correct degree of gloss.

Following initial testing of the different coatings, treatment proceeded of the entire organ case. After removal of the restoration coatings of beeswax and shellac with ethanol poultices, the following coatings were applied (fig. 8):

- 2 coats of 10% Paraloid B-72 in toluene as a barrier layer
- 2 coats of Golden High Flow Transparent Yellow Iron Oxide
- 4 coats of Golden High Flow Transparent Brown Iron Oxide
- 3 coats of a violet-brown mixture (this mixture contained 81% Golden High Flow Transparent Brown Iron Oxide, 16% Golden Fluid Quinacridone Violet, and 3 % Golden High Flow Carbon Black and was diluted 1:1 by volume with Golden Airbrush Medium to get the desired consistency)
- 10 coats of 10% Paraloid B-72 in xylenes with 4% w/w of 40-nm zinc oxide.

After treatment, the organ was reassembled in its original location (fig. 9) on the balcony above the Equestrian court. An extensive campaign of tuning and regulation was subsequently undertaken by Trupiano to ensure that the organ could again be played without risk. During treatment of the organ, the carpet was removed, the underlying hardwood floors were refinished, and a new platform was made for the instrument's display.

6. FUTURE TESTING

In the short term, light exposure remains an issue on the balcony where the organ is displayed. Our treatment aimed at achieving the best possible protection for both wood and organic colorant (quinacridone violet); however, ongoing study will be critical to understanding how our coatings will age. Further, such a study will serve to clarify the time scale in which window filters or scrims should be applied and ideally provide additional supporting evidence for such an improvement. To this end, exposure test panels will be created to reside discretely in situ on top of the organ. Two substrates have been chosen—2 x 3.5 in. aluminum Q-panels and mahogany—and the various permutations of colorants and zinc oxide-doped Paraloid B-72 will be applied to them. Blue Wool Standards and a light logger will be placed alongside these sample panels, and all will be regularly checked. Partial coverage of both our samples and the Blue Wool Standard will enable qualitative comparison and a semiquantitative analysis with a colorimeter. This will allow for evaluation of the lifetime of both colorants and zinc oxide protective coatings and indicate their efficacy in protecting the mahogany organ casework as they age.

7. CONCLUSION

The temporary closure of the musical instrument galleries for renovation offered a rare opportunity to perform an extensive treatment of the Thomas Appleton organ. This is the only time since its installation that the instrument has been fully disassembled. The organ fulfills multiple roles in our collection, being both an excellent historical example of 19th century American organ building practice and, additionally and vitally, serving as a playing instrument. The treatment therefore reflected both aesthetic needs and the needs of mechanical components used in playing.

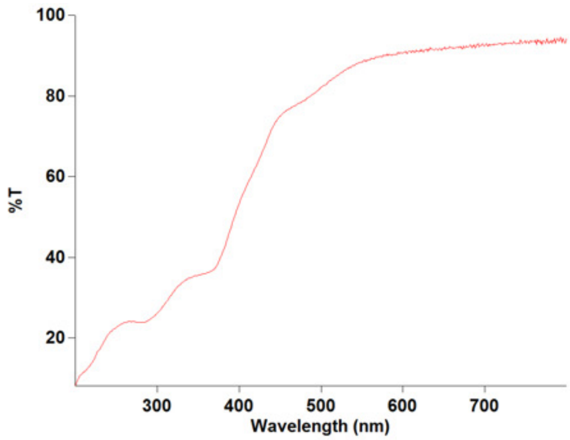
This endeavor was aided substantially by a combination of factors, not least the collaboration between specialist organ restorers and musical instrument conservators. Extant photo-documentation from the 1980s installation coupled with first-person perspectives of the restorer and curators who performed that installation gave a confident understanding as to how the organ originally looked. The lack of original surface coating and a lengthy period of time in which to evaluate the organ meant that not only could such a large-scale treatment be carefully conceived, researched, and executed but also that a thorough campaign of documentation could be conducted. This documentation has included time-lapse videos of disassembly and reassembly, infrared reflectance photography of signatures and graffiti that may provide further insight into the organ's early life, and technical drawings of joinery methods used to construct this instrument.

We have strived to amass the best information possible and deploy it responsibly to conduct the restorative conservation of this instrument—a process that will continue with the proposed light study. The treatment of the Appleton organ serves as an excellent case study of the challenges posed by large-scale objects and functional objects still in use. Further, it indicates the necessity of monitoring and maintenance of not just the original components of this object but especially of the conservation intervention performed. The opportunity to conserve such an instrument as the Appleton was a rare one, and we are gratified that our work will allow for this organ to continue to be enjoyed by the public and scholars alike.

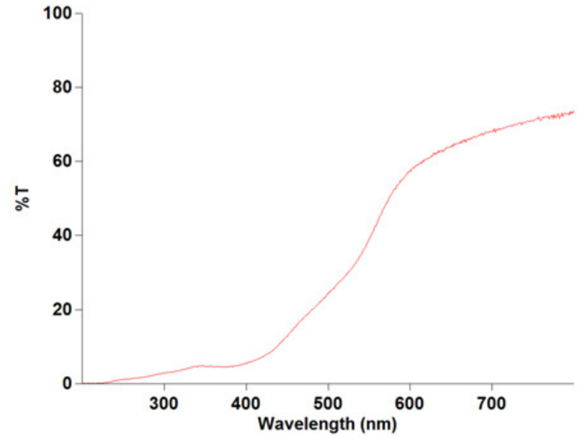
ACKNOWLEDGMENTS

We would like to extend our appreciation to colleagues within the Department of Objects Conservation and Department of Musical Instruments, who provide guidance and assistance whenever needed. Further, we would like to thank Lawrence Trupiano for his part of the treatment of the Appleton pipe organ and for sharing research, archival photographs, and his extensive knowledge of American organs. Technical support from Golden Artist Colors Inc. was invaluable throughout this process, and we thank them as well.

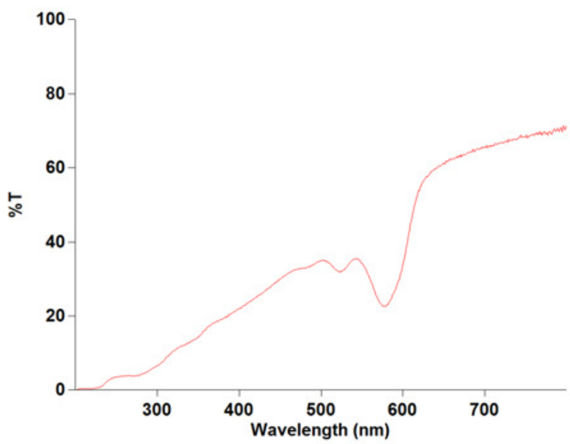
APPENDIX 1. UV-VIS SPECTROSCOPY



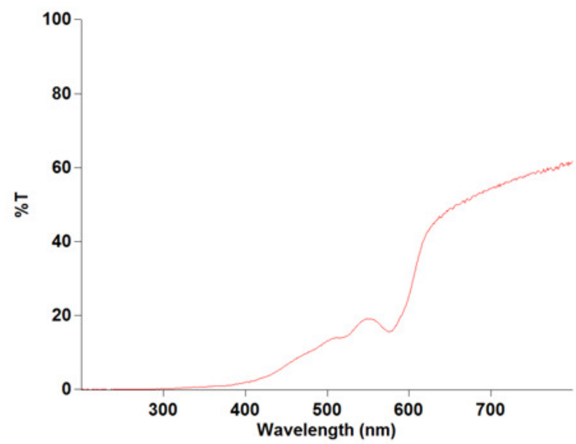
2 coats of Transparent Yellow Iron Oxide



4 coats of Transparent Brown Iron Oxide



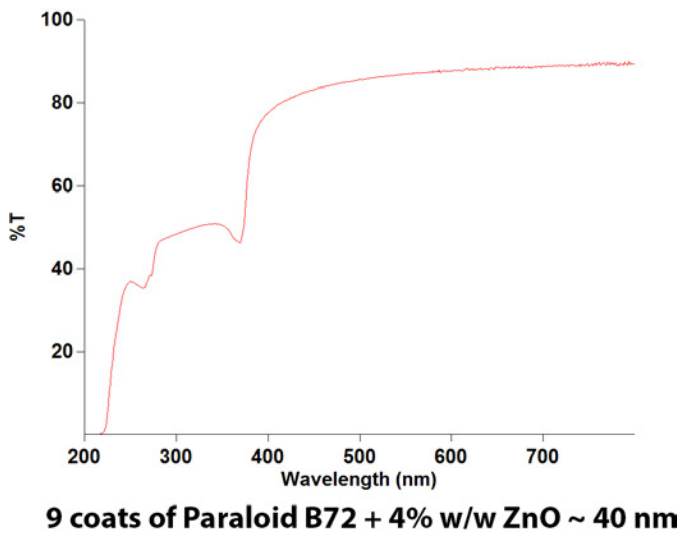
3 coats of 81% Golden High Flow Transparent Brown Iron Oxide
16% Golden Fluid Quinacridone Violet
3 % Golden High Flow Carbon Black
1:1 (v/v) Golden Airbrush Medium



all coats combined

UV-Vis spectroscopy of transparent iron oxide containing coatings. Materials applied to quartz slides and analyzed using a Varian Cary 50 UV-Vis Spectrophotometer equipped with a Xenon flash lamp and a diode array detector. Spectral range: 190 to 1100 nm, approximately 1.5-nm fixed spectral bandwidth.

APPENDIX 2. UV-VIS SPECTROSCOPY



Nine coats of Paraloid B-72 containing 4% w/w 40-nm zinc oxide. Materials applied to quartz slides and analyzed with a Varian Cary 50 UV-Vis Spectrophotometer equipped with a Xenon flash lamp and a diode array detector. Spectral range: 190 to 1100 nm, approximately 1.5-nm fixed spectral bandwidth.

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SOURCES OF MATERIALS

40-nm Zinc Oxide Nanoparticles CAS# 1214-13-2 Dispersion in Propylene Glycol Methyl Ether Acetate CAS# 108-65-6, 40 wt%

Nanophase Technologies Corp.
1319 Marquette Dr.
Romeoville, IL 60446
630-771-6709
http://www.nanophase.com

Transparent Yellow Iron Oxide #8565 High Flow Acrylic, Transparent Brown Iron Oxide #8562 High Flow Acrylic, Quinacridone Violet #2330 Fluid Acrylic, Carbon Black #8524 High Flow Acrylic, Airbrush Medium

Golden Artist Colors Inc.
188 Bell Rd.
New Berlin, NY 13411-9527
607-847-6154

Q PANEL Standard Test Substrates Type A, Alloy 3003H14, 0.025-in. thick (0.6 mm), bare mill finish

Q-Lab Headquarters & Instruments Division
800 Canterbury Rd.
Cleveland, OH 44145
440-835-8700

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Wooden Artifacts Group Session

Manufacture and Treatment Study of Coffin and Mummy Cartonnage, at Egyptian Museum in Cairo

Moamen Othman, Eman H. Zidan, Rania El Atfy, Mohammed A. Hussein, Randa El Helw, Sabah Abdel Razek

Ancient Egyptians used various materials to made coffins; stone, ceramic and wood. They developed substrates and painting techniques to cover the surface with using different pigments and coatings. Technical studies, investigations and analysis application are important to identify materials and core elements used in the past.

This deliberate study aims to analyze a wooden coffin and mummy cartonnage presumably dated to late period. It was found during a working season in the Egyptian Museum basement storage in 2004. The only a single document that contain information about it was found in a report written by Maspero in 1901, indicating that the object entered the museum collection in 1900. It was left unregistered since then. In Maspero's report, he addressed that, it was discovered by Petrie excavating in Lahon, Fayoum. The report includes a black and white photograph shows the object by the time of discovery.

The type of the coffin and cartonnage suggests a middle Egypt type of third intermediate and late period. The broad collar, pendants, rosettes and other decorative elements suggesting belonging to the late period stylistic motifs. The central inscription, which is repeated on both the coffin and the cartonnage, represents the offering formula addressing the god Osiris. The name of the owner was demolished in both coffin and cartonnage. The coffin set includes coffin base, lid and a mummy cartonnage.

The wooden coffin lid (193 cm long) is made of four wooden planks joined by wooden dowels, the wood base in the central area of the lid is covered by gesso and pigment, pigments vary; white, black, yellow, red and blue. The coffin base (193cm long, 48.5cm width and 34cm height) consists of 13 wood pieces that form the rectangular shape. Pieces are covered with mud as preparation layer and then were painted in yellow. The coffin base was dismantled into 11 pieces when it was first received in the conservation department.

The mummy cartonnage (180cm long) features a woman, the iconography matched in both coffin lid and the mummy cartonnage. It is a mummy covered with more than 33 layers of textile then gesso and then painted in bright colors; white, black, red, yellow and blue. The wooden coffin consists multi-layers: wood, gesso layer, additives (under investigation) and painted layer. There are different pigments used in the decoration of the coffin: white background covered with blue, red, black and yellow for inscription and decorations. The state of the wood is very poor, the coffin is dismantled into many pieces (base, 2 sides and fragments), and some pieces are still joined together by wooden dowels. The head block has areas of loss, cracks, breaks and disjoints. Regarding the mummy cartonnage, the pigment and painting palette is quite similar to the one in the wooden coffin. Its state of preservation appears to be moderately stable except the lower parts that suffer some losses, cracks. The lower part (foot area) has a severe damage.

Wood Working Tools as Art

Jonathan Thornton

For many years I have made woodworking tools in order to explore alternative and "ethnographic" methods of working wood, to teach those concepts to students in art conservation, and to create my own works of art. Initially, these tools were more strictly functional, though carefully finished and ergonomic. In time, the tools became more obviously sculptural, though the utilitarian aspect was never lost. In recent years my tools have become zoomorphic and sculpturally sinuous, using natural and found materials, and incorporating hand-forged blades. Materials include tool steel, "Damascus" steel, various types of wood, stone, glass, cordage, leather, ivory and bone.

This approach is informed by many cultures worldwide that have produced elaborately decorated tools, sometimes to the point that function can be perceived as compromised. The spiritual power of tools and their master-users in other cultures will be touched on. This paper will present a selection of my sculptural tools as well as their inspiration, including those based on the "crooked knives" of Native Americans, axes and adzes of Pacifica and the Northwest Coast of North America, bow drills of Africa, the "spear plane" of Japan, and scorps and chisels of more innovative design not obviously derived from ethnographic prototypes. My methods of work will be described. Fine points of form following function will be detailed, as will other subtle aspects of hand tools. Use of the tools will be linked to the actual objects that were made using them.

Technical Analysis and Conservation Treatment of a Mid-Eighteenth Century Chinese Carved Wood Lacquer Bodhisattva Sculpture

Lisa Ackerman, Jonathan Thornton, Dr. Aaron Shugar, Dr. Rebecca Ploeger, and Jiuan-Jiuan Chen

Asian lacquer is an ancient art form resulting in a beautiful, hard, gloss material derived from resin that comes from the sap of sumac trees in the Anacardiaceae family (Rivers and Umney 2003). These trees grow in a number of Asian geographical regions. In China this traditional lacquer is known as qi, however, the Japanese term urushi has become commonly accepted for Asian lacquers. Both qi and urushi are made from urushiol sap collected from Toxicodendron verniciflua. Vietnamese and Taiwanese lacquers are made from laccol sap collected from Toxicodendron succedaneum, and thitsiol sap from Gluta usitata is used in Thai and Burmese lacquers. Also depending on the country of origin, other organic materials such as drying oils, persimmon juice, blood, animal glue, wood oil, benzoin and starch are often added to the lacquer to alter working properties, appearance and cost.

Minerals and/or organic pigments are often used to add color ("Characterization of European and Asian Lacquers" 2010). Inert organic fillers such as clay or powdered ceramic are often added to thicken and provide body. Urushiol is the main monomeric component of urushi lacquer. Lacquer is applied wet and hardens when exposed to humid air. Molecules in the resin absorb oxygen and form a durable, cross-linked polymer that is impervious to water, salts, acids and alkalis and is insoluble in any solvent (Ma, Lu and Miyakoshi 2014). Often for export lacquerwares, laccol, a much less expensive lacquer, was used while reserving the more costly urushi for lacquerwares that were made to stay in China. This project involved the technical analysis and conservation treatment of a mid-18th century Chinese carved wood lacquer bodhisattva sculpture, thought to be made for a Chinese emperor, and not for export.

In order to determine the materials used, method of manufacture, confirm the country of origin, and determine a method of treatment; conservation issues were assessed, and sampling was conducted in appropriate areas of the lacquer for analysis. Examination and analyses were carried out using photographic techniques, x-radiography, optical microscopy, X-Ray Fluorescence spectroscopy (XRF), Scanning Electron Microscopy and Energy Dispersive X-ray Spectroscopy (SEM-EDS), Fourier Transform Infrared spectroscopy (FTIR). Pyrolysis–Gas Chromatography–Mass Spectrometry (Py-GC-MS). The results were then used to consider the types of materials used, the fabrication method, and possibilities of origin and quality; and to formulate a suitable plan for treatment using appropriate conservation materials and methods.

Joint Session Architecture + Wooden Artifacts

The Framing of a Masterpiece: The history and conservation of a monumental tabernacle frame

William B. Adair, Stephan C. Wilcox

In the past, Museums sometimes deferred the care and treatment of frames in favor of the treatment of the paintings they housed. Often a new frame was selected over the old in accordance with changes in fashion, time and ownership. The old frames were then deaccessioned or put in storage, resulting in areas bulging with discarded frames waiting to be reunited with an appropriate painting.

This benign neglect has now actually provided conservators with rare opportunities for proper conservation treatments of important historical frames. In this paper, conservators William B. Adair and Stephan C. Wilcox, explain the various treatment options available and elucidate the rationale leading to the final decisions for conservation of the tabernacle frame for Bellini and Titian's The Feast of the Gods. The tabernacle frame has now been conserved back to its intended finish.

The Feast of the Gods was originally commissioned by the Duke and Dutchess of Ferrara in 1514 as part of a series of paintings placed in an architectural setting for the Gonzaga's palazzo in Mantua. The frame, complete with pilasters and polychrome entablature, is considered by some to be one the most important Renaissance paintings in America. In particular, the dilemma of what time in history a work of art should be presented to the viewer will be discussed. Starting in the mid 19th century, when the Camuccini brothers from Rome sold the Feast of the Gods to the 4th Duke of Northumberland, to the 1916 sale by London dealers Thomas Agnew and Arthur Sulley to Joseph Widener, and eventually bequeathed to the National Gallery of Art.

Structural Treatment of Wooden Beams

Mostafa Sherif

Wooden beams of ceilings in historical buildings in Cairo are suffering from overloads, biodeterioration, and human and environmental deterioration that is causing cracks, deflection, and twisting or broken wooden beams. Study of wooden ceiling conditions in the Ganem Albahlawan mosque in Cairo found a five broken beams and deterioration of wooden panels in the ceiling. A numerical study and specific survey of this case study was made through structural calculation for each wooden beam, and an intervention proposal. Furthermore, an experimental study is presented about use of fiber reinforcement polymers (FRB) to treat broken wooden beams. Three groups of wooden samples were used: small, medium and full-scale sample beams. The samples were evaluated by bending and testing strength, while the experiment study used many methods of treatment, changing the type of FRP or applying different methods to be calculated and suitable for the span, condition, and the load capacity of wooden beams. Results showed the ductility of wooden beams increased, to absorb loads of more ten times than before treatment; this revives the historical wooden beams so they can continue their function.

Exposing Graffiti in George Washington's Cupola

Steven Stuckey

Frequent visitation to George Washington's Mount Vernon home has been a common occurrence since the 18th century, and sometimes those visitors left a permanent memory. "Exposing Graffiti in Washington's Cupola" is about uncovering the signatures of guests visiting Mount Vernon during the 19th century and specifically leaving their mark in the iconic cupola. This paper will explore a change in an approach to treatment of the wood window architraves in the cupola that was initially designed to completely remove the existing coating, but was then modified to conserve specific layers of paint containing names, dates, and locations in pencil. Discussion will also cover varied techniques utilized for the pre- and post-treatment documentation of the architectural elements, including digital photography, measured drawings, computer generated modeling, and multi-spectral imaging. Lastly, the long-term maintenance and utilization of the architraves will address the plan for extending the life while displaying this unique piece of architectural history at Mount Vernon.