

Three-dimensional works of art provoke viewers to contemplate volume and contour, but it is the surfaces of these works, with their colors, textures, and finishes, that most compellingly contribute to our visual experience. Articles in the current issue of *met objectives* illustrate several of the material aspects of surfaces that engage conservators. A comparison of blue paint layers on three French thirteenth-century polychrome sculptures reveals the varying degrees of purity and different methods of applying natural ultramarine, a pigment that became popular in Europe at that time. A Herter Brothers upholstered side chair with flake-gold finish, and an Indian seventeenth-century “mixed media” *qalamdan* are presented as the focus of visual and instrumental analyses, highlighting the importance of investigating surviving surfaces in order to understand and, when appropriate, evoke original appearances. A study of the deterioration of archaeological copper alloy surfaces and a consideration of artificial patinas illustrate how specificity of corrosion products and structure plays an important role in the authentication of ancient bronzes.

met objectives



Mixed Media: An Islamic Writing Cabinet

In 1998, the Islamic Art Department acquired a wooden writing cabinet—*qalamdan* in Persian—produced in India during the mid-seventeenth century (*Figure 1*), when Muslim rule within the country was divided between the Mughal Empire in the north and smaller kingdoms of the Deccan in the south. Complete with drawers and compartments, this box served as a portable desk, and the importance placed on the art of writing in Islamic cultures is expressed in the precision of its wood joinery and the sumptuous decoration on the exterior. The top and sides are covered with wide bands of gilded metal sheet separated by stepped ridges into rectangular and square fields. Silver floral ornament, executed in *ajouré*

and set against a dark red textile background, is contained in cartouches, rosettes, or lobed medallions cut into each field (*Figure 2*).

Assuring the preservation of objects of mixed materials presents unique challenges. Forms of deterioration characteristic of different media vary according to their nature, and in addition to exposure to deleterious environmental conditions damage may result from contact between incompatible materials, or from past treatments designed for one material that compromised the stability of another. Changes in appearance resulting from surface deterioration often obscure the interplay between materials and finishes that are essential for a full appreciation of a

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Figure 2

work of art. Only fragments of the textile survive on the writing cabinet, and because its original appearance has also been significantly altered by silver tarnish and an accumulation of dirt and polishing residue, treatment was required before the box could be placed on display (Figure 3).

The repeating floral motifs on the exterior were produced by stamping silver sheet into intaglio metal dies. Such dies, known in India as *thasa*, *thappa*, or *chhancha*, have been used extensively in the manufacture of Indian jewelry. Radiographs reveal thin borders, now masked from view, around these delicate openwork decorations, which helped to prevent deformation during working and handling (Figure 4). Thicker silver sheet was used on the moldings of the lid and bottom, and gilded metal braces reinforce the edges on the sides of the box.

Qualitative X-ray fluorescence analysis of the strap hinges and the interior drawer pulls indicated that they are fashioned from a brass alloy, while the substrates of the gilded panels and exterior handles are unalloyed copper. The gold was applied using an amalgam technique. Facilitated by the presence of mercury, the gold is bonded to the substrate through the interdiffusion of gold and substrate atoms during heating. Where not accessible to burnishing tools and

protected from wear, the gold layer still displays the porous texture typically produced by the mercury as it volatilizes.

Other materials used in the fabrication of this box derive from living sources. The wood may have come from the *sisham* tree, an indigenous hardwood related to rosewood that was commonly used in the construction of Indian writing cabinets of similar date. Microscopic examination of fibers from the plain-woven textile on the exterior revealed it to be wool rather than silk, as had been assumed when the box was acquired. Mughal rulers, beginning with Akbar (r. 1556–1605) and continuing with Shah Jahan (r. 1628–1658), made a point of patronizing wool production, and the use of this textile may have implications for establishing the cabinet's provenience within India. Viewed under ultraviolet light, the textile fragments exhibit an orange fluorescence, most likely indicative of madder lake, a dye derived from indigenous *chay* roots or other plants of the *Rubiaceae* family.

The combination of metallic and organic materials is cause for concern with regard to the box's long-term stability. Keratin, the structural protein of wool, contains sulfur, which can promote the corrosion of metals, and the volatile organic acids found in many wood species induce corrosion as well. This problem may be less of a concern with aged wood, but on the other hand, the interior surfaces of this box have been treated with a dressing that contains beeswax and it is probable that the free acid content of this material contributed to the corrosion of the interior brass fittings. In spite of the potential for further deterioration, the dressing was not removed, as it may have been applied when the box was originally manufactured. The fact that works of art can suffer from vapors emitted by adjacent materials has motivated extensive efforts by museums to use safe products in the construction of display cases (see *The Oddy Test improved*, p. 4).

Cleaning techniques used for works of mixed materials must be highly selective,

Figure 1. (Cover) Writing Cabinet (qalamdan), India (Mughal or Decanni), mid-17th century. Wood, silver, gilded copper, brass, and textile, w. 41.6 cm. Purchase, Gift of Dr. Mortimer D. Sackler, Theresa Sackler and Family, 1998 (1998.434).

Figure 2. Detail of writing cabinet (Figure 1), with silver ajouré work within lobed medaillon. Note surviving fragments of textile.



Figure 3

Figure 3. Detail of writing cabinet (Figure 1), before treatment.

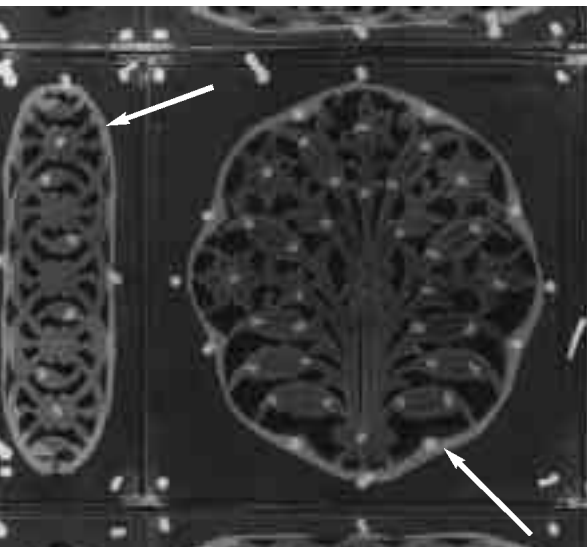


Figure 4

and dry cleaning methods are usually preferred because the flow of liquids can be difficult to control. For removing superficial tarnish from silver inlays on damascene metalwork without polishing the silver or disturbing adjacent metal surfaces, non-abrasive vinyl erasers have been found effective. When the build-up of tarnish is more severe, an aqueous paste of .05 micron alumina can be used for mechanical spot cleaning.

In this case, however, preliminary cleaning tests indicated that pretreatment with a thiourea solution was required to soften the thick sulfide layer on the silver fittings so that it could be removed mechanically without damaging the metal surface. Since embrittlement of the various metals and the complexity of the assembly preclude removal of individual elements for cleaning, the thiourea was applied to the silver in situ with microswabs in order to confine it as much as possible to the silver surfaces. Any thiourea absorbed by the porous textile and wood was extracted using a poultice of synthetic colloidal clay and distilled water. This poultice also proved effective in softening accretions on the surfaces of the wood, textile, and gilded elements. To minimize wetting of the hygroscopic materials, as little water as possible was used during removal of the poultice. Since they do not detract from the

overall appearance of the writing box, old repairs were left intact and losses not restored, and after treatment the *qalamdan* communicates once more some of its original brilliance while preserving evidence of its age and history.

A nitrocellulose lacquer was applied to the silver fittings in order to prevent retarnishing. This decision was made reluctantly, as lacquers slightly alter the appearance of silver and eventually degrade, requiring removal and reapplication. Exhibition cases can be equipped with filtration systems to remove the ambient sulfur that causes silver to tarnish, but the effectiveness of such a system when the silver is directly adjacent to or actually touching the source of the corrosive agent has not been established. Furthermore, it is anticipated that this work will be loaned to other institutions, and given the difficulty of continuously controlling the box's environment during transport, storage, and display, the lacquer ensures that it will not be subjected to lengthy or repeated tarnish removal treatments in the future.

Even though the silver elements have been lacquered, the quality of the environment in which this box is displayed or stored still is critical. When two metals are in contact, exposure to high relative humidity, salts, or acidic compounds can lead to accelerated corrosion of the less noble metal. On gilded copper alloys, corrosion of the substrate often causes lifting and loss of the gold, as well as darkening of the surface due to the migration of copper oxides. As the substrate cannot be isolated or treated, its stabilization is dependent on environmental control. While dry environments tend to inhibit the formation of corrosion, low humidity levels are not suitable for organic materials, and the competing needs of all materials present must be taken into consideration to establish an appropriate median.

Fiber identification was carried out by Maya Naunton, Polaire Weissman Fellow, The Costume Institute.

Figure 4. X-ray radiograph of detail in Figure 2. Arrows indicate thin borders on ajouré floral decorations underlying gilded copper sheet.

Jean-François de Lapérouse joined the staff of the Sherman Fairchild Center in 1990, shortly after receiving a Certificate of Conservation from the Institute of Fine Arts, New York University. Primarily involved in the study and treatment of objects from the Islamic Art and ancient Near Eastern Art Departments, he recently completed the coursework requirements for a doctorate in ancient Near Eastern art at the Institute with assistance from the Museum's IFA/NYU Scholarship for Course Tuition program.

The Oddy Test improved

Museums go to great lengths to monitor and regulate the environments in which works of art are displayed, stored, and transported. While many of the variables that affect preservation are considered on a gallery- or museum-wide scale, microenvironments in exhibition cases, packing crates, and storage containers also require oversight. Materials used for fabricating and furnishing vitrines, including wood products, paints, adhesives, textiles, mounts, and gaskets, all potentially produce corrosive vapors that harm works of art. Because of the limited flow of air in both sealed and unsealed vitrines, damaging effects are accelerated, and all materials to which works of art might be exposed must be tested to assure their suitability.

A testing procedure developed by Andrew Oddy, former Keeper of Conservation at the British Museum, was first proposed in a 1973 issue of the *Museum Journal* and became a widely used tool for evaluating materials for display and storage applications. Lorna Green and David Thickett of the British Museum Department of Conservation later introduced a standardized Oddy test, to be carried out in three sealed glass vials each containing the material to be tested, a coupon of copper, silver, or lead, and a fixed quantity of distilled water sufficient to maintain a relative humidity of one hundred percent. The sealed vials are placed in an oven set to 60°C for a period of four weeks, after which the metal coupons are inspected for evidence of corrosion. On the basis of changes observed in luster, color, or texture, the materials tested are classified either as suitable for long-term or temporary use, or as unsuitable. A problem still encountered using this standardized procedure is that the containers specified are not airtight, leading to the loss of water vapor and other gases during the test period.

In 1995, as a guide for the Museum's designers and curators, Fairchild Center conservators Ellen Howe, Yale Kneeland, and Pete Dandridge began to assemble a list of



Figure 5

Figure 5. Elements of a three-in-one set-up for testing a sample of wood laminate.

materials tested at the Center or otherwise known to be suitable or unsuitable for display and storage applications. In connection with this project, and in order to facilitate more efficient and reliable evaluation of new products, a variation in the Oddy test set-up was developed. During the last six years nearly three hundred materials have been evaluated using the revised system, with the results stored in a departmental database.

Whereas the British Museum procedure places the material to be tested in three separate containers, each with a copper, silver, or lead coupon, the Center's "three-in-one" version specifies that a product sample be placed in a single glass jar with all three coupons (Figures 5, 6). Sufficient space is available to avoid contact between the coupons, the sample, and the distilled water. An improved method for sealing the containers assures that no water vapor or other gases are lost during the test period. A threaded cover lined with a sheet of Teflon® is sealed with silicone grease, and then retightened after the complete set-up has been preheated for half an hour. Each assembly is weighed before and after the twenty-eight day period and the weight loss is consistently zero, demonstrating the reliability of the three-in-one Oddy test.

This project received assistance from George Wheeler, Research Chemist, and Diana Harvey, Assistant Conservator. Thanks also to Ellen Pearlstein, Conservator of Objects, Brooklyn Museum.

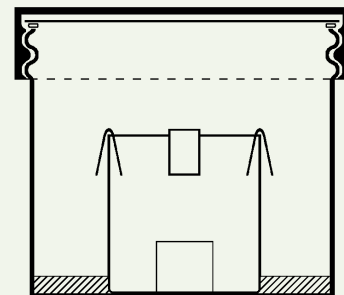


Figure 6

Figure 6. Three-in-one Oddy test set-up.

Joseph Bamberger received degrees in mechanical engineering from the City College of New York and New York University. He was on the scientific staff at Brookhaven National Laboratory for over twenty years, where his work included the design, development, and operation of low-temperature and high-vacuum equipment and facilities. He was active in many of the Laboratory's safety programs, and served as chairman of the Cryogenic Safety Committee. More recently, he taught courses in engineering and technology at Suffolk Community College on Long Island, New York. He has volunteered his expertise at the Sherman Fairchild Center since 1996.

The Use of Lapis Lazuli as a Pigment in Medieval Europe

In recent years, studies of historical trends in the use of color have focused on the increasing popularity of blue in Europe during the twelfth century. Notably, Michel Pastoureau, in *Bleu, histoire d'une couleur*, demonstrates that blue appeared more frequently on stained glass, sculpture, paintings, and illuminated manuscripts, but also in secular contexts, on royal emblems, banners, and ordinary textiles and clothing. The material aspects of blue paint, particularly on sculpture, have also become the subject of investigation. The valuable mineral lapis lazuli, known as natural ultramarine when used as a pigment, has been identified in conjunction with recent restorations of early Gothic facades on the cathedrals of Senlis, Angers, Bourges and Poitiers, and its presence on twelfth-century wooden sculpture from France, Italy, Spain, Germany, and Scandinavia has been confirmed as well.

Lapis lazuli is a semi-precious stone consisting of the blue mineral lazurite, with secondary silicates and inclusions of calcite and pyrite. Exported in medieval times from Badakshan in modern day Afghanistan, lapis was probably routed through the port of Venice. It became known in Europe as *azurum ultramarinum*, Latin for "blue from across the sea," and its value is described in contemporary contracts as rivaling that of gold.

Found as veins in limestone or granite formations, lapis lazuli must be extracted, crushed, and purified before it can be used as a pigment. Unrefined ground lapis is a pale gray-blue mixture of lazurite crystals and colorless particles. To obtain a more intense color, medieval tracts recommend two



Figure 7

general methods. The first consists simply of washing the ground lapis with water, or a mixture of water and substances such as honey, gum, or vinegar. The second, which produces a superior quality of ultramarine, calls for the addition of the powdered mineral to a wax-resin-oil mixture, wrapping it in cloth, and kneading the mass while keeping it submerged in dilute lye, an aqueous solution of potassium or sodium hydroxide. The

Figure 7. Enthroned Virgin and Child, French, Auvergne, said to be from St.-Victor at Montvianex (Puy-de-Dôme), late 12th century. Walnut with traces of polychromy, h. 68.6 cm. The Cloisters Collection, 1967 (67.153).



Figure 8

impurities remain in the wax mass while the blue particles of lazurite are washed out and settle at the bottom of the vessel. Although the most famous description appears in the fifteenth century, in Cennini's treatise *Il Libro dell'Arte*, first mention of this method in Europe is found in the *Liber Claritas*. Probably translated into Latin in the thirteenth century, this treatise is believed to be the work of an Arab alchemist named Jabir, or Geber, who reportedly was active in eighth-century Baghdad.

The Cloisters is fortunate to have in its collection three twelfth-century French wooden sculptures on which the use of ultramarine in the original decorative scheme has been confirmed: the *Enthroned Virgin and Child* said to be from Montvianex (Figure 7), the *Enthroned Virgin and Child* from Autun, and the *Torso of Christ from a Deposition Group* said to be from Lavaudieu (Figure 8). The research presented here focuses on the purity of the ultramarine pigment used on these three works, as well as methods of

application. To this end, analysis using energy-dispersive X-ray spectroscopy, Raman microspectroscopy, and polarized light microscopy on both dispersed pigments and cross-sections have been undertaken. The composition of binding media on two of the sculptures was considered as well. The Montvianex Virgin's paint layers were investigated with the use of Fourier transform infrared spectroscopy, high performance liquid chromatography, and gas chromatography/mass spectrometry (GCMS), while cross sections of the Lavaudieu Torso were examined only with GCMS.

Samples of natural ultramarine removed from the two Virgin figures and the Torso of Christ are all of a purity that suggests at least partial refinement of the lapis. The traces of deep blue found on the Autun Virgin's mantle contain a significant amount of large lazurite crystals that measure up to twenty-five microns, while the remainder range from five to ten microns (Figure 9). Visible in the cross-section are two generous layers of blue paint applied sequentially that together measure in excess of 150 microns. The sample, however, may not be representative since it was removed from the bottom of a fold, where paint was likely to accumulate. The blue layer lies directly on a lead white ground, and the pigment-to-medium ratio suggests a matte, opaque appearance. No media analysis was carried out on the sample because the paint layer was contaminated during a past consolidation treatment, but given the twelfth-century date of the Lavaudieu Torso the binder is most likely an egg or glue tempera.

The binder of the blue pigment present on the mantle of the Montvianex Virgin was examined instrumentally and indeed found to contain egg protein. The ratio of lazurite to gray impurities is less than that observed on the Autun Virgin, although still greater than in unrefined lapis specimens (Figure 10). In addition, the lazurite crystals are smaller, measuring ten microns or less, and the thickness of the paint layer does not exceed forty

Figure 8. Torso of Christ from a Deposition Group, French, Auvergne, said to be from the abbey at Lavaudieu (Haute Loire), late 12th century. Poplar, polychromy, and later gilding, h. 104.1 cm. The Cloisters Collection, 1925 (25.120.221).

In October 2002, Lucretia Kargère was appointed Associate Conservator in the Sherman Fairchild Center for Objects Conservation at The Cloisters, where she has worked as an objects conservator since 2000. She came to the Museum in 1994, when she was awarded the first of several fellowships for the technical study and treatment of medieval sculpture. A graduate of the Institute of Fine Arts, New York University, she received an M.A. in art history and a Certificate in Conservation after completing internships at the Institut Royal du Patrimoine Artistique in Brussels and at private conservation laboratories in Florence and Venice.

microns. To increase the intensity of the blue color, and perhaps to allow for a more parsimonious application of the valuable pigment, the paint was applied over a gray preparation layer containing lead white and charcoal black.

The original blue color on the loincloth of the Torso of Christ is now obscured by red overpaint (*Figure 11*). With the use of GCMS the medium of the blue layer was analyzed, and based on the presence of characteristic fatty and amino acids was identified as egg yolk tempera. The particle size of the lazurite is ten microns or less, while the percentage of gray impurities lies between the values observed on the two Virgin figures. The first layer of natural ultramarine paint, measuring from forty to eighty microns in thickness, was applied over a pale-blue preparation layer consisting of lead white and small, dark blue particles that measures about twenty microns in thickness. Using Raman microspectroscopy it was possible to analyze individual blue particles in this layer, and the results indicate indigo, a dyestuff derived from a variety of plants belonging to the family of *Papilionaceae*. In twelfth-century France indigo was prepared from either woad (*Isatis tinctoria*) cultivated in Picardy, Provence, and Languedoc, or from the indigo plant (*Indigofera tinctoria*), which was grown in India and Persia and exported to France.

Examination of the three twelfth-century sculptures at The Cloisters revealed differences in the purity and particle size of the natural ultramarine, as well as in the preparation layers. The presence of refined natural ultramarine calls attention to the absence of documented techniques for processing lapis lazuli in Europe prior to the late thirteenth century and underscores the need for further research into the origins of purification methods. Although European artists undeniably depended on Central Asia for precious materials such as lapis lazuli, this may not have been the case for the processes used to refine them. To answer this question, not

only the occurrence and characteristics of natural ultramarine in European contexts must be considered, but also examples of the pigment on works of art attributed to the many regions along the route from Afghanistan.

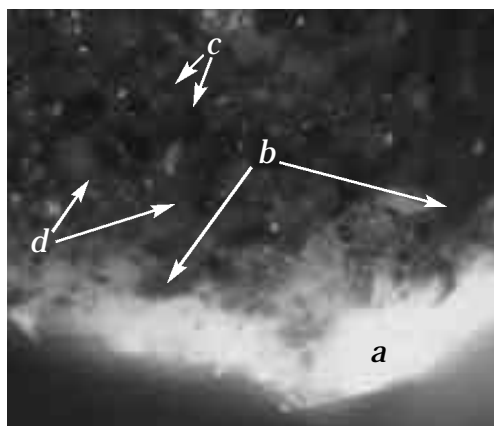


Figure 9

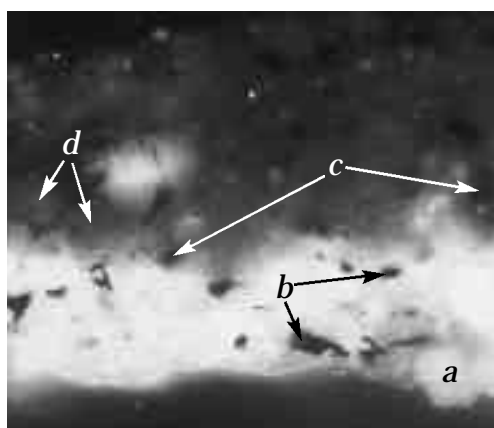


Figure 10

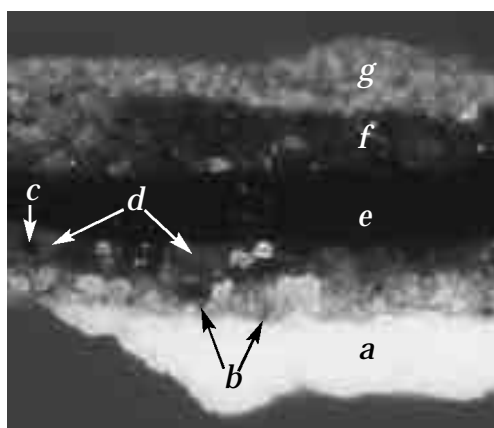


Figure 11

Instrumental analyses were carried out by Silvia Centeno, Associate Research Scientist, The Sherman Fairchild Center for Works of Paper and Photograph Conservation and The Sherman Fairchild Paintings Conservation Center, Richard Newman, Research Scientist, Museum of Fine Arts, Boston, and Richard Laursen, Professor of Chemistry, Boston University.

Figure 9. Cross-section from the mantle of the Autun Enthroned Virgin and Child (47.101.15); a) lead white ground, b) large lazurite particles (~25µ), c) small lazurite particles (5–10µ), d) gray impurities.

Figure 10. Cross-section from the mantle of the Montvianex Virgin (Figure 7); a) lead white ground, b) charcoal black particles, c) lazurite particles, d) gray impurities.

Figure 11. Cross-section from Christ's loincloth (Figure 8); a) lead white ground, b) indigo particles in lead white preparation layer, c) lazurite particle, d) gray impurities, e) black paint layer, f) second application of natural ultramarine, g) red overpaint. The black paint layer (e) corresponds to geometric patterning on the blue loincloth. At the sample site the black layer was partially covered by a second, original application of natural ultramarine.

Preserving a Herter Brothers Side Chair

During the second half of the nineteenth century the design of American furniture enjoyed a phase of extraordinary creativity. While the preceding years had witnessed a succession of historicizing European styles, interiors of the Gilded Age were highly eclectic, freely mixing stylistic elements from a much larger repertoire of cultural sources. During this time of seemingly limitless exploration and experimentation, the American aesthetic sensibility was intrinsically transformed.

Major figures in this movement were Gustave Herter, a wood carver and cabinet-maker who emigrated from Stuttgart, Germany to the United States in 1848, and his younger brother Christian, who joined him in New York City in 1859. By the 1880s, their influential firm was known for well-executed furniture and elaborate interiors. Herter Brothers also designed entire residences, specifying every single interior and exterior decorative detail, and its success can be measured by the prominence of patrons such as President Ulysses S. Grant, William H. Vanderbilt and J. Pierpont Morgan.

A Herter Brothers side chair that entered the collection of the Department of American Decorative Arts in 1995 represents one of several related models that were executed for different clients (*Figure 12*). These designs share the basic form of their frames, while each incorporates a unique combination of decorative motifs and surface treatment. The Metropolitan Museum's chair, with the manufacturer's number 426 stamped onto the bottom of the rear seat rail, combines hoof feet, flared stiles, a crescent backrest, and carved, Japanese-inspired floral motifs in the lower back rail, all executed with an elegance drawn from French furniture of the late eighteenth century. The original owner is not certain, although the Museum's side chair is identical to those made for the



Figure 12. Herter Brothers (American, 1864–1906), Side Chair, New York City, ca. 1880. Painted and gilded maple, h. 87.9 cm. Gift of Margot Johnson, Inc., 1995 (1995.149).



Figure 13

Figure 13. Herter Brothers (American, 1864–1906), Mr. J. Pierpont Morgan's Drawing-Room. J. Pierpont Morgan residence, 219 Madison Avenue, New York. From Artistic Houses (New York, 1883–84), vol. 1, pt. 1. Thomas J. Watson Library, The Metropolitan Museum of Art, New York. Detail with side chair.



Figure 14



Figure 15

Figure 14. Herter Brothers (American, 1864–1906), Side Chair, New York, ca. 1881–82, made for the drawing room of William H. Vanderbilt’s New York residence. Gilded maple, mother of pearl, upholstery not original, h. 87.6 cm. High Museum of Art, Atlanta, Virginia Carroll Crawford Collection (1982.316).

Figure 15. Herter Brothers (American, 1864–1906), Side Chair, New York, 1879–82. Gilded maple, h. 87.5 cm. Purchase, Charlotte Pickman Gertz Gift, 1994 (1994.442).

drawing room of Pierpont Morgan’s Madison Avenue residence, built between 1880 and 1882 (Figure 13). Herter Brothers produced a similar interior furnished with the same side chairs for the home of Oliver Ames in Boston (1883). In these rooms the stylized sunflower motif was incorporated into the design of the wall frieze, the wallpaper, and the delicate fabrics used for curtains and upholstery.

The finish seen on the Museum’s chair, with gold flakes against an ivory-colored background, recalls decorative surfaces found on Japanese ceramic and lacquered objects. Two display cabinets from the Morgan and Ames drawing rooms with the same finish also reflect the influence of Japanese design. Illustrative of the eclectic taste of the time, these cabinets combine late-eighteenth-century English tapered square legs and Rococo-inspired floral swags with a Japanese shelving arrangement.

Another side chair from this group of related designs, stamped 170 by Herter Brothers, was produced between 1879 and 1882 for the drawing room of William H. Vanderbilt’s New York mansion (Figure 14). Decorated with carved beads, ribbons, and a pair of undulating snakes on the lower backrest, the surface of the chair is gilded and inlaid with mother-of-pearl. Two less elaborate side chairs were made for the homes of Mrs. R. L. Stuart and Jacob Ruppert. Both have turned front

legs with conical feet, and while the crest rail on the Stuart chair is inlaid with a floral pattern in black and white marquetry, the other is entirely gilded and displays a carved floral bas-relief (Figure 15).

The condition of the Metropolitan Museum’s “gold-flake” side chair is quite delicate, in part because poor adhesion of the white ground to the maple substrate—presumably induced by exposure to high relative humidity—led to a very unstable finish. Some fifty percent of the surface has been lost through the gradual delamination of small fragments (Figure 16). Likewise, the chair’s surviving upholstery is extremely fragile. Still, it is exceedingly rare to find a late-nineteenth-century chair retaining much unmodified original finish and upholstery, even if both are in poor condition.

To prepare this chair for display in one of the Museum’s galleries would require an inappropriately invasive restoration campaign of prohibitive length. Therefore, in consultation with the Department of American Decorative Arts, it was decided not to “complete” the chair, but to preserve what is extant. A thorough investigation of the finish was carried out in order to characterize materials and application techniques, and to help choose a safe treatment that would prevent further loss.

Microscopic examination of cross-sections of the finish under visible and ultraviolet

Since 1994, Pascale Patris, Assistant Conservator, has worked at the Fairchild Center, where her main responsibility is the research and treatment of gilded surfaces on furniture and wooden objects, primarily from the Departments of European Sculpture and Decorative Arts and American Decorative Arts. Her training and private practice in Paris, from 1980 to 1988, focused on the conservation of European decorative arts and sculpture. She has participated in diverse conservation projects in France, including the restoration of early Baroque frescoes in Brittany and preliminary studies for the restoration of a Baroque monumental altar in Grenoble and Renaissance busts in the Louvre.

light revealed that the wood substrate was first covered with several thin, white paint layers. The small flakes of gold leaf on top of this base are covered with by a layer of clear varnish (*Figure 17*). An attempt to characterize the varnish using Fourier transform infrared spectroscopy proved unsuccessful, but when observed under ultraviolet light it displayed a distinct blue fluorescence, suggesting the presence of a natural plant resin. Gilded surfaces on other Herter Brothers furniture emit a similar UV-fluorescence when viewed in cross-section, and in these instances analysis of the varnish layers resulted in the identification of copal as the main component. In the nineteenth century this natural resin was a common addition to furniture finishes, serving to increase their durability as well as introducing a warm tone. Linseed oil, identified as an ingredient in the finish of the Metropolitan Museum's chair on the basis of the fatty acids present, was similarly common in nineteenth-century varnish recipes, as it increases elasticity. Elemental analysis of the paint layers with energy-dispersive X-ray spectroscopy demonstrated the presence of lead white and barium sulfate, which appear frequently as ingredients in nineteenth-century recipes for white oil paints. The gold flakes in the finish also were analyzed, and the alloy found to contain approximately thirty percent silver.

Instrumental analysis combined with solvent testing helped to establish that stabilization of the surface could be carried out safely with a solution of five percent Acryloid® B67 in equal parts xylene and Stoddard solvent.

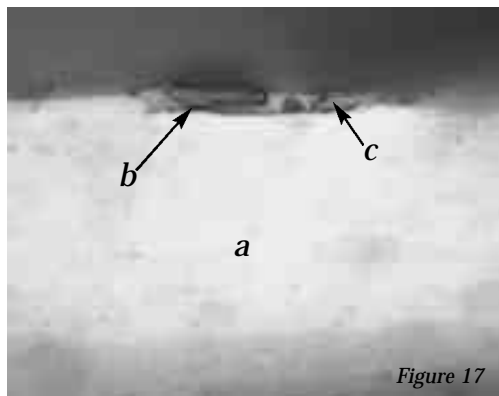


Figure 17



Figure 16

Figure 16. Detail of side chair (Figure 12) with carved rosette, showing loss of finish on the proper left stile.

Figure 17. Cross-section of side chair (Figure 12), viewed under UV-light; a) ivory colored ground, b) gold leaf, c) clear varnish.

Following introduction of the consolidant, each unstable paint fragment was eased down individually, and slight pressure was applied to treated areas using small weights isolated from the surface with Mylar® film. It was necessary to relax severely cupped fragments before they could be consolidated, which was achieved by wetting them with the same solvent mixture.

The visual imbalance between the original finish, which over the years has acquired an almost green hue, and the aged maple, was reason to inpaint the wood in places where it was exposed. A solution of rabbit skin glue in distilled water was applied to seal the maple, after which a visually more uniform surface was created using pigments mixed in an acrylic medium. Only where the substrate had turned very dark was it necessary to increase the opacity of the acrylic paint by adding fumed silica.

After encapsulation of the upholstery with a cover of Stabiltex™, a plain-woven multifilament polyester fabric, the chair was installed for long-term display in the Henry R. Luce Center for the Study of American Art, where it can be viewed by the public. Equally important, and befitting the American Wing's tradition of strong interest in the material aspects of its collection, this chair provides a valuable opportunity for furniture scholars to further research the materials and techniques originally applied in the highly evolved furniture trade in New York at the end of the nineteenth century.

Nancy Britton, Associate Conservator, treated the upholstery of the side chair. Gas-chromatography analysis of the varnish was carried out by Richard Laursen, Professor of Chemistry, Boston University.

The Characterization of Artificial Bronze Patinas

The composition and structure of corrosion products are important criteria in evaluating the authenticity of historical bronzes, and for this reason naturally-occurring copper corrosion products have frequently been the subject of scientific investigation. On the other hand, less attention has been paid to artificially induced corrosion, despite a well-documented, legitimate tradition for the patination of bronze statuary, and increasingly sophisticated efforts by forgers of antiquities to produce credible “archaeological” surfaces. The most reliable scientific method for detecting forged archaeological bronzes is the examination of their microstructure, but the procedure usually requires sampling, which in some cases is not feasible. The goals of a project currently underway at the Fairchild Center are to identify methods that effectively falsify archaeological corrosion, and to establish a methodology for characterizing the resultant patinas using the least invasive analytical techniques possible.

Simply stated, metal corrosion is a process of chemical dissolution. Cations migrate from the metal substrate and react with available anions to form the metal salts that constitute tarnish layers and corrosion crusts. The character and chemical makeup of the corrosion products depend on the nature of the substrate and the environment to which it is exposed. Bronzes and other copper alloys in indoor settings develop copper oxides on their surfaces. In open-air environments this initial growth of cuprite (Cu_2O) over tenorite (CuO) is usually obscured by green or blue secondary corrosion products, for the most part carbonates, sulfates, and chlorides. Over time, or if the outdoor environment becomes more aggressive, the layers increase in thickness and porosity, but as a rule the cuprite does not penetrate the substrate metal.

Corrosive attack proceeds differently if a bronze is buried. Soils contain mixtures of dissolved salts that function as weak or strong electrolytes, depending on their composition. Facilitated by these electrolytes, the oxygen present in aerated burial environments migrates very slowly through the superficial

oxide layer into the metal, affecting first the areas most susceptible to deterioration, which are usually the grain boundaries. At the same time, metal cations move through the cuprite layer to produce secondary corrosion products on the surface. A layered structure develops, comprised of a porous, uneven deposit of secondary corrosion products overlying a coherent cuprite layer that penetrates the metal substrate along its grain boundaries. The intergranular corrosion formed by this process is typical of archaeological copper alloys (Figure 18).

The most common means of patinating bronze surfaces is the application of a reactive solution, but no known formulations have proven effective for producing convincing archaeological corrosion because they do not generate a significant cuprite layer (Figure 19). Recipes designed to produce green and blue corrosion products generally are solutions of copper salts, and in such cases the patina results from the deposition of these salts on the metal surface and their subsequent conversion to more stable, hydrated sulfate, nitrate, or chloride species. Cations from the substrate metal are minimally involved in these reactions, usually only for initial oxidation. Experimental work designed to produce convincing corrosion layers using repeated applications of such solutions followed by the reduction of the precipitated copper salts to cuprite is now in progress.

Another possibility for reproducing archaeological patinas involves treatment with solutions that do not contain copper ions and replicate conditions encountered in natural burial environments. To this end, bronze samples are exposed for extended periods to aerated environments containing different salts in various concentrations, and thus far these attempts have produced visually convincing blue and green corrosion crusts. The next phase of this project will concentrate on the characterization of these corrosion layers, and the comparison of their structure and composition with those observed on authentic archaeological bronzes.

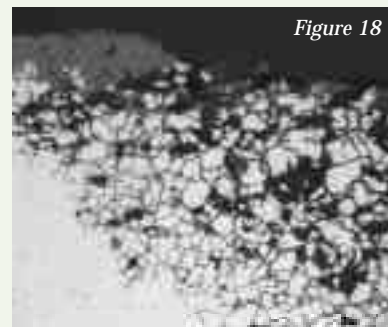


Figure 18. Polished section of a Scythian bronze buckle from southern Siberia, with cuprite precipitated along the grain boundaries, as typically seen on archaeological copper alloys.

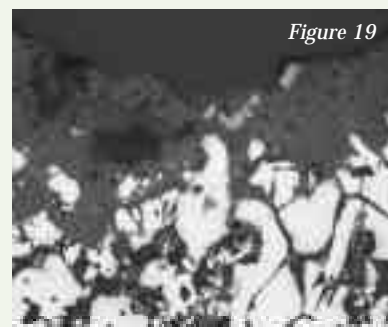


Figure 19. Polished section of an “Egyptian” bronze known to be a modern forgery. At first glance, the microstructure appears to have intergranular corrosion, but redeposited copper, rather than cuprite, is present along the grain boundaries.

Svetlana Burshneva is the L. W. Frohlich Fellow at the Sherman Fairchild Center. She received a diploma in archaeology from St. Petersburg University and in metal conservation at West Dean College. Since 1990, she has worked in the State Hermitage Museum as an archaeological metal conservator and she received her superior qualification in restoration in 1998. She has participated in excavations in Siberia, Central Asia, and Russia as archaeologist and field conservator, and has taught intensive metal conservation courses for conservators in provincial museums. Her research interest is the relationship between burial environments and the composition and structure of corrosion products on archaeological bronzes.

The Sherman Fairchild Center for Objects Conservation provides for the preservation and technological study of ten curatorial collections in the Metropolitan Museum. The activities of the Center encompass the conservation of archaeological objects, sculpture, furniture, ceramics, and glass, as well as investigative research related to mechanisms of deterioration, preservation treatments, and historical technology. More than thirty professional conservators, scientists, and installers conduct their work in modern facilities located in the Henry R. Kravis Wing. These laboratories are equipped for a variety of analytical and investigative methods, including electron microscopy, X-ray spectrometry, X-ray diffraction, Fourier transform infrared spectroscopy, ultraviolet-fluorescence microscopy, metallography, and radiography. Areas of research that are of special long-term interest to the Center's staff include the development and testing of methods for the treatment of deteriorated stone sculpture, the development of safe and effective methods for the monitoring and control of biodeterioration, and the evolution of metalworking technologies throughout the world.

Staff members also serve as adjunct faculty at the nearby Conservation Center of New York University, and the Fairchild Center is the site of seminars and internships for students from this and other graduate programs. Postgraduate fellowships are awarded annually to conservators and other researchers from institutions in the United States and abroad.

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New Conservator in Charge at the Sherman Fairchild Center for Objects Conservation

Tony Frantz, Conservator in Charge, is leaving the Sherman Fairchild Center for Objects Conservation in August 2003 to become Research Scientist in the Museum's newly established science group. He received his undergraduate education at Harvard University (B.A., 1963) and his graduate education in conservation at New York University (M.A., 1974; Certificate in Conservation, 1975). Tony came to the Museum's Objects Conservation Department in 1976 with the monumental task of establishing a modern and professional facility for the treatment and scientific study of three-dimensional works of art. Under his leadership the Department steadily expanded, and with generous funding from the Sherman Fairchild Foundation, Tony supervised the design and construction of the Center's current home, which was completed in August 1992. He has taught physical metallurgy and instrumental analysis at the Conservation Center of New York University's Institute of Fine Arts since 1980, educating a generation of conservation students and providing post-graduate training, and has offered opportunities for professional advancement to an international roster of conservators and conservation scientists. Tony is currently a doctoral candidate in geochemistry at Columbia University.

Lawrence Becker has been appointed to the new position of Sherman Fairchild Conservator in Charge. A graduate of the Conservation Center of New York University's Institute of Fine Arts, Larry started his career at the Metropolitan Museum in 1980. He left in 1989 to become Conservator of Objects at the Virginia Museum of Fine Arts. As Chief Conservator at the Worcester Art Museum, a position he has held for the last eight years, he reestablished the Conservation Laboratory founded by George Stout, a pioneer in the field of conservation treatment and technical research. Another major achievement during these years was the technical study, conservation, and reinstallation of the Antioch Mosaics. As an adjunct professor at the Institute of Fine Arts, he was instrumental in establishing advanced examination and treatment courses for archaeological and ethnographic objects.

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Editors: Marijn Manuels & Deborah Schorsch

met.objectives@metmuseum.org

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