PART FOUR

Investigations and Treatment

Monochromy, Polychromy, and Authenticity

The Cloisters' *Standing Bishop* Attributed to Tilman Riemenschneider

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Figure 1
Standing Bishop, attributed to Tilman Riemenschneider (ca. 1460–1531). H:117 cm; W:34.3 cm; D:22.8 cm. The Metropolitan Museum of Art, The Cloisters Collection, 1975 (1975.25).

In 1975, the polychrome wood sculpture *Standing Bishop* was acquired for The Cloisters collection, the Metropolitan Museum of Art, New York. This piece—considered at purchase to be a mature work of Tilman Riemenschneider (ca. 1460–1531), a leading German master of Late Gothic sculpture—was intended to complement early works by the artist already in the collection. The sculpture (Fig. 1) is indisputably in the style of Riemenschneider; furthermore, its provenance (established to before 1907) includes the renowned Munich collection of Julius Böhler.[1] The *Standing Bishop* was accepted as an autograph work by the great Riemenschneider scholar Justus Bier (1956), who was reversing his earlier opinion. It has been compared stylistically to a number of works by Riemenschneider from about 1505–10.

In the 1970s, a research project was begun by art historians and conservators in Germany to establish the chronology and authorship of a group of sculptures thought to be early works of Riemenschneider. The Cloisters' sculptures, including the *Standing Bishop,* were examined as part of the project, and cross sections were sent to Munich for analysis by Hermann Kühn. This research project resulted in an exhibition of the early work of Riemenschneider in Würzburg in 1981; The Cloisters sent two sculptures from its collection, but the loan of the *Standing Bishop* was not requested. Certain stylistic anomalies of the figure, as well as several technical peculiarities discussed below, contributed to the increasing suspicion that it was not of the period. Another cause for concern was that in the nineteenth century the *Standing Bishop* was owned by a Mr. Kahle, a collector and sculptor.[2] By the late 1980s, the sculpture was removed from exhibition at The Cloisters for further study.

Riemenschneider and Monochromy

Tilman Riemenschneider was active in Würzburg as a master sculptor of stone and linden wood from 1485 until the mid-1520s. It is evident from the eclectic style of his early work that he received training in Ulm and had contact with Netherlandish and Upper Rhenish works. He had a large workshop in Würzburg, employing twelve apprentices at the height of his production (Baxandall 1980:259). Riemenschneider is a particularly well-documented sculptor, with a number of commissioned works firmly attributed to him. An early example of a documented shrine is the former high altarpiece for the Saint Maria Magdalena parish church in

Münnerstadt, commissioned in June 1490 and completed by September 1492. This retable is particularly important because it is the earliest example of an altar that was decorated in a monochromatic, as opposed to polychromatic, technique (Staatliche Museen Berlin 1981:117). The recognition of the practice of creating umpolychromed works appears in the art historical literature as early as 1912 (Lossnitzer 1912:139ff.), although the observation of a distinct coating on the wood surface is not published until more than fifty years later, as first reported by Oellermann (1966). The subject has also been taken up, to varying degree, by Wilm (1923:114–18), Lill (1940), Willemsen (1962), Paatz (1963:79–82, 86–93), Taubert (1967), Baxandall (1980:42–48), Melzl and Buchenrieder (1980), Oellermann (1981), Westhoff and Haussmann (1987), Rosenfeld (1990), and Westhoff (1993), among others.

Many of Riemenschneider's early works in wood were decorated in the traditional medieval manner, with lifelike flesh tones, burnished gold robes with matte blue linings, silvered armor, elaborate textile imitations, and other painterly attempts at verisimilitude. Riemenschneider worked with *Fassmaler* (painters), who executed the *Fassung* (painted and gilded decoration) of wood sculptures carved by Riemenschneider and his workshop. With the Münnerstadt altarpiece, however, a radical departure from tradition is encountered: the surface of the pale linden wood is covered not with layers of preparation, metal leaf, and paint but with a thinly applied, transparent, brown-to-black pigmented glaze. Riemenschneider, while continuing to produce polychrome sculpture, created altarpieces using this technique well into the sixteenth century, as did other sculptors working in Germany, including Veit Stoss, Hans Leinberger, Niklaus Weckmann, and Henrik Douvermann. These sculptures, somewhat inaccurately termed *monochromes,*[3] are sometimes further embellished with red for the lips and for wounds, and with black for the eyes; there are also examples where the flesh tones and attributes are painted, leaving the balance of the figure brown (Westhoff and Haussmann 1987; Rosenfeld 1990). Since the sculptor could not rely on painting to convey the rich variation of texture and gloss that was appreciated on medieval sculpture, he often elaborated the surface with a range of knives and punches to create a similar effect. Monochromatic relief sculpture can display a particularly impressive range of surface embellishment in this fashion.

For a number of reasons, the identification of a sculpture as a monochrome is especially complex. The pigmented glaze layer itself, as much a penetrating colorant as a distinct coating, can be difficult to recognize during examination and is usually preserved only in traces. The medieval sculptor's practice of painting the eyes directly on the wood during manufacture (perhaps to set the gaze of the figure or to help position the form during carving) can be mistaken for the finished eyes of a monochrome work. In addition, a transparent surface coating applied directly to the wood may serve as a final, intentional decorative layer, or as a wood sealant for subsequent ground and paint layers. After their creation, monochromes were occasionally brightly overpainted, obscuring the original appearance of the sculpture. The most famous example of such an alteration is the Münnerstadt altarpiece, which was finished and delivered as a monochrome, then redecorated twelve years later with a traditional polychromy by Veit Stoss (Staatliche Museen Berlin 1981:117). This redecoration was later removed from the sculptures, taking with it much of the

monochromy. Sculptures that are sometimes confused with monochromes may actually be polychrome figures that had been stripped with lye, a practice common to the nineteenth century. During an investigation, therefore, it is important to bear in mind that a suspected monochrome may actually be an unfinished sculpture (Rosenfeld 1990), or a work that has lost its original polychromy.

Techniques of Manufacture: The *Standing Bishop* Support

Figure 2
Standing Bishop, back view.

Samples of the wood from the support of the *Standing Bishop* were removed for microscopic identification and radiocarbon dating analysis. The wood was identified as a species of the genus *Tilia,* exhibiting the physical characteristics of limewood, or linden (Quirk 1989). Radiocarbon dating analysis, using accelerator mass spectrometry, gave an adjusted calendar age range for the wood of 1280–1440 C.E., indicating that the tree was felled in the medieval period (Tamers 1989).

Examination of the techniques used to sculpt the figure yielded several interesting observations. Macroscopic and radiographic examination of the *Standing Bishop* revealed that the figure was carved from a single piece of relatively knot-free wood, except the hands and attributes, which were attached separately. The back of the *Standing Bishop* was not hollowed out, as is customary with late medieval wooden figural sculpture, but was flattened with an adze; several practice cuts with a chisel are to be found on the back as well (Fig. 2). Although (to the best of the authors' knowledge) no other Riemenschneider sculptures of this size carved three-quarters in the round were treated in this manner, there are other Late Gothic sculptures of a similar scale with flattened backs (Tångeberg 1989:161). Marks from the sculptor's bench, which held the log in a horizontal position while it was carved, are preserved on the sculpture. A hole (diameter approx. 2.2 cm; depth approx. 3.7 cm), now filled with wood and painted, remains in the top of the miter, where a dowel or pin had held the log fast at one end. Beneath a modern pine base, added to the bottom, are found rectangular impressions from the knives that had secured the log at the other end (Fig. 3). Since they are so close together, it is likely that the impressions in the bottom resulted from separate skewerings in the bench. Although sculptors' benches are thought to have been used in Germany until the early twentieth century, these marks are almost identical to those found on indisputably medieval works of art (von Ullman 1984).

Restorations to the figure include sections of the hands and crosier staff, the sudary (handkerchief held by a bishop), and the plinth. It was also detected that carved decoration is obscured by the thick ground layer; this is noticeable especially at the edge of the cope, where an undulating craquelure has developed that follows the punch work beneath. In addition, the backs of the gloves have been incised with a pattern of overlapping circles (executed with a compass?) surrounded by shallow half-moons. Detailed carving that is covered by subsequent paint layers does not alone provide proof of the sculpture's original monochromy, since *Fassmaler* sometimes obscured or corrected details of carving when they decorated sculptures. Rather, it may be taken in this case as corroborative evidence of a change of appearance for the *Standing Bishop.*

Polychromy

Figure 3
Detail of marks that are a result of securing the sculpture in the sculptor's bench, found beneath the modern base.

At first glance, much of the polychromy appears to be medieval. There are traces of several different restoration campaigns on the surface. A fair amount of overpaint is evident on the figure—especially in the hair, gloves, collar, back of the sculpture, and plinth—and probably dates to when the attributes, fingers, and plinth were renewed. The balance of the polychromy—the flesh tones and garments—appears to belong to the same period. The burnished water gilding on the cope exhibits some regilding and a craquelure usually associated with a certain amount of aging; extensive retouching and a developed craquelure pattern are seen in the flesh tones and the cope lining. Many of the surfaces bear fine parallel scratches left from a mechanical removal of overpaint layers. The miter and chasuble were cleaned of their overpaints in this fashion (there are traces of two overpaints on the chasuble) but in such a way as to remove most of the red- and green-glazed silver leaf, revealing the red preparatory bole layer. It appears likely from the exceedingly smooth surface and from faint depressions visible in raking light that this bole layer was later polished, probably with an agate, to give it the appearance of a deliberate decorative layer (Hückel 1978). The flesh tones consist of lead white, with the addition of vermilion and charcoal black, and the alb is decorated with a thin layer of lead white. All pigments were identified with polarized light microscopy (PLM) and confirmed, as necessary, with energy-dispersive X-ray spectrometry.

A closer look at the polychromy, however, reveals several aspects that are inconsistent with an early-sixteenth-century date. The decorative scheme of gold banding on a glazed silver garment is unusual for the period. In addition, the small size and thinness of the gold leaves are more typical of, although not restricted to, a nineteenth-century gilding. A preparatory ground of calcium carbonate in animal glue, executed in at least two layers, extends over the entire sculpture, with the exception of the face and hair. In these areas, the color appears to have been applied directly on the wood. The fringe of the cope is coarsely painted in an alternating pattern of white, red, and blue, the latter two decorated with gold highlights. The red areas are constructed not in the typical multilayer fashion, but in a single layer consisting of a mixture of red lead, red earth pigments, and charcoal. The blue lining of the cope and the fringe (both heavily retouched with artificial ultramarine) was executed in two layers, as was common in medieval practice. The choice of materials, however, indicates a more recent date for the blue: it consists of a coarsely ground layer of azurite, with the addition of dolomite, lead white, and a small amount of barium sulfate (identified by energy-dispersive X-ray spectrometry), supported on a finely ground layer of the same mixture of pigments. Barium sulfate was first proposed as an artists' pigment about 1782 and did not reach widespread commercial application (often as an extender for lead white) until the early nineteenth century (Feller 1986). Its presence on the figure provides a *terminus post quem* for the blue areas, and, since the blue appears contemporary with the balance of the decoration, in all likelihood for the entire polychromy.

Further study of the *Standing Bishop* was carried out in an effort to reconcile the difference between the apparent age of the wood and that of the paint and gilding layers. No trace of earlier polychrome layers was

found below the ground. Excavations made through the flesh tones of the face, however, revealed an additional, intermittent dark layer between the paint and the wood that consists of small black particles (identified by PLM as charcoal) in a brown colored, brittle, water-soluble binder. This layer is found under the ground and directly on the wood in all areas of the sculpture, except the modern replacements. There appears to be a conscious modulation of this layer, with pigment applied more thickly to the fringe and more thinly to flat areas of the sculpture. The eyes, which were partially cleaned of their paint before the figure entered the conservation studio, have the pupils and edges of the irises rendered in black directly on the wood. An excavation in the area of the mouth revealed, under the paint layers, a red glaze that was applied to the wood. Excavations through the paint and ground layers to the wood found wood-boring beetle holes that were filled with ground; the pigmented glaze, however, stopped at the edge of the holes, indicating that the glaze predates not only the infestation but also the polychromy. It appeared from these investigations that the *Standing Bishop* was originally a monochrome.

Cross sections of the paint layers, together with the wood, were taken from several areas for further characterization of the pigmented glaze. No trace of a dirt or dust layer was found beneath the glaze, indicating that it was applied shortly after the figure was carved. A cross section from the area of the mouth (Fig. 4) shows quite clearly the red pigment (a red lake, probably madder lake) and its binder penetrating the pores of the wood support. On top of this layer are occasional particles of charcoal that are separated from the subsequent overpaint by a very thin, brightly fluorescing layer. This intermittent coat of black pigment corresponds to the layer found directly on the wood over the balance of the figure.

Initial inquiries into the binding medium of the pigmented glaze were made. Media analysis is particularly difficult in this case due to the microscopic remains of the layer, interference from the wood, and contamination from the overlaying ground layers and consolidation treatments. Infrared or amino-acid analysis, therefore, was not attempted. For the present study, the placement of the binding medium into one (or more) of three broad categories of material was made using ultraviolet microscopy in conjunction with fluorescent stains. The stains were applied to the cross sections with felt-tip markers that had been loaded with a

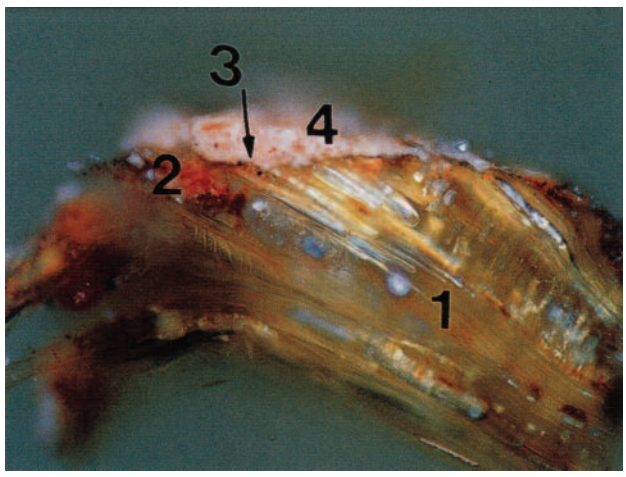

Figure 4
Microphotograph of a cross section from the bottom lip of the *Standing Bishop:* (1) the wood substrate, (2) the red lake glaze, (3) the glaze pigmented with charcoal, and (4) the pink overpaint. Normal light, ×40.

specific fluorochrome,[4] and the sections were examined under high magnification in ultraviolet light. Staining of cross sections with triphenyltetrazolium chloride (TTC) (4% in methanol) for carbohydrates gave a positive reaction in the region of the pigmented glaze (Fig. 5). The application of fluorescein isothiocyanate (FITC) (0.25% in acetone) for proteins produced a positive reaction above the glaze, as well as in discrete portions of the layer that correspond to cracks in the glaze. The fluorochrome Rhodamine B (0.25% in ethanol) for drying oils gave negative results in the glaze but reacted quite positively for some of the later polychromy. The absorption of TTC in the pigmented glaze, indicating the presence of carbohydrates, points perhaps to the use of polysaccharide gums, applied alone or in conjunction with a plasticizer such as honey. The use of fruit-tree gums for painting on wood is mentioned by Theophilus in the twelfth-century treatise *Schedula diversarum artium* as a rapidly drying alternative to oil colors (Hawthorne and Smith 1963:32–33); these gums were especially used in tempera systems on account of their emulsion-building properties, and can be combined with linseed oil, balsams, egg, or casein. Gums increase the adhesion of paint films to hygroscopic substrates and impart an enamel-like gloss to the paint surface (Schramm and Hering 1988:124–26). With the knowledge that the glaze layer on the *Standing Bishop* appears to contain carbohydrates, a possible avenue for further characterization might be simple-sugar ratio analysis.[5]

Comparative Material

Several autograph works by Riemenschneider have been examined in the course of conservation treatments for traces of their original surface decoration. The results have been published and will only be summarized here as they compare with the findings for The Cloisters' *Standing Bishop.*

Individual sculptures belonging to the Münnerstadt altarpiece were investigated in 1977–78 and traces of a pigmented surface coating were found on many of them (Fig. 5). This layer is described as consisting of a protein (animal glue) and a tiny amount of oil-binding black particles (charcoal), red or yellow oxides, and occasionally lead white. The eyes (irises, pupils, folds of the eyes, and eyebrows) are rendered in black, and the mouths in red, directly on the wood; pigmented glaze is found over these areas. The pigmented material has penetrated deeply into the pores

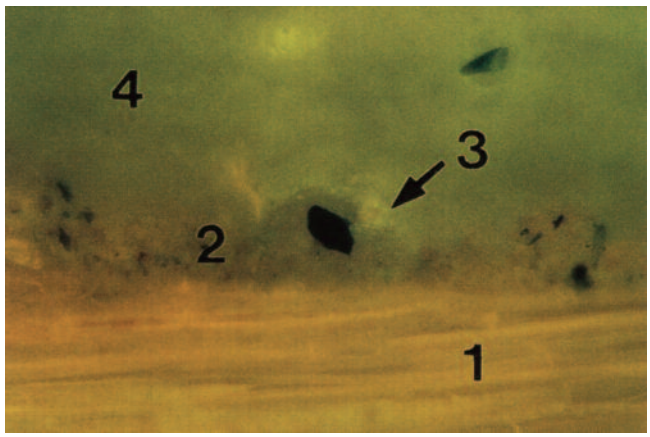

Figure 5
Microphotograph of a cross section from a fold in the chasuble, stained with triphenyltetrazolium chloride (TTC) and fluorescein isothiocyanate (FITC): (1) the wood substrate; (2) the glaze pigmented with charcoal, exhibiting a positive reaction for carbohydrates; (3) a separation layer between the glaze and the later ground, exhibiting a positive reaction for proteins; and (4) the ground layer. UV light, blue-violet filter, ×1,132.

of the wood and exhibits few characteristics of a discrete layer (Staatliche Museen Berlin 1981:318).

The *Altar of the Holy Blood,* commissioned by the city of Rothenburg for the church of Saint Jakob in 1501 and delivered in installments until 1505, underwent a technical examination in the early 1960s. Both the linden wood figures and the shrine and foliate ornaments carved from spruce were coated with a pigmented glaze composed of egg white and oils (egg tempera?) with the addition of ochre, charcoal, gypsum, and lead white (perhaps as a dryer). This glaze was found directly on the wood, and also under the painted eyes and lips, as on The Cloisters' *Standing Bishop* and the Münnerstadt altarpiece. As with these works, no trace of a dirt or dust layer was found beneath the pigmented glaze, and later restorations bear no sign of the coating, indicating that it must have been applied shortly after the sculpting of the figures (Oellermann 1966).

Similar coatings have been identified on other works by Riemenschneider, including the Crucifix from Saint Nickolaus in Eisingen (Melzl and Buchenrieder 1980), the altarpieces of the *Coronation of the Virgin* in Saint Jakob, Rothenburg ob der Tauber (Melzl and Buchenrieder 1980), and the *Crucifixion* in Dettwang (Oellermann 1966).

An interesting comparison can be drawn between The Cloisters' *Standing Bishop* and the figure of Saint Mary Magdalen from a crucifixion scene made in 1509–16 for the Zweifalten cloister and recently attributed to Niklaus Weckmann the Elder. Under a later polychromy from 1624, a layer of animal glue was found that is *not* pigmented; small losses at the drapery borders, however, reveal a transparent glaze containing pigment particles (Westhoff and Haussmann 1987). This seems to be an attempt to contrast the cooler toned borders with the balance of the draperies and calls to mind the *Standing Bishop,* which appears to have a deliberately strengthened application of its pigmented glaze in the fringe.

Conclusion

The presence of a transparent, pigmented glaze applied over painted eyes and lips—which appears, both in terms of material content and application method, to be similar to other coatings found directly on the wood of late-fifteenth- and early-sixteenth-century sculpture—is a strong indication of the original monochrome appearance of the *Standing Bishop.* Both material analysis and tool mark traces suggest the wooden support was felled and carved in the Middle Ages. On the basis of cross-section analysis, the glaze appears to date to the period of the carving, and not to the nineteenth-century polychromy visible today. While the results of this investigation cannot offer proof of authenticity, the presence of a decorative layer not described in the literature until well after the sculpture was known supports a medieval date for the creation of the *Standing Bishop.*

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Notes

1 The Cloisters, the Metropolitan Museum of Art, department file no. 1975.25, catalog card 3.

2 See note 1.

3 This term is currently undergoing discussion in Germany; for purposes of convenience, the English word *monochrome* shall here designate nonpolychromed sculpture.

4 The authors are indebted to Richard Wolbers, associate professor of Paintings Conservation, Winterthur/University of Delaware Program in Art Conservation, for supplying the markers.

5 The authors are grateful to Richard Newman, research scientist, Department of Objects Conservation and Scientific Research, Museum of Fine Arts, Boston, for this suggestion.

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Conservation of the Fourteenth-Century Ceiling at Saint Helen's Church, Abingdon

Anna C. Hulbert

The town of abingdon is on the river Thames near Oxford. It has been a prosperous town since the early Middle Ages; its abbey, of which little survives, was founded in the late seventh century. Saint Helen's parish church may be the one mentioned in late-tenth-century records, but the present five-aisled building dates mainly from the thirteenth to sixteenth centuries. The Lady Chapel was founded in the mid–thirteenth century by William le Reeve, whose name was later recorded on its ceiling. The chapel is situated at the east end of the inner north aisle of the church, adjacent to the chancel. Its ceiling originally had thirteen pairs of figures on each side (i.e., a total of fifty-two), sloping up to a flat soffit 1.32 m (4 ft. 4 in.) wide. Around the cornice, at purlin level, a hymn to the Virgin Mary is painted in black letter script, with an inscription recording the chapel's benefactors, notably William Cholsey (d. 1373), who paid for the roof. Also present on the inscription is an indulgence granted by Pope Boniface IX in 1391; this suggests that the ceiling may date from the last decade of the fourteenth century.[1] Borenius (1936), Preston (1936), and Liversidge (1965) discuss the history at greater length; it is sufficient here to add that close examination while the ceiling was dismantled refutes Tristram's suggestion (1955:64) that the inscription was added later. The costumes of many of the kings of the House of David, with their broadly splayed cuffs and pointed shoes, are in accord with a date in the 1390s. (English panel paintings of the fourteenth century are fairly rare. This author has recently cleaned the rood screen at All Saints' Church, Clifton, Bedfordshire, where two female saints have similar splayed cuffs.)

The figures depicted are the ancestors of Christ listed in Matthew 1:6–16 (Table 1). On the south side, the sequence began with a giant recumbent figure of Jesse, and continued with the kings of Judah up to the Babylonian captivity. Each king is paired with an Old Testament prophet bearing an inscribed scroll; most of these Latin texts and juxtapositions of figures have subtle theological significance. (Several of these texts continue in use as Advent antiphons in our own time.) On the north side, the series continues with the great spiritual ancestor Moses (unlike the kings, the prophets are not in chronological order) and leads to Saint Joseph, from the New Testament, and the Annunciation group (Fig. 1). The archangel Gabriel is the only figure wearing a gold-embroidered

Table 1 Figure panels on the ceiling of Saint Helen's Church, Abingdon

Pairs on south side	Pairs on north side
1. Jesse* and David**	1. Moses and Josiah
2. Nathan (with Jesse's legs) and Solomon**	2. Jeremiah and Jeconiah
3. Ahijah and Roboam**	3. Zephania and Salathiel
4. Prophet** and Abijah**	4. Obadiah and Zorobabel
5. Prophet** and Asa	5. Haggai and Eliakim**
6. Baruch and Josaphat	6. Habakkuk and Zadok
7. Amos(?)** and Jehoram	7. Jonah and Eleazar
8. Elijah and Uzziah	8. Zechariah and Mathan
9. Patriarch Jacob and Joatham	9. Malachi and unidentified king
10. Hosea** and Achaz	10. Joel and unidentified king
11. Nahum and Hezekiah	11. Isaiah and King Jacob (?)
12. Micah** and Manasses**	12. Saint Joseph and archangel Gabriel
13. Prophet** and Amon**	13. Lily Crucifix and the Virgin Mary

* fragment

**missing

Figure 1
Saint Joseph, the archangel Gabriel, the Lily Crucifix, and the Virgin Mary; panels from the east end of the north side of the Lady Chapel ceiling, conservation nearly complete.

garment. Unfortunately, the figure of Mary is badly damaged after six hundred years adjacent to a damp exterior wall at the east end of the chapel. Between them, Christ is shown crucified on the lily, which is his mother's emblem; this seems to have been a peculiarly English devotional subject.[2] Here, the combination of the Lily Crucifix with the Jesse Tree gives a special meaning to the prophecy in Isaiah 11:1: "Et egredietur virga de radice Iesse, et flos de radice eius ascendit." Only in Latin is the "rod that shall come forth from the stem of Jesse" clearly referred to as a flower. This is extensively discussed by Watson (1934).

One of the most interesting features of this Jesse Tree is the careful characterization of the individual kings. In every case in which the Bible gives information about a monarch's life, the artist has taken pains to portray his personality and has succeeded with remarkable vividness. It should be remembered that the Bible had recently been translated into English by the reformer John Wyclif (d. 1384) and his circle, and it had not yet come to be regarded as seriously heretical to study it in English. This master painter might, therefore, have had an unprecedented opportunity to read it himself. Below the figures, their names were painted on a series of horizontal boards at wall-plate level. Three godly kings—Asa, Josaphat, and Hezekiah—have square-cut gemstones in their crowns; the rest have varieties of cabochon. Such cutting was a relatively new technique (Campbell 1991:136).

Technique

The ceiling is constructed of straight-grained, quartersawn oak of prime quality, imported from the Baltic area.[3] The ceiling may, in fact, have been built very slightly later than the aforementioned papal indulgence. The construction is somewhat unusual in that the tracery is built up from sev-

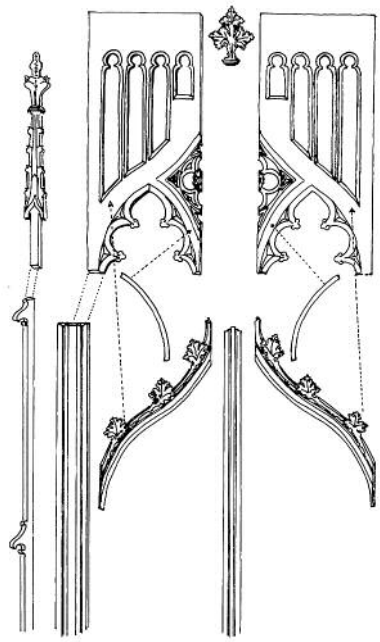

Figure 2
Diagram of the tracery overlay of panels shown in Figure 1, through which the green background may be seen at the top of each panel (compare with Fig. 7).

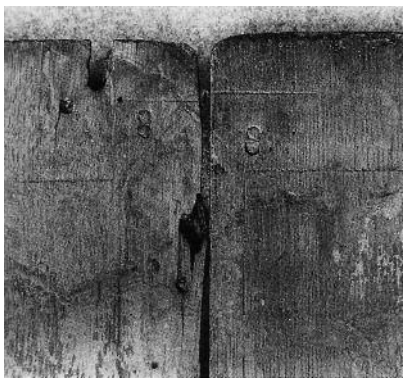

Figure 3
Detail of the panels of prophet Zechariah and King Mathan, showing the arabic number eight in the corner of each panel and incised setting-out lines for positioning the tracery frames.

eral layers of thin planks (Fig. 2). These layers were secured by wooden pegs; but because all the medieval rafters have disappeared, it is not known how the whole ceiling was originally attached to the roof.

The tracery overlay of the soffit forms a lattice pattern with bosses of lion masks and other small foliage designs. Most of these bosses retain some color. The sloping figure panels are framed in pairs under crocketed ogee "canopies": thirteen ogee arches on each side, with finials, and little pinnacles in between. The components retain many incised setting-out (layout) lines. The various parts were numbered, using small punches. These figures represent one of the earliest examples of arabic numerals being used by an English artisan, although some were employed by sculptors at Wells (ca. 1240), which the masons of the time seem to have had difficulty in reading.[4]

The figure panels are, on average, just over 2 m (7 ft.) long, nearly 30 cm (1 ft.) wide, and about 7 mm thick, sometimes less. Some retain distinct marks from the adze used to prepare the surface. The front surface was finished by planing. The panels are numbered in pairs, 1–13, using small punches on the north side (Fig. 3), and cruder figures cut with an auger and a chisel on the south side. Both sets are arabic numerals and both contain a few fragments of fourteenth-century color. It is possible that the large, crude set was designed differently simply to distinguish the south side from the north when the panels went to the painter's studio. There are also incised lines marking the exact location of the tracery and frames. The frames in their medieval position protected the paint when the panels were later cleaned with soda, so their outline is clear and accurately follows the incised setting-out lines. (It appears that the painter had been told that the panels were "a foot" wide, and he had prepared cartoons in advance without allowing for the width of the frames, because the figures are slightly cramped, often encroaching on the incised outline, and have sometimes been slimmed down by allowing the background vermilion to overlap them.) Traces of yellow were found on the crockets and in crevices elsewhere. Its hardness and pale lemon hue are characteristic of lead-tin yellow. English medieval oil gilding invariably was applied over some kind of reddish or orange ochre, so it seems clear that this yellow was a substitute for gold.

Each panel received an extremely thin priming of glue and chalk, barely filling the wood grain; in some places it cannot be seen under the microscope in a cross section. The top end remains bare wood, as it extends above the cornice. The area behind the tracery overlay, in the spandrels of the ogee arch, is green like the backboarding of the soffit overhead. This green is built up of a pale undercoat containing lead white and a rich, resinous glaze. The rest of the panel received a further undercoat of red ochre.

The vine was presumably added next, with black underdrawing; it is continuous and gradually tapers across both rows of panels, from a gnarled and much-pruned stem springing from Jesse, to fine twigs below the Annunciation. The stem is buff colored with green shading, and the leaves modeled with white veins laid over glazes (Fig. 4). There are many tendrils but no grapes. The figures standing on the vine display a rich and varied palette, with much use of crimson and other glazes. Many paint samples were taken during work in order to monitor the cleaning process,

Figure 4
Vine below the feet of King Zadok (detail).

and others are being analyzed.[5] They include vermilion, red lead, lead white, carbon black, azurite, malachite, copper green, a range of ochres, and two unidentified colors, a crimson lake and a translucent purple. The gold, which is applied on an oil mordant, was used with restraint. It is found on the crowns and scepters of the kings, Josaphat's belt, and on the halos of the Annunciation group, Gabriel's cope, and Christ's loincloth. (Water gilding, which has solubility characteristics completely different from oil gilding, is fairly uncommon on English medieval woodwork.) The vermilion background was obviously applied last, possibly with the panels already in situ, since a few neat, square-headed tacks bearing scraps that appeared to be of vermilion were found among many corroded nailheads of different periods that studded the edges of the panels. The tracery was then laid over the panels, and evidently pegged through them; it must have been polychromed before assembly, as there are no paint splashes on the figure panels. Among the last components to fit into position were the cornices and name boards, which were secured with nails, being much heavier than the rest.

The faces are modeled in shades of pink in the normal manner, with one particularly interesting exception—that of the Moses figure (Fig. 5). Here, flat pink was applied over the head and neck, followed by gray on the hair and beard. When this had dried, the features and curls of hair were boldly drawn by brush in black—a glass painter's technique.[6]

Previous Interventions

Figure 5
Face of Moses (detail).

During the Reformation, evidently following the edict of 1547–48 against images, the three panels depicting Gabriel, the Virgin Mary, and the Lily Crucifix were concealed with a pinkish overpaint. Similar pink was found at Clifton, where the backgrounds are also vermilion, and on those rood screen panels at Ranworth, Norfolk, and Pilton, Devon, with red backgrounds. Presumably, the parishioners wished to spoil their polychromed furnishings as little as possible while keeping within the law. It was probably E. T. Long who removed most of this pink layer at Abingdon, during his 1935 work mentioned below.

At some stage, before any of the medieval framework was displaced, attempts were made to clean the ceiling with caustic soda (sodium hydroxide). Caustic soda was still occasionally used to clean English polychromy well into the twentieth century; it tends to raise the grain of the wood, and leaves oak surfaces a dull gray. It saponifies an oil medium, and—although it was usually rinsed off areas where it was not intended to strip the paint—its residue leaves the medieval oil paint permanently sensitive to any form of moisture. The ceiling may also have been dismantled and given a reddish resin varnish. Certainly, the nine westernmost panels on the north side, from Moses to Haggai, were taken down to be overpainted in 1854 or 1856, together with their name boards.[7] Until the overpaint was removed, between 1989 and 1991, these nine panels were the brightest in the ceiling and the most widely reproduced.

All of the panels were taken down in 1872, and the structural timbers of the roof completely renewed. The panels and their tracery were reassembled in a mixed sequence, thirteen panels from the south side and one from the north having been discarded. It must have been at this time that the polychromy was stripped from the tracery of both figures and soffit, although the soffit backboarding retained its richly glazed green.

These green areas were coated with a layer of thin black paint. The figure panels were nailed back onto horizontal softwood planks, at right angles to the grain of the fragile medieval panels.

In 1935, Long completed his very careful cleaning of the paintings, which resulted in Borenius's appreciative publication (1936). However, he was obliged to work in situ, and thus did not attempt a complete cleaning of the most fragile areas (notably the vine, onto which much caustic soda had run). Consequently, Borenius makes several inaccurate observations about the color. Long is recorded to have applied a "preservative," which at that date may well have been wax (Ballantyne and Hulbert 1993; Plummer and Hulbert 1990), or possibly size; traces of the latter were encountered during cleaning.

Blown-air central heating was later installed in the church, causing extreme fluctuations in relative humidity. During a winter weekend early in 1983, conservators recorded a drop in the relative humidity from 75% to 30% in the vicinity of the ceiling. Some twenty years of similar conditions had not only loosened the paint but also considerably degraded the oak. The figure panels, being constrained by many nails, were seriously weakened, but the tracery overlay survived in much stronger condition. It had probably suffered less stress because its design is pierced (Fig. 2). In addition to flaking paint and damaged wood, the ceiling was caked with dirt deposited by the current of hot air.

"First Aid" and Preliminary Work

Early in 1983, when repairs to the tiled roof were about to begin, the church architect, John Glanfield, requested a report on the ceiling. The paint was found to be flaking so badly that it was imperative to secure it without delay. Paint consolidation was carried out over several weekends. This turned out to be extremely fortunate, for the presence of the conservators during weekends allowed them to observe the sharp rise in temperature and the associated drop in humidity on Saturday afternoons, after the heat had been turned on in readiness for Sunday worship; this was instantly diagnosed as the cause of the loose paint. In a March 1983 report, the author tentatively suggested that the Lady Chapel might be isolated from the effects of the blown-air heating by placing glass tympana in its arches. Before this scheme could be implemented, however, a great deal of investigation needed to be done. Meanwhile, for the foreseeable future, the parish had funds only for emergency work.

Since there appeared to be some wax on the panels already, and it was evident that a facing would have to remain on the paintings for some years, a mixture of beeswax and dammar (7:1) was chosen as a consolidant, melted through Japanese mulberry tissue with hot-air blowers and heated spatulas. The proportion of dammar was kept low, so that it could easily be removed if it did have to remain on the paintings for many years. A heat-melt adhesive has a great advantage over one requiring a solvent, in that shrinkage problems are minimized. Great care was taken to ensure adequate penetration of the wax so there would be no danger of the tissue pulling off the paint surface. The green area behind the tracery overlays could not be treated at this stage.

Expense precluded modification of the entire heating system, but the parish began to monitor the environment within the chapel. Conditions produced at the ceiling by the full blast of the nearby heating

outlet were compared to those produced by blocking the arcades with temporarily installed polythene (polyethylene sheet) tympana.[8] The introduction of these barriers caused the relative humidity—which had previously ranged from 40% to 70% or more—to level off to around 60–65%; the temperature—which had similarly fluctuated, from 6 °C to 34 °C—also became far more stable. In due course, it was clear that a permanent glass tympanum blocking each arch would provide effective protection for the ceiling, while allowing some air to circulate at ground level.

Dismantling and Documentation

The ceiling's most complex problems were those involving the woodwork, which clearly demanded expertise in joinery. Accordingly, a preliminary report was prepared in 1983 by Hugh Harrison, consultant in the conservation of woodwork.[9] There were innumerable splits in both tracery and panels, frequently associated with corroded nails, and the medieval timber was in extremely fragile condition. A great deal of water must have seeped in before the 1872 repair of the roof, and the panels had suffered from fungal and insect attack. After the paint on the figure panels had been consolidated, three panels on the north side (Eleazar, Zechariah, and Mathan) were taken down in 1983 for investigation and were cleaned as funds became available during 1983–85.

In 1988, when John Glanfield retired, Martin Caroe took over as church architect. Caroe was responsible for coordinating the major part of the work and for assembling the varied team of specialists. Dismantling work was resumed in 1989 (Fig. 6); the last components came down in 1991. The many nails attaching the ceiling to the softwood planking were carefully sawn off behind the panels and their corroded heads later extracted from the oak. Softwood wedges sandwiched between small pieces of very thick Melinex, and inserted close to each attachment point, were used to gently pry apart the layers of woodwork.[10] Occasionally, splinters became detached from rotten edges, but these, however tiny,

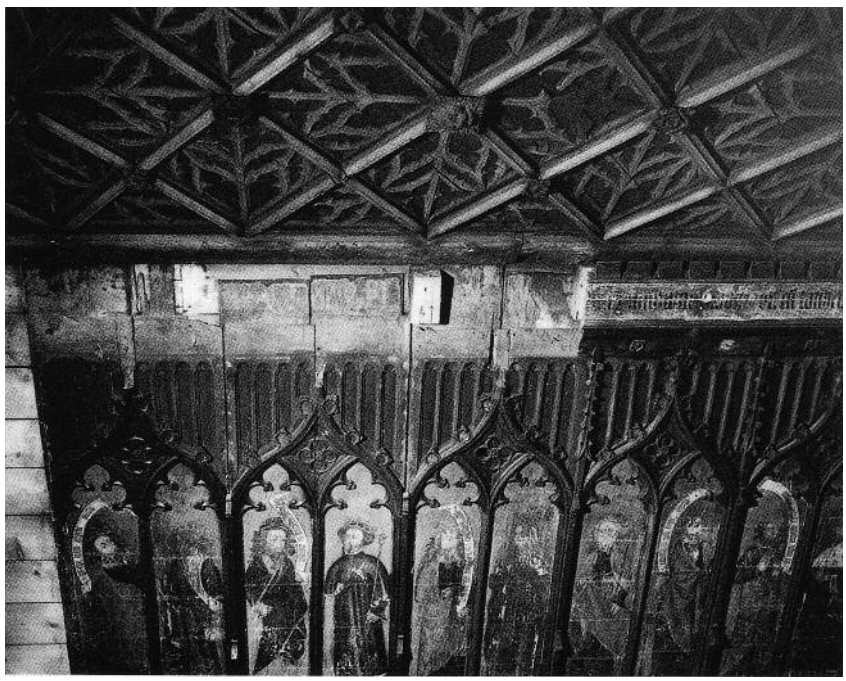

Figure 6
North side of ceiling during dismantling. These were among the best-preserved figure panels. Note the construction of the soffit, above, and a section of the cornice with inscription, on the right.

were labeled and eventually adhered back in position. The most difficult panels to remove were, of course, the first in each row, as it was not easy to reach the 1872 nails. During work, an 1854 penny was discovered, with the date 1872 added to the adjacent woodwork in pencil. (In 1991, a new five-pence piece was similarly hidden during reassembly.)

When the tracery overlays had been removed, the green backgrounds, which could not be reached previously, were faced with Eltolene tissue and consolidated with beeswax and dammar (4:1). The edges of the panels that had been covered by the frames were similarly treated.[11]

Each component was carefully numbered, labeled, and mapped so the position of even the smallest piece was precisely located. For the soffit, this involved a scale drawing on transparent overlays representing the layer structure of the tracery. Reports were produced at the completion of each step of the work, resulting in a massive amount of documentation.[12]

In 1989, a photogrammetric record was made before further dismantling took place. A very important aspect was the tracing of each figure panel to scale as soon as it was cleaned (Fig. 7). Thick transparent Melinex or acetate sheet was used, and every detail recorded, down to the last nail hole. A full-scale photocopy was made of every tracing and mounted on hardboard to be used when sorting the tracery into its original order (for which the early peg holes were important evidence) and when fitting the new, concealed aluminum housing. This saved wear and tear on the paintings.

The tracings were also reduced in size in order to provide handy line drawings. These proved invaluable when checking the continuity of the vine trail—and, consequently, the original order of the panels—because soda-damaged details could be shown far more clearly in the drawings than in a photograph, and missing outlines could be recovered from surviving paint fragments. The lettering on the name boards also was traced where it was damaged (probably by soda residue) and this process proved an invaluable aid in deciphering some of the less legible names. Fortunately, the

Figure 7
Panels from Moses to Haggai, north side. These were the nine figures previously overpainted.

black paint had left a clear yellowish stain on the white background where it had been washed off during the early attempts at cleaning.

All parts of the ceiling were routinely photographed at significant stages of work, in color and in black and white. Before any wax consolidation was carried out in 1983, the faintest areas of the painting were photographed on infrared film, but this did not reveal anything significant. In addition, rubbings were made of several interesting toolmarks, setting-out lines, et cetera.

Woodwork Repair

The repair of all the woodwork and the removal of corroded nails, together with the cleaning of all bare oak surfaces, the green soffit backboarding, name boards, and cornice inscriptions were carried out in the Devon workshop. The finest available quartersawn English oak was used for all repairs, but it was difficult to match the superb quality of the original timber. Poly(vinyl acetate) emulsion was selected as the adhesive for unpainted wood, since in this context it should prove adequately resoluble, and it is less sensitive to changes in humidity than traditional animal glue. A 20% solution of Paraloid B72 in xylene was used to consolidate decayed wood; the same resin was mixed with oak sawdust and used for fillings. Owing to the extreme thinness of the priming layer, it was often impossible to prevent the wood consolidant from reaching the paint surfaces, so it had to be safe for the paint as well as for the wood.

Splits in the tracery were glued and, where appropriate, reinforced with oak pegs. Lost pieces of carving that created an unsightly gap in the design or weakened a component were replaced, with care taken to minimize disturbance to the broken surface of the medieval wood. Some long splits in the panels were reinforced with V-shaped oak wedges at the back.

A special problem was posed by the discovery, behind the figure of Moses, of a tapered sliver on one of the panels discarded in 1872. Vermilion and green paint and incised lines identified it as coming from the upper part of a figure panel, but the foliage was painted much closer to the top of the panel than any other part of the vine. It seemed likely, therefore, that the figure had been a recumbent Jesse at the bottom of the panel, with some foliage above his head. This was confirmed when tiny fragments of dark crimson were found to match the drapery covering Jesse's giant feet at the bottom of Nathan's panel. (The recumbent figure originally spanned three panels, the middle one being that of the lost David.) The sliver was accordingly mounted in a recess in a new panel that was fractionally thicker than the medieval ones, and could thus be restored to its correct position.

Nahum's panel had occupied the easternmost position on the south side since 1872 and had become damp from contact with the exterior wall. It was consolidated before being taken to the Devon workshop. Not only was the wood seriously damaged by fungal attack, with cracks across the grain, but the panel had bowed across its width, creating a huge bulge. Before the facing could be removed, the back of the panel had to be thoroughly impregnated with Paraloid B72 (it absorbed about half a liter). The panel could not be enclosed in a fume hood because it was necessary to constantly monitor the paint surface for seepage of consolidant; therefore, the work was done outdoors where the xylene evaporated rapidly in the mild English sun. Fortuitously, it was discovered that the panel could be considerably flattened while warm; it was carried indoors, gently weighted,

and left to cool. The panel remained flat when the consolidant had fully hardened. Probably the same effect could have been achieved on a vacuum hot table, but since none of the other panels had bowed in this way, there was no occasion to explore further this purely accidental discovery. Its success probably depended on the combination of warmth and the precise moment at which the solvent had almost, but not quite, evaporated.

Cleaning

Before the 1983 facing was removed from the figure panels, the paint surface was further impregnated with beeswax and dammar (3:1).

Isopropyl alcohol proved to be the most useful solvent for the old varnish; there was no danger of dissolving the fixing wax. However, a wide range of solvents were used on different areas. A 3% solution of ammonia was occasionally used, but with caution, for fear of reactivating the alkaline residue remaining from the previous intervention with soda. The special problems caused by the soda have been discussed elsewhere (Hulbert 1994). For the initial softening of overpaint, a commercial paint stripper (green label Nitromors), applied on a very small brush, was frequently indispensable. After this had been rinsed off with white spirit, the overpaint was sufficiently soft to respond to milder solvents.[13] The author has worked on more than thirty English medieval rood screens and church panel paintings, which over the centuries have usually received at least one coating that is now harder than the original polychromy. Experience has shown that a strong solvent used quickly and carefully, especially when its action depends on its vapor's reaching the surface of the overpaint from the gel, is far safer than prolonged use of milder solvents, which may begin to act on the original paint before the overpaint is soft enough to respond to gentle scraping. Preliminary tests with a wide range of solvents confirmed that this was the case with the overpainted panels at Abingdon. The most valuable tool, however, was a scalpel kept very sharp with a Belgian sharpening stone. A large part of the work on every panel was done under a binocular microscope at ×10 magnification.[14]

Reassembly

The various clues by which the original sequence of the figure panels was rediscovered have already been published in detail (Hulbert 1992:19–20). Each prophet could be identified by his text. The name boards could be correctly positioned through reference to the list of kings in Saint Matthew's Gospel. There was nothing on the figure panels to identify the individual kings. However, by establishing the continuity of the vine trail, kings could be placed between the correct prophets, so that when the prophets were lined up with their names, the names of the kings would also be below the proper panels. The arabic numerals also confirmed the sequence, but the cruder numerals on the south side were not recognized until they were already in the correct order.

It was obviously essential to support the panels in some kind of housing that would not restrict movement, as the nails had. Since the chapel is just under 8 m (26 ft.) long, and the slope of the rafters creates a tapering space that absolutely precludes any additional thickness in the assembly of panels and tracery, this called for some ingenuity. After long discussions with colleagues, grant-giving bodies, and diocesan authorities, the following solution was devised by Hugh Harrison. All of the components were first fitted together in the workshop and then taken to the

church for reassembly. (Tracery components were pegged together in their respective sections.)

Aluminum was obtained in an H-shaped section to fit the panels. The slots of the H were lined with balsa wood (pretreated with insecticide) and the lengths of aluminum cut as necessary. Pieces that would be visible through apertures in the tracery were cut away. In places, distortion had occurred; such places required extra welded aluminum. Keyhole slots were cut to correspond with screws in the back of the tracery, which were inserted into existing, plugged holes; the slots were designed to allow some movement. (The screwheads were isolated from the panels by the balsa wood.)

The soffit was the last part to come down and the first to go up. It was secured with brass screws through existing holes. The aluminum sections were then accurately positioned, using the tracery as a guide (already slotted into place), and screwed to the softwood boarding, which had been retained. The tracery was unslotted, and the vertical pieces of aluminum unscrewed one at a time. One panel was inserted into the balsa-lined housing; the aluminum was then screwed back, using the same holes so the tracery would still fit the keyhole slots. The process was repeated until all the panels were in place and the tracery was slotted over them (Fig. 8). A further piece of aluminum was used to prevent each panel from slipping down. Holes had been predrilled for the vertical members of the frames, and the attachment of small individual items, such as finials, was also straightforward. Before the panels were in place, brackets were positioned and the cornice and inscription boards attached, using the old nail holes. The name boards were similarly fixed to blocks at the bottom. Stainless or nonferrous screws were used throughout and any visible heads covered with pigmented wax.

Figure 8
A portion of the south side of the ceiling during reassembly. King Asa, Prophet Baruch, and King Josaphat; some of the panels damaged by early attempts at cleaning. Note the blank panel on the right, with reconstruction of the vine trail under way.

The thick plaster into which the edges of Mary's and Nahum's panels had been deeply embedded was removed from the east wall and replaced with a thin layer of traditional lime and sand, feathered off just short of the ceiling.

Retouching and Varnishing

After cleaning, the panels were very lightly waxed. Most unsightly lacunae were retouched in watercolor using a stippling technique, and gold powder in gum arabic was used to repair gilded areas. No imaginative reconstruction was attempted, and faces (with the exception of the tip of Joel's nose and Mary's cheek and chin) were left untouched. The thinnest possible varnish was applied, as the panels had to travel from one workshop to another and be stored wrapped in Melinex, and a normal thickness of varnish would not dry while thus wrapped.

When all the panels were back on site, more retouching was done to minimize the uneven effect of varied damage. The vine trail on the south side, much of which would have been invisible from ground level, was reconstructed by filling in the vermilion background only, using the tracing as a guide. A further thin dammar varnish matted with beeswax was applied in situ. A few details were finished with pigments in a medium of the same varnish.

Watercolor was also used for retouching the lettered boards. These were sealed with beeswax and dammar (3:1). A 4:1 mixture was used to polish all bare wood.

New oak was spirit stained to match the old. (The fourteen lost panels had been replaced in 1872 with very poor wood.) New blank panels were made, and the tops painted and glazed green behind the tracery overlays, using artists' acrylic paints. The vine was then reconstructed in outline to join with surviving adjacent panels, using raw umber pastel crayon, and the whole surface was toned down with raw umber acrylic applied with a sponge. Red watercolor was then applied by the same method, to simulate the vermilion background, leaving a "ghost" shape suggesting a figure but in no way reconstructing it. Finally, these panels were varnished. Acrylic paints were also used to color some modern sections of name board. This technique satisfactorily restores continuity to the composition, while remaining clearly distinguishable from the original painting.[15]

The stone cornice below the ceiling was cleaned, and the plastered walls of the chapel limewashed, the lime being pigmented to a warm tone.

Lighting and Display

New electric lighting was installed. Unfortunately, it is impossible to avoid all reflection; had a more matte varnish been selected, the pigments would not have been as satisfactorily saturated. There is also a fine chandelier, dated by C. C. Oman to the early seventeenth century, and attributed to the Low Countries.[16] The candles of the chandelier are lit only for major feasts of the Church, including feasts of the Blessed Virgin, and are unlikely to burn for more than six hours a year. The chandelier hangs well below the ceiling, and its beauty is such that the small amount of soot may be disregarded, especially if low-soot candles can be obtained

Environmental monitoring continues, and results are regularly studied. One of the humidity monitors has been positioned on the chandelier. The ceiling is checked at close quarters by the author every few years.

Smoke detectors have been placed in the church; one is attached to the truss at the west end of the ceiling, and there is a loud siren on the tower.[17]

Conclusion

It is a rare privilege to work on objects that are still in use for their original purpose, and it is fully appropriate that the ceiling should be enhanced by a sympathetic modern tapestry,[18] which takes up the theme of the Cross, associated with the church's patron, Saint Helen. Embroiderers within the parish designed kneelers that echo the vine trail. The ceiling was blessed by the bishop of Oxford on the last Sunday in Advent 1991, when the Bible readings for the season referred to Jesse.

Saint Helen's is an Anglican (Church of England) parish church. The congregation is responsible for raising the funds for maintenance, either from local donations or from charitable trusts and government funds. Work was carried out by private conservators after approval was obtained from diocesan authorities and any grant-giving bodies involved. The whole project demonstrated excellent and happy teamwork among all the specialists involved.

Acknowledgments

In addition to all those named in the notes, warm thanks are due to the Reverend David Manship, Rector of Saint Helen's, and to many parishioners who provided practical help, hospitality, and support. During the second phase of work, the Reverend Allan Doig (curate) was responsible for a huge amount of organization, and the master and governors of Christ's Hospital, who administer medieval almshouses beside the church, generously assisted with facilities.

At different stages of the work, the following people participated in the Herbert Read team: Stuart Anderson, Laurence Beckford, Gareth Brown, Bob Chappell, Clare Cully, Ruth Davis, John Gentry, Dave Harvey, David Luard, Torquil McNeilage, Russell Powell, Richard Stokoe, Stephen Webb, and Brett Wright. The author's assistants were Mary Baker, Ann Ballantyne, Liz Cynddylan, Elwira Pluta, Jane Rutherfoord, Eddie Sinclair, and Katherine Stainer-Hutchins. Simon Egan polished paint samples. John Matthews, of Wessex Press in Wantage, took extraordinary trouble over the reduction photocopies of my tracings. Local builder Alan Norridge was endlessly helpful with many essential tasks.

The National Heritage Memorial Fund and English Heritage contributed two-thirds of the cost of the work; the parish raised the rest, assisted by Saint Andrew's Trust of Wells, the Council for the Care of Churches (Pilgrim Trust), the Sainsbury Trust, the Abingdon Environmental Trust, Christ's Hospital, Abingdon, and numerous local businesses and individuals. The project won a National Art Collections Fund award, which was added to these donations.

Notes

1 "Relaxation of four years and four *quadragene* to penitents . . . the like to penitents who on the four feasts of St. Mary the Virgin similarly visit and give alms to her altar in the church of St. Helen, Abingdon." 2 Kal. March 1391 (Bliss and Twemlow 1902:407).

2 Fourteen examples are listed in Hildburgh (1925; 1932) and Edwards (1979). There is another on a window mullion at Wellington, Somerset.

3 The ceiling was closely examined by Gavin Simpson and Robert Howard of the Department of Classical and Archaeological Studies at the University of Nottingham. For their dendrochronological and other findings, see Howard and coworkers (1992:53, 56).

4 The author's attention was drawn to this fact by Jerry Sampson, a consultant archaeologist who undertook archaeological observation throughout the project.

5 Analysis is being carried out by Caroline Babington at the conservation studio of the Historic Buildings and Monuments Commission for England (English Heritage).

6 Michael Liversidge of the Department of History of Art at the University of Bristol (to whom I am much indebted for his continuing art historical input) has drawn my attention to the very close affinity of the Abingdon paintings with the contemporary work of Thomas the glazier of Oxford. Harvey (1975), in his chapter on painting, comments on the association between glaziers and other painters.

7 Mieneke Cox, of the parish, drew my attention to a letter from a "Miss D'Arcy," who recollected the event. The repainting was done by Emma Dodson, the vicar's daughter, under the direction of the architect, Mr. Clacy. D'Arcy recorded the disintegration of panels during this dismantling, which may have caused the project to be abandoned. Art historians have accordingly judged the Abingdon master by the poor quality of Dodson's work. D'Arcy's letter is quoted among the Preston papers in the Berkshire Record Office, File D/EP 7/63. Reading, England.

8 This was done under the direction of R. J. Noyes of the Culham Laboratories; the late Keith Dawson of the Rutherford Laboratories, Harwell; and David Saunders of the National Gallery, London. William Bordass, building scientist, later continued the measurements.

9 Harrison, at that time, was the managing director of the Devon ecclesiastical joiners, Herbert Read Ltd., a firm established in 1888, combining traditional joinery skills with those of modern conservation. He is now an independent consultant.

10 The materials mentioned here and in the following sections—such as Melinex, Eltolene, and Paraloid B72—are available from most conservation materials suppliers.

11 This was carried out by conservators from Herbert Read Ltd.

12 The reports were produced by the author and Hugh Harrison. The documentation was eventually collated by Jerry Sampson.

13 The Nitromors was a commercial paint stripper in gel form, containing methylene chloride. It was an old formula that may now be unobtainable.

14 Similar methods were used for the polychromed items cleaned by Herbert Read's team, for which the author was consultant.

15 The technique was devised with the assistance of conservator Ann Ballantyne.

16 Installation of the electric lighting was carried out under the direction of Martin Caroe, in consultation with Ronald Clough. For chandelier dating, see Oman 1937. Martin Caroe designed the glazed tympanum at the west end of the chapel as an extension of the nineteenth-century screen below, and the glass has been lettered with a translation of the text on Mary's scroll by calligrapher David Peace.

17 The environmental monitoring is carried out by William Bordass, environment consultant, and Martin Caroe.

18 The tapestry is the work of weaver Bobbie Cox.

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The Interior Decor of the Ursuline Chapel in Quebec City

Research and Conservation

Claude Payer, Marie-Claude Corbeil, Colombe Harvey, and Elizabeth Moffatt

During the eighteenth century, the interior of few churches in New France could rival that of the Ursuline Chapel, in the complexity of iconography, the richness of carving, or the extent and variety of gilded and polychromed surfaces. It was one of the rare interiors to survive the bombardment of Quebec City by the British in 1759. It has also been spared from fire and saved from the dispersal that often accompanies changing tastes. Today, it is the only assemblage of furnishings from the French regime that is nearly intact, making it one of the oldest extant in North America. For these reasons, it is exceptional.

The first Ursulines arrived in New France in 1639 to establish a school for girls. In 1642, they moved to a building situated on the heights of Quebec City, on a plot of land that their convent still occupies today. An initial fire in 1650 and a second in 1686 obliged them to completely rebuild twice. After the second fire, they had to wait until 1723 before their new chapel was finished. It was a stone building, featuring a nave (or outer chapel), reserved for the general population; a sanctuary, later to be embellished with the rich carved furnishings that are the subject of this article; and, to the right (liturgical south) of the sanctuary, the nuns' chapel, a place of prayer for the Ursulines and their pupils (Fig. 1). Since this was a cloistered community, the nuns' chapel was enclosed by a screen.

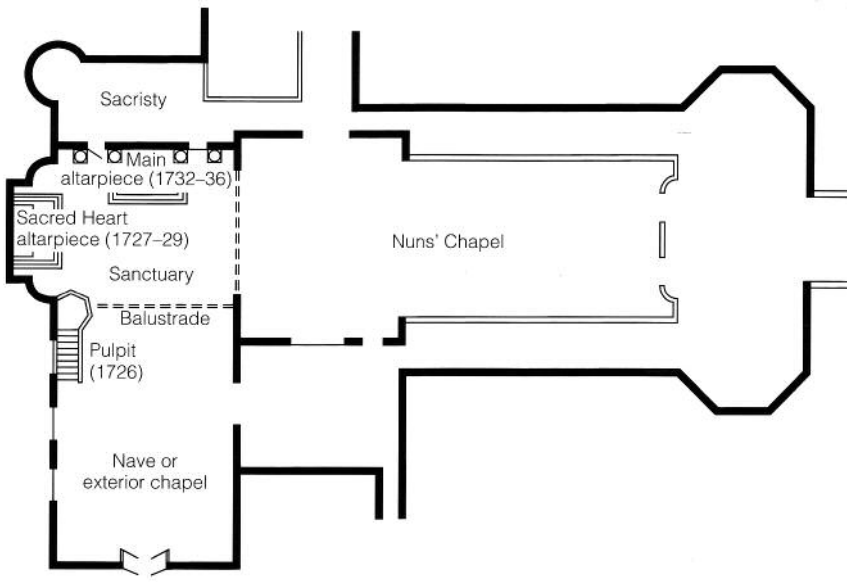

Figure 1
Floor plan of the Ursuline Chapel, in Quebec City, as it is today.

The Decor

Located mainly in the sanctuary, the furnishings were provided over a ten-year period, between 1726 and 1736. First, the pulpit was installed on the north wall at the junction of the nave and the sanctuary. This was followed by the Sacred Heart altar and altarpiece,[1] which were situated within a recessed bay on the north wall, facing the nuns' chapel. Finally, the main altar and altarpiece at the east end were completed, facing down the nave toward the congregation. Included in the ensemble were a few statues and older reliquaries salvaged from the fire that destroyed the earlier structure.

The iconography chosen by the nuns for this group of sculptures is among the most elaborate ever created in Quebec. The main altarpiece, constructed in the form of a triumphal arch, symbolizes a gate leading to heaven (Fig. 2). It contains statues of Saint Joseph, the patron of New France; Saint Augustine, one of the Church fathers whose rule the Ursulines follow; and Saint Ursula, the patroness of the community. Reliefs of the Annunciation adorn the panels of the sacristy doors, and the pedestals bear reliefs of Saint Peter, Saint Paul, Saint John the Baptist, and Saint John the Evangelist—veritable pillars of the Catholic Church. The high-altar painting, an *Adoration of the Shepherds,* is in an expertly carved, arched frame adjoined by four Corinthian columns with twin pilasters (Fig. 3). A relief of *The Good Shepherd* embellishes the richly decorated tabernacle, which contains a number of saints' relics.

The convent archives contain the 1730 contract for the main altarpiece and balustrade, signed by Pierre-Noël Levasseur (1690–1770), one of the most illustrious members of the Levasseur dynasty, a family of sculptors and craftsmen famous in New France. Historians also attribute to him (or at least to his family) the pulpit and the Sacred Heart altarpiece.[2] The contract mentions approval of a drawing initially submitted by the artist, but now lost. All of these architectural structures, including their decorative reliefs and motifs, statues, and items of furniture, were carved in wood, chiefly white pine and basswood, and were assembled using traditional joinery techniques.

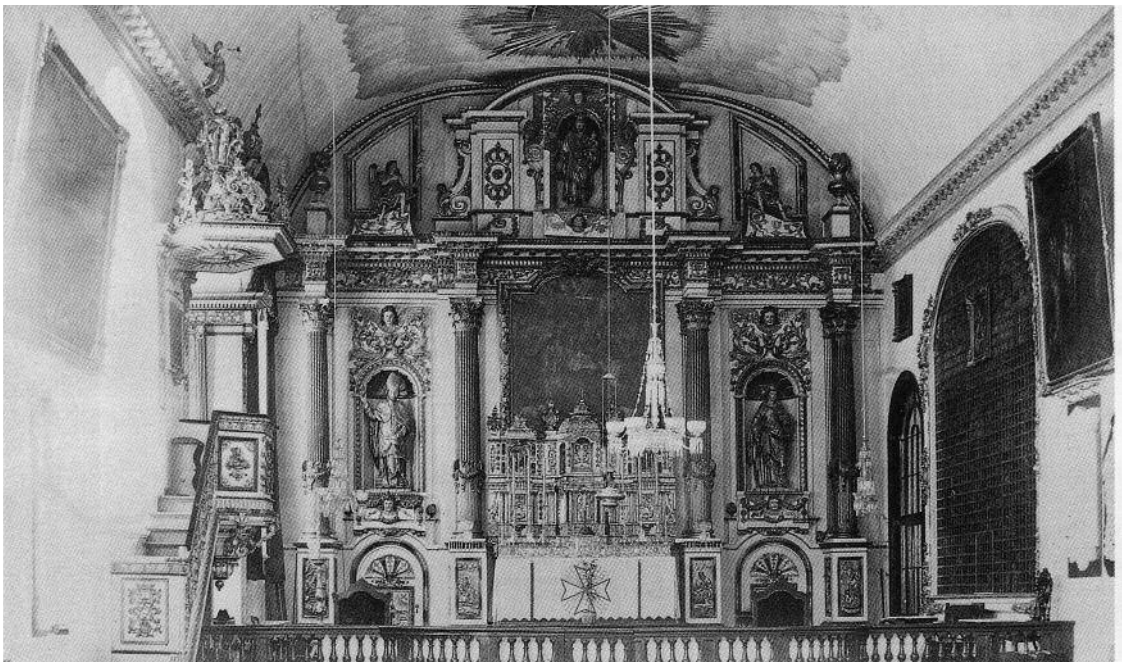

Figure 2
The interior of the Ursuline Chapel, prior to the 1901 demolition, showing the main altarpiece, the pulpit, and the balustrade (photographer unknown). Archives des Ursulines de Québec A1-142 (copy print, May 1993).

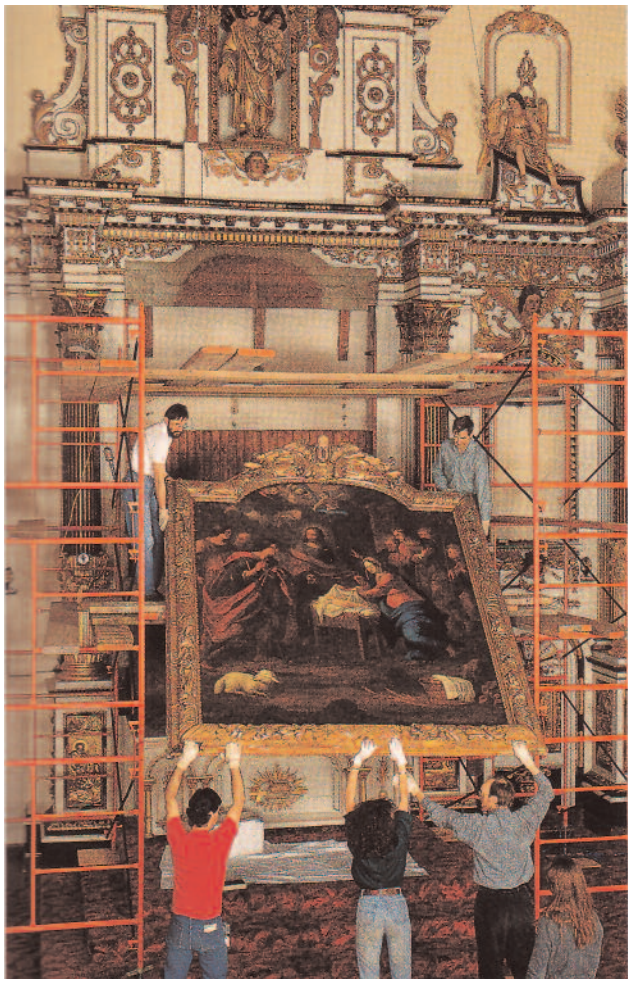

Figure 3
The high altar painting being taken down for treatment in February 1994.

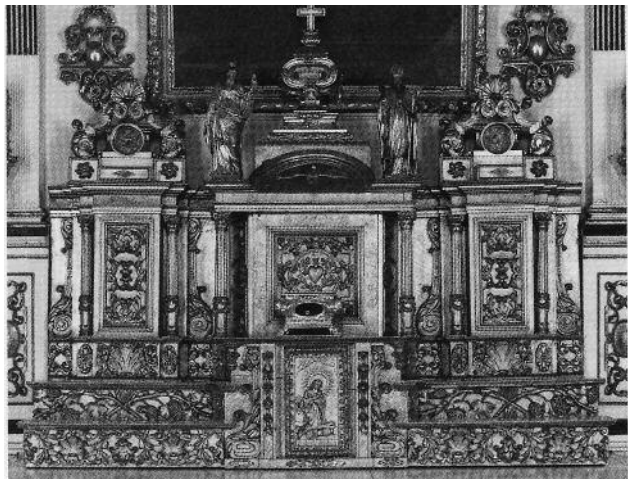

Figure 4
Tabernacle of the Sacred Heart altar, with statuettes and reliquaries. Various motifs resulting from *recutting* the gesso ground during the gilding operations can be seen on the surface of the tabernacle.

All polychromy and gilding, however, were excluded from the contract and were carried out by the nuns themselves. It is known that a number of the Ursulines were painters, and that the order operated a celebrated gilding workshop that served parishes and communities in and around Quebec City (Porter 1975).[3] They meticulously executed all the gilding and polychromy for their chapel according to traditional techniques, a task that probably continued for three years following the completion of the sculpture, just in time to celebrate the 1739 centenary of the nuns' arrival in New France. All visible parts of the wood were first covered with a gesso ground. The flat beds of the wooden architecture, as well as the walls, the background of niches, and the hollows of the pilaster capitals, were painted pale blue. Many sections of molding in the entablature, pedestals, outlines of doors and panels, and the fluting of the columns and conch shells were painted black to imitate ebony. The statues' hands and faces, the cherubs, and the angel heads were painted with flesh tints. With one exception, the clothing and wings of the figures were water gilded. The column capitals and lintels, tabernacles, and reliquaries, as well as the wall appliqués and ornamental motifs, were also completely gilded. The gilders made great use of *recutting:* incising geometric and floral motifs directly into the white ground (Fig. 4). Gold leaf was applied over a reddish brown bole, then burnished with agate stone in selected areas to create contrasts in brilliance. As a finishing touch to the gilding,

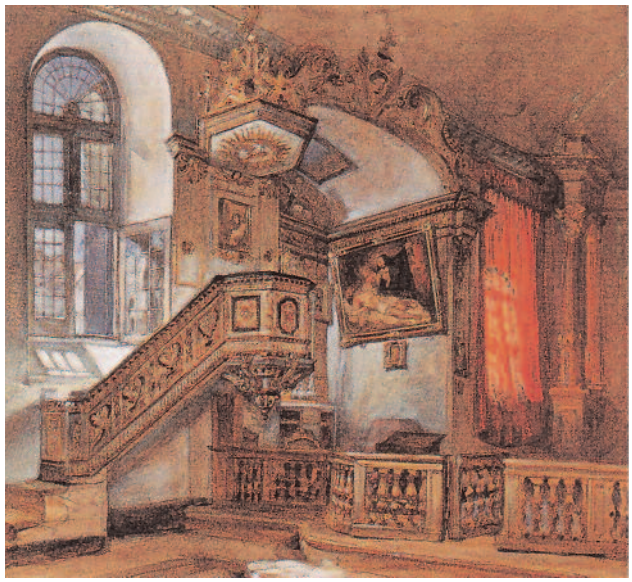

Figure 5
John Richard Coke-Smyth, *Interior of the Chapel of the Ursuline Convent, Québec,* 1838; watercolor on paper with graphite underdrawing, highlights of body color, 25.5 × 28.5 cm. This watercolor shows the decor a century after it was created: the pulpit, the balustrade, and part of the two altarpieces. A side window provides dramatic raking light for the main altarpiece. The red drape filters the light and accentuates the contrasts between gilded surfaces and blue-colored walls.

many hollows were highlighted with red watercolor. These different surface treatments produced visual contrasts, accentuated in the evening by gleaming candles and during the day by lateral light from broad windows. Two large windows draped in red were situated to the left of each of the altarpieces, producing a dramatic raking light (Fig. 5).

In 1901, however, during work to enlarge the nuns' chapel, it was discovered that the walls of the outer chapel and sanctuary building were badly deteriorated. It was decided that the furnishings would be disassembled and reinstalled the following year in a completely new building erected on the same site. While the new structure essentially adopted the same form as the old one, the architect increased its scale: the vault was raised, the side chapel expanded, the fenestration modified, and the balustrade (communion table) simplified. Elements of the sculpted decor were also modified to suit their new home. Architectural elements on the walls that served to integrate the furnishings and the architecture were eliminated, including parts of the entablature of the Sacred Heart altarpiece and the pulpit. The springing of the principal vault is now much higher than that of the main altarpiece, breaking the original continuity of horizontal lines in the decor. The raising of the vault also created large voids above the altarpieces, which the architect filled with appliqués and other accessories (Fig. 6). Elimination of the large side windows resulted in the loss of the raking light on the altarpieces and, thus, a flattening of the relief and a dulling of the Baroque character of the work. The contrasts of color and brilliance, the sculptural relief, and the richness of surface finishes accentuated by the various light sources of day and night had created an effect that was both grand and theatrical. A large part of this disappeared in 1902 during the reconstruction of the building.

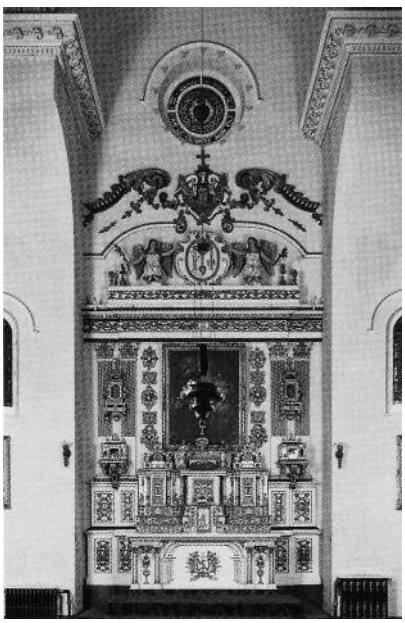

Figure 6
The side altar and altarpiece, called the Sacred Heart altarpiece. In 1902, the empty space above the sculpted decor was filled with a stained glass window and other accessories.

Repairs and changes to the gilding and to the painted surfaces, which had been carried out at various times over the years, also contributed to changing the balance of forms and colors. For example, dull colors (white and beige) applied over the blue backgrounds have diminished the impression of volume that the backgrounds originally conveyed.

As a result, we now have an early-twentieth-century building that somewhat clumsily houses extremely important early-eighteenth-century furnishings. Despite the building and the overpaints, the decor still retains much of its majesty and refinement. Its age, history, and uniqueness, together with its high artistic and technical qualities, have earned it the designation of a historic monument by the Government of Quebec under the Cultural Property Act, as well as the recognition by art historians across Canada as a jewel of the nation's cultural heritage. Today, the chapel continues to serve the Ursuline community and the public as a place of prayer.

The Conservation Program

In 1988, at the nuns' request, the Centre de conservation du Québec (CCQ) submitted a report and proposals concerning conservation of the decor. At that time, it was concluded that the furnishings and decorative elements were suffering from surface abrasion; flaking of the gilding and polychromy; damage from wood-boring insects; and cracks, marks, and losses due, among other things, to the work of 1901–2. The bright, contrasting water gilding had been covered, in large part, by dull layers of oil gilding and bronze paint, and the statues' faces had been darkened by crude overpaints. The ebonized surfaces had been covered with a matte black paint, now dusty and lifeless. The report recommended a long-term program. Most urgent was the aim of the first stage: to preserve the decor—that is, to undertake a treatment designed to slow the deterioration of the sculpted works. Only then could the second phase—namely, the aesthetic treatment—be undertaken. The goal was to understand the decor by systematically documenting it, to consolidate its structural and surface elements, and to carry out several preventive measures. Any attempt to improve its appearance without ensuring the survival of its component parts would be fruitless.

After a couple of years, during which the decor received its designation as a historic monument and the necessary funds were secured, the nuns gave the CCQ a mandate to implement the first phase of this conservation program. With grants from the provincial and federal governments and the financial participation of the Ursuline community, a small team of sculpture conservators with expertise in polychromed wood was formed. An advisory committee was created to serve as a forum for discussion of all major questions. The committee consisted of Ursuline nuns, CCQ members, a delegate from the Canadian Conservation Institute (CCI), a representative of the Quebec Department of Culture and Communications, and an art historian acting as special advisor to the Ursulines. This ad hoc committee met whenever necessary. Work proceeded over a four-year period until the fall of 1995. The scope and resources involved make this in situ project a first in Canada. The project has also taken on an exceptional character by virtue of the uniqueness of the object being treated.

Apart from the consolidation of an insect-damaged column, all operations were carried out in the chapel itself. Each of the three sections of the decor was scaffolded in turn for access. An enclosed workshop was laid out in the nave to offer a suitable space for treatment of the movable elements, for all writing and drawing, and to separate the conservators from visitors, since the chapel is open to the public during the tourist

season. The workshop area, measuring 9 m by 4 m, consisted of a very simple freestanding structure made of wood and drywall boards. It was illuminated with daylight-balanced, UV-filtered fluorescent lights, and sufficient electrical outlets were provided for all equipment. The workshop also contained a photography area, worktables, storage space for tools, and an area for a computer, a tool we found indispensable.

The Documentation

On a job site of this complexity, documentation is both crucial and complex. All parts of the decor have been measured, probed, photographed, drawn, and described in writing. The CCQ photographer took black-and-white photographs and 35 mm color slides, and sometimes color 4 × 5 in. transparencies and X rays. A draftsperson did most of the drawings from black-and-white 8 × 10 in. prints; these drawings were complemented and annotated by the conservators. Types of joints and hardware; tool marks; evidence of modifications, additions, and removals; losses and areas of damage; and the many layers of original finishes and overpaints were all noted.

The computer (a word processor, with a laser printer) allowed us to standardize written documentation and add to it as work proceeded, and to establish adequate files without needing to leave the premises or to employ a secretary. Diskettes and hard copies were kept on the job site; backup diskettes were stored elsewhere. The user-friendly software package (WordPerfect for Windows), compatible with equipment at the CCQ, enabled each of the conservators to enter data and consult that of others. It was considered too expensive and complicated to digitize the visual data (photos and drawings).

Materials Analysis

The wood, gold-leaf alloys, pigments, and paint media were analyzed by a team of conservation scientists from the Canadian Conservation Institute in Ottawa. CCI made this a major research project and designated a coordinator, who also served as CCI's representative on the advisory committee.

By removing the paint in small areas layer by layer and preparing cross sections, it was possible to determine the original appearance of the sculpted furnishings. The following sections will discuss the original materials (i.e., the wood, the ground, the polychromy of the architectural elements and of the carved figures, and the gilding), as well as the general composition of the overpaints. The results of the analyses of the original paint layers are summarized in Table 1.

Methods of analysis

Three types of samples were taken: fragments of wood, cross sections of paint or gilding, and particles of paint or varnish. The wood samples were examined by incident light and polarized light microscopy.

The paint and gilding cross sections were prepared according to standard methods but were dry polished with progressively finer, cushioned abrasives.[4] This method of polishing was preferred to the conventional method, which uses an alumina suspension in water, in order to avoid dissolving the water-sensitive paint layers. The cross sections were examined by light and fluorescence microscopy, generally with a ×40 magnification, and then by scanning electron microscopy. The latter at times made it possible to distinguish layers of very similar color but of

Table 1 Composition of original paint layers

	Painted architecture		Painted parts of carved figures		Gilded parts	
	Blue surfaces	Black surfaces	Flesh tints	Hair	Water gilding	Ochre surfaces
Highlights					red ochre or vermilion, calcite, and gum arabic	
Gilding and polychromy	Prussian blue, calcite, and protein	charcoal black, calcite, and protein	vermilion, lead white, lead carbonate, and drying oil	raw sienna, burnt umber, calcite, trace lead white, drying oil, and protein	matting glue gold leaf bole: burnt sienna, red ochre, charcoal black, kaolin, calcite, and protein	yellow ochre, calcite, silicates, and protein
Size	calcite and protein					
Ground	calcite and protein					

different composition. Conversely, light microscopy helped to distinguish layers of identical composition that were separated by a very fine layer of dirt or that were of slightly different colors. By combining the two methods, it was therefore possible to establish the stratigraphy of the samples with greater precision. Examination by scanning electron microscopy (SEM) was coupled with analysis by X-ray energy spectrometry. The latter allows the detection of chemical elements with an atomic number equal to or greater than 11 (sodium). Furthermore, certain layers of paint were analyzed in situ by X-ray microdiffractometry using a 30 μm collimator.

The composition of the alloys used for the gold leaf was determined by X-ray energy spectrometry combined with SEM.

Identification of the pigments and extenders in the samples of paint particles was done by X-ray diffraction using a Gandolfi camera, and by polarized light microscopy. The nature of the medium was determined by Fourier-transform infrared (FT-IR) spectroscopy using a diamond cell microsampling device and an infrared microscope accessory. This method also served to confirm and complement identification of the pigments in the sample. Samples of some layers of the cross sections were also analyzed in this way. Infrared spectroscopy and gas chromatography were used to analyze some varnish samples.

Wood identification and dendrochronology

Most of the wood in the altarpieces and pulpit was identified as either white pine (*Pinus strobus*) or basswood (*Tilia* spp.). White pine seems to have been used mostly for the Sacred Heart altarpiece, while basswood was used for the main altarpiece, with the exception of the tabernacle, which was made of white pine. The two statuettes on the Sacred Heart tabernacle and the frame of the painting above them, as well as the angels sitting on top of the main altarpiece, are made of white oak (*Quercus* spp., subgenus *Leucobalanus*).

In the case of the basswood and white oak, it is impossible to distinguish between European and North American species by microscopy. *Pinus strobus,* on the other hand, is a soft pine indigenous to northeastern

North America, and was a rare import into Europe in the seventeenth century. Dendrochronology, which was provided by the Centre d'Etudes Nordiques (CEN) of l'Université Laval, in Quebec City, helped to confirm the origin of the white pine more specifically (Delwaide and Fillion 1993; 1994).[5] The growth curves from elements of the tabernacles were a very close match to the curves established by the CEN for *Pinus strobus* grown in Quebec and for a beam of white pine that had been taken from a wing of the Ursuline convent rebuilt in 1688. This leaves no doubt as to the origin of the white pine for many elements of the decor. Analysis of the wood also demonstrated that the butternut (*Juglans cinerea*) frame of the high altar painting must have been carved in New France as well, since butternut is found only in North America.

Dendrochronology was also used to estimate the age of the two tabernacles. The tabernacles were not specifically mentioned either in the account books or in the contract for the main altarpiece. Some historians believed that the Sacred Heart tabernacle was of French origin, a theory disproved by identification of the wood as *Pinus strobus* (Fig. 4). One school of thought held that one of the two tabernacles had been carved by Jacques Leblond de Latour, an artist who died in 1715. However, analysis of the growth rings of the white pine has set the probable year of felling at 1721 for the Sacred Heart tabernacle and 1719 for the main tabernacle (Delwaide and Fillion 1993; 1994); this would rule out the participation of de Latour and suggests that the tabernacles are probably the work of Pierre-Noël Levasseur. The main tabernacle could have been modified, however, and the limited number of measuring areas leave the dating and origin of some of its components in doubt.

Ground

The first layer observed in the cross sections is the ground. This layer, lying directly on top of the wood, is generally a typical gesso composed of calcite in a protein medium.[6] However, there are a few exceptions. In a sample from the central motif of the Sacred Heart altarpiece, dolomite appears instead of calcite. In samples taken from the pedestals and the entablature, a mixture of calcite and gypsum was identified; the medium could not be identified because of interferences due to the gypsum in the infrared spectrum. In a sample from the flesh tints of the angel with the trumpet (Fig. 7), the ground is composed of calcite and protein, but a trace of drying oil was also detected. This oil may be from the oil-based layer applied over the ground (see "Polychromy of the carved figures" section).

On the ground, there quite often appears to be a layer of size; in some cases, it appears as a brownish transparent layer, in others as a yellowish infiltration in the upper part of the ground layer. The brownish layer and yellowish infiltration were analyzed and proved to have the same composition as the ground. A layer of size would make the ground less porous, preventing penetration of the medium from the paint applied over it, in order to obtain bright and resistant colors.[7]

Polychromy of the architectural elements

Most surfaces of the altarpieces and the pulpit—that is, the backgrounds and flat surfaces—as well as the robes of the angels sitting on top of the side altarpiece, were painted pale blue. In general, the blue layer contains Prussian blue and calcite in a protein medium. In some cases, gypsum and

Figure 7
Documenting the pulpit. The angel with the trumpet can be seen on top of the sounding board.

traces of lead white and drying oil, or traces of drying oil alone, were also detected. In one sample, gypsum and indigo were found, in addition to Prussian blue, calcite, and protein.

As may be seen from the description above, the layer of blue varies in its composition and appearance: the color varies from blue to green, from very pale to dark, and from translucent to opaque. The shift in color of Prussian blue from blue to green over time has been noted by a number of authors since its introduction as a pigment. These reports were recently summarized by Kirby (1993).[8] Some attribute this color shift to the presence of oil, association with a white pigment (the paler the blue, the more it tends to become green), or the reaction of Prussian blue with basic compounds, which produces yellow and brown iron salts. Some samples of blue paint contained traces of oil, probably through contamination from the upper layers; no yellow or brown compound was observed by microscopy. Unintentional variations in the composition of the blue paint, which was applied to these large surfaces over a period of a few years, might explain the variations in its appearance. The hypothesis that these gradations were deliberate can be ruled out, as no logical repetition in the different tints of blue was noted.

Another interesting fact deserves mention with regard to Prussian blue: when observed by optical microscopy, the particles of Prussian blue did not resemble those of the modern pigment, but rather they resembled particles of ultramarine. Nevertheless, there is no doubt that the pigment is Prussian blue, since this pigment has a characteristic infrared spectrum. The same observations have been made by Welsh (1988) regarding samples of original paint taken from an eighteenth-century building in Philadelphia, and by Townsend (1993) regarding samples from works by Turner. The difference in appearance between particles of old and modern Prussian blue was attributed to different methods of preparation (Welsh 1988).

Certain elements of the decor, mainly the moldings, the hollows of fluting, and certain backgrounds, were originally painted black to imitate ebony wood. The black paint consists of charcoal black and calcite in a protein medium. It is usually covered with a thin layer of proteinaceous material, most likely a size applied to give it protection and gloss.

Polychromy of the carved figures

The decor includes several full-length sculptures of saints and angels, as well as winged angel heads and masks. The clothes of most full-length sculptures were entirely water gilded; this technique will be discussed in the next section. The robes of the two angels in the Sacred Heart altarpiece were originally painted in the pale blue previously described, and were embellished with water-gilded stars. Therefore, this section will discuss more specifically the remaining parts of the polychromy—that is, the flesh tints and hair of the figures.

In all the samples of flesh tints, lead white and lead carbonate in a drying oil were identified. The red pigment used to tint the paint a flesh color was not detected by any analytical technique. Microscopy shows very few red particles, which made identification difficult. However, on the basis of the microscopic examination of the particles, we may assume the pigment to be vermilion.[9]

The brown hair of the angels in the side altarpiece was painted with a mixture of raw sienna, burnt umber, calcite, and a small amount of lead white in a mixture of drying oil and protein.

Figure 8
Detail of the main altarpiece showing part of the entablature, the upper part of the left niche, and the head of the statue of Saint Augustine.

Gilding

The original layer of gold leaf is set on a reddish brown bole composed of burnt sienna, red ochre, charcoal black, calcite, and kaolin in a protein medium. The gold on sand found in a few spots at the top of the main altarpiece and of the two tabernacles is applied on a yellow bole that consists of quartz, yellow ochre, calcite, and clays in a collagen-type protein medium (Fig. 8).

The composition of the gold leaf varies from 21.5 to 24 carat. Six different compositions were found. Most gold-leaf samples were alloyed with silver and copper, and just one contained only copper in addition to the gold.

In some samples, the original gold is covered with a thin layer of either varnish or matting glue (size). In one sample from the pulpit, this layer was composed of calcite and silicates in a mixture of protein and drying oil; on a reliquary, it was essentially drying oil; on a wall appliqué and on the robe of an angel, the varnish was made of copal dissolved in linseed oil; on the reliefs of the main altarpiece pedestals, it was linseed oil. We may assume that the matting layers are original, since the application of a matting agent is part of the traditional technique of gilding. It is less obvious, however, whether the layers of varnish are original. It should be mentioned that most of the reliquaries and appliqués came from other places in the convent, and that several were not contemporary to the chapel. It is therefore possible that they were varnished when they were installed in the chapel in order to give them a finish (a patina) that integrated well with the rest of the furnishings.

Certain parts of the gilded areas, sometimes complete motifs in the case of the pulpit, were painted yellow, no doubt to economize on gold leaf but also to create contrasts. For example, in the upper part of the pulpit, every second gadroon is gilded, and the others are painted yellow. The yellow paint is composed of yellow ochre, calcite, and silicates in a protein medium. In certain samples, the yellow paint was covered with size, which was identified in a sample taken from the pulpit as a mixture of calcite and animal glue.

Quite fine and often translucent red highlights were applied in the hollows of the gilding and the parts painted yellow, accentuating the effect of depth and volume. On the pulpit, red ochre and gum arabic were used; on the angel with the trumpet, vermilion and calcite (also in gum arabic) were used.

We may conclude that the parts to be gilded were first defined by application of the bole. Next, the gold leaf was applied and burnished in places, the ungilded surfaces were painted yellow, and then the red highlights were added. Here, the order of the gilding operations, as well as the application of red highlights with watercolor, are variations on the traditional gilding technique. It was usually the custom to first yellow the hollow areas, then apply the bole, and finally add the gold leaf (Watin 1773:149–60).

Composition of the overpaints

The original blue surfaces were overpainted more often than surfaces of other colors. They were first repainted blue, most likely at the end of the eighteenth century. In some places, one or two additional layers of blue paint were observed, which could be localized overpaints. All blue layers were applied using a technique similar to the original. The blue was later covered with a pink overpaint layer composed of lead white, vermilion, Prussian blue, drying oil, and a significant amount of barium sulfate, which indicates that the overpaint was applied after the end of the eighteenth century (Feller 1986:47–64). The pink layer is covered with five white overpaints, all containing lead white and drying oil, except for the last one, which consists of lithopone (barium sulfate and zinc sulfide) and calcite.

Figure 9
The statue of Saint Joseph and Child, in the upper niche of the main altarpiece. The angel heads on either side of the niche were originally painted with flesh tints.

The dark-colored surfaces, such as the black elements and the brown angel hair, in general, were overpainted only once. The ebony black was overpainted in a matte black. The flesh tints were overpainted three or four times. The layer visible now, like the last white overpaint, contains lithopone. In addition to lead white, the second layer contains barium sulfate, indicating that this overpaint, like the pink overpaint, was applied after the end of the eighteenth century. The flesh tints of the angel with the trumpet contain fewer layers, the number varying from one place to another. We may assume that this angel has at times been partially overpainted, perhaps while left in place over the sounding board, the result being that some parts were difficult to reach and were therefore left unpainted.

The two tabernacles, as well as the shafts of the columns and pilasters, are now entirely covered with oil gilding. The other water-gilded surfaces have been preserved, although there has been much retouching with oil gilding and bronze paint. Many of the ochre parts in the gilded areas were overpainted once.

In summary, the decor as a whole has undergone major changes in color scheme: the backgrounds, initially pale blue, were changed to pink and then to white. Certain elements changed drastically in appearance: some gilded motifs were painted; others that had originally been painted are now covered in bronze paint; some elements initially painted black were repainted white. Most of the black and gilded elements underwent less obvious transformations: the black motifs were overpainted in matte black; the flesh tints were repainted in a cruder fashion; and the water-gilded surfaces were partially regilded in oil or were covered with bronze paint (Fig. 9).

Treatment

Surface consolidation

The old surface finishes—gilding and polychromy—were unevenly afflicted by problems of extensive lifting and flaking, which had increased over time. For example, the gilding on the frame of the high altar painting had flaked badly, while the surface on the capitals of nearby columns was much better preserved. Gilding made from a different formula, as well as the two layers of water gilding on the frame, may explain this phenomenon.[10] In other areas, water infiltration had caused the damage. Most of the cleavage was between the ground and the wood; therefore, the first task was the systematic consolidation of the lifted layers—which proved to be a long and arduous process.

Various methods and materials were considered for consolidation: animal glue, wax-resin mixtures, acrylic, and polyvinyl acetate (PVA). The goal was to find an adhesive that was simple and safe to use. On a job site where many of the tasks are performed on scaffolds, often in uncomfortable positions without an air evacuation system, it is essential to use a nontoxic adhesive that is easy to prepare, apply, and remove. The product would also need to retain its physical properties (good flexibility in particular) over the long term in order to accommodate the movements of the wood during summer-winter environmental changes. Animal glue does not have this elasticity.[11] Wax-resin mixtures have the great disadvantage of impregnating and darkening the matte colors, although one was used (unbleached beeswax mixed with dammar resin, 10:1) in the few instances where cupping required a gap filler between the ground and the wood. A few acrylics met these requirements,[12] but Jade 403, a polyvinyl acetate emulsion that is well known in the North American conservation community, was finally selected. The authors already had a great deal of experience with it, and a study undertaken at CCI confirmed its exceptional chemical and physical properties.[13] It is easily applied by brush, it can be thinned with water, and a little wetting agent can also be added to assist in penetration.[14] Since it contains water, it can soften the ground slightly and facilitate repositioning of the flakes.

Surface cleaning

Concurrent with the surface consolidation, the surfaces were cleaned. First, dust and debris were removed with a brush and a vacuum cleaner. Then the water-sensitive surfaces were cleaned with Stoddard solvent, and other surfaces were cleaned with saliva or water with a wetting agent added.[15] This eliminated the accumulated dust, fly specks, and candle-wax accretions. A multitude of nails, pins, and miscellaneous fasteners were also removed during the cleaning process. The matting glue on the original gilding was retained, even though it had oxidized and become dust-laden. No overpaint was removed, because any aesthetic treatment was excluded from the first phase of the project .

Wood consolidation

The joints, fastenings, and anchorings were systematically checked, and were reinforced if necessary. When practical, elements were remounted using stainless steel screws or other hardware that would allow for easy dismantling, both to facilitate future work and to ensure rapid disassembly in case of fire or other emergencies. Split and broken pieces were reglued

with hide glue or fish glue.[16] Pine additions, such as brackets, dowels, and inlays were made only when required for the solidity of the structure. When it was necessary to provide support for small surfaces, impregnation was performed with Jade 403, and fillings were made with fine oak sawdust mixed with Jade.

The main altarpiece had been attacked by wood-boring insects (*Anobium punctatum*). The four columns and their pedestals suffered damage, particularly columns 1 and 4 (numbered from left to right) (Fig. 2). The shafts are trunks of basswood, partly hollowed at the ends by the sculptor. Shaft 4 was so fragile that it no longer supported its gilded surface in many places; therefore it was imperative to stabilize the weakened wood. Column 4 had to be removed, and the column shaft was treated in the laboratory. Impregnation with Acryloid B72, a consolidant often used for degraded wood, was deemed impractical—first, because of the need to provide high mechanical strength for an element of considerable weight that supports the entablature; and, second, because problems were anticipated in evaporating such a large quantity of solvent. A large mass of wood partially sealed by gilding would require many consecutive applications of resin, interrupted with lengthy periods of evaporation. Araldite AY103,[17] a two-part epoxy, was chosen as an adequate alternative because of its long-term stability, low viscosity, moderate exothermic reaction, and fairly rapid polymerization (Down 1984). It was injected through small openings, taking maximum advantage of the access offered by splits and losses.

Preventive Measures and Ambient Conditions

Long-term preservation of polychromed and gilded wood demands stable temperature and relative humidity conditions. The Ursulines were aware of this, and various preventive measures were discussed. However, investment in a climate control system for the building was felt to be an excessive option. The building is of masonry construction with double-paned windows; it is heated in the cold season by a network of hot-water pipes; and thermal insulation is present above the plaster vault. While imperfect, this system ensures a fairly regular temperature and prevents most abrupt changes in relative humidity. The months of July and August are a critical period, however, when rapid variations of relative humidity have been recorded. The seasonal transition in spring and autumn is gradual; relative humidity decreases in a fairly uniform manner, from an average of 60% in July and August to a level of 29% in January. The temperature ranges from 20 °C to 24 °C in summer, and is maintained between 22 °C and 24 °C as soon as the heating system is activated. A sophisticated system to control relative humidity might create disastrous situations in the event of a breakdown, and could trigger the swift deterioration of a building that was not designed to withstand a relative humidity of 40% or 45% in winter. Major modifications to the building would be necessary before installing humidity control. Simple preventive measures, such as lowering the chapel temperature a few degrees in winter months, should prevent most future damage to the polychromy and gilding.

The nuns remain in charge of maintenance of the premises and have implemented suggested preventive measures, which include improvement of the electrical system; installation of sprinklers, smoke detectors, and an alarm system; and UV filtration on the windows.

Conclusion

The four-year preservation program of Canada's oldest church interior was a testing ground for large-scale treatment, as well as for analytical and historical research. Each day, comparing the results of examination, analysis, and historical research proved challenging and essential. For example, dendrochronology helped clarify conflicting attributions to artists.

Of major importance was the identification of both the traditional techniques used by the artists and artisans for this group of furnishings and the variations they introduced to these techniques. The original polychromy and gilding method may be summarized as follows: application on all visible surfaces of an animal-glue gesso ground, protected by a coat of size; followed by water gilding and water-based paint everywhere except the flesh tints, which were painted in oil; and, in order to obtain bright and resistant colors, application of a thin protective layer of size on all water-sensitive surfaces, except the large blue areas. It is possible that no size was ever brushed on the blue, presumably to blend the decor with the blue-painted walls of the chapel. Another possibility is that the blue surfaces had been sized but were later washed prior to being repainted, a theory supported by the fact that no layer of dirt was observed on top of the original blue paint.

Another reward of this project was the establishment of an inventory of the alterations (addition, modification, and removal) that had been made to the furnishings, hence providing a precise scheme of the original layout.

As mentioned earlier, various overpaints and regildings have altered the color and tonal balance of the decor. Most regrettably, the reconstruction work of 1902 compromised the original architectural plan and diminished the stylistic unity of the chapel's interior. The authors therefore believe that, to do justice to the furnishings of the chapel, the preservation work already undertaken must be followed by a second, development phase designed to restore the brilliance of the decor and part of the original contrast. This could involve major work in exposing original surfaces. Regarding the water gilding and flesh tints, tests indicate that the rather dull overpaints could be removed without damaging the original surfaces beneath. If the same cannot be reasonably done for the blue backgrounds and black moldings—whether because of the difficulty of uncovering matte, fragile, water-soluble paint layers or because of their lack of uniformity (variations in the blues)—it would be possible to simulate their colors and finishes by painting over the present overpaints. The missing forms, particularly the parts of repetitive architectural elements, such as the capital and frieze foliage, could be carved and finished to match existing elements. Furthermore, the colors of the walls and the vault could be modified to restore, to some degree, the original relationships of volumes and tones. The vault, for example, could be overpainted with a darker color to make it appear lower. Artificial lateral lighting could be used to simulate the original daytime atmosphere.

The decisions on this possible second phase are yet to be made. The Ursuline nuns will make the final decision on the nature and extent of treatment, based on recommendations made by the advisory committee. The authors believe that the extensive research and preliminary treatment that has been done since 1988 will help to demonstrate the importance of continuing work to preserve this treasure of the cultural heritage.

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Notes

1 The *altarpiece* (*retable,* in French) is the architectural furnishing that covers the wall behind the altar; it usually contains statues and a painting. The *tabernacle* is the elaborate gilt eucharistic reserve that sits on the altar table. The *altar* consists of both the tabernacle and the table, and it stands in front of the altarpiece.

2 On the history, style, and iconography of the chapel, see Trudel 1972.

3 The Ursulines operated a gilding workshop from around 1650 until 1828. They were the first in New France to engage in such an activity and progressively transmitted their expertise to many other communities.

4 Micro-mesh grades 1500 to 12000.

5 The CEN researchers have established reference series for a few Quebec conifers: tamarack (*Larix laricina*), black spruce (*Picea mariana*), white spruce (*Picea glauca*), white pine (*Pinus strobus*), Canadian hemlock (*Tsuga canadensis*), and Eastern cedar (*Thuja occidentalis*). This technique has, as yet, been little used in Canada in the arts.

6 In most cases, the FT-IR analysis did not permit a more precise identification of the protein medium. However, in some samples, the proteinaceous medium was further characterized as a collagen-type protein, such as rabbit-skin or bone glue.

7 A thin white layer containing lead white and lead carbonate in a drying oil is also present immediately under the layer of blue paint, in some of the parts originally painted blue.

8 Jo Kirby plans to undertake research to investigate the phenomenon of the greening of Prussian blue.

9 This conclusion is supported by various lists of shipments to the Ursulines in the 1720s and 1730s (Archives des Ursulines de Québec 1680–1755, 1682–1761), in which *vermillon* (vermilion) is mentioned several times. These lists include other materials related to painting and gilding, such as *noir de fumée* (lampblack), *safran* (saffron), *ocre jaune* (yellow ochre), *ocre rouge* (red ochre), *terre d'ombre* (umber), *blanc de céruse* (lead white), *blanc de litharge* (litharge), *sanguine* (sanguine), *gomme arabique* (gum arabic), *rognure de parchemin* (parchment clippings), *rognure de gant* (glove clippings), *blanc d'Espagne* (calcium carbonate), and *craie blanche* (white chalk). There is no reference in the shipment lists to Prussian blue, but *cendre bleue* (azurite) is repeated many times. *Azur* (lapis lazuli) is also mentioned occasionally. It can be assumed that Prussian blue, a recent discovery at that time, was sent from France as a substitute for traditional, more expensive blue pigments.

10 The frame of the high altar painting is the only element that has been regilded with water gilding. Close examination shows that the altarpiece may originally have been designed to accommodate an older framed painting.

11 Rabbit-skin and fish glues are sometimes used for surface consolidation on sculptures that are kept in controlled environments.

12 The following acrylic adhesives were considered: Rhoplex AC-33, Plextol B-500, and Lascaux 498HV (see Materials and Suppliers).

13 The study, conducted by Down et al. 1992, covered the following characteristics of various resins, in natural aging: pH, volatile emission, yellowing, and flexibility (modulus of elasticity, elongation at break, cohesive tensile strength). The report states that Jade is actually a vinyl acetate copolymerized with ethylene.

14 The stock solution of Jade 403 was thinned 1:1 with water in small (30 ml) bottles, and a drop of wetting agent was added to each bottle. The wetting agent was Aerosol OT solution, 75% (w/w) aqueous (see Materials and Suppliers).

15 Aerosol OT solution (see note 15) was added to tap water. Saliva was preferred to water in cases of small and intricate surfaces that were sensitive to a wet cotton swab. It is easier to adjust the moisture content of a swab with saliva, and saliva is somewhat more active than water, which often proves useful.

16 When a long setting time was necessary for fine adjustment, liquid fish glue (sold as high-tack fish glue) was used undiluted at room temperature. In most cases, however, hide glue (no. 135 grade hide glue—4 parts glue in 5 parts water) was the first choice; it must be heated and sets rapidly but allows for some adjustment. Glue was chosen rather than acrylics or other synthetics, as it was compatible with any residue of old glue that might remain even after cleaning the surfaces.

17 Araldite AY103 resin, with H956 hardener, was mixed in batches of 200 g, and was preheated to 45 °C to start the reaction; then 20 g of acetone (10%) was added to further lower its viscosity. Only a small amount of resin was injected in an opening at any given time, to prevent any buildup of temperature. Polymerization was complete in less than twenty-four hours. Other epoxies were considered, such as Epo-Tek 301-2, which is more fluid than the AY103 but which takes days to polymerize, making large-scale impregnation impracticable.

Materials and Suppliers

Acryloid B72, Rohm and Haas Co., Independence Mall Street, Philadelphia, PA 19105.

Aerosol OT solution, Fisher Scientific Ltd., 112 Colonnade Road, Nepean, Ontario, K2E 7L6, Canada.

Araldite AY103 resin, with H956 hardener, Ciba-Geigy Canada Ltd., Polymers Division, 7030 Century Avenue, Mississauga, Ontario, Canada, L5N 2W5.

Epo-Tek 301-2, Epoxy Technology Inc., 14 Fortune Drive, Billerica, MA 01821-3972.

Jade no. 403, TALAS, Technical Library Services Inc., 213 West 35th Street, New York, NY 10001-1996.

Lascaux 498HV, Lascaux Farbenfabrik, Riedmuhlestrasse 19, Bruttiselem, Switzerland.

Liquid fish glue, Norland Products Inc., 695 Joyce Kilmer Ave., New Brunswick, NJ 08902. Sold as high-tack fish glue by Lee Valley Tools Ltd., 1080 Morrison Drive, Ottawa, Ontario, K2H 8K7, Canada.

Micro-mesh grades 1500 to 12000, Micro-Surface Finishing Products Inc., 1217 West Third Street, Wilton, IA 52778.

No. 135 grade hide glue, Bjorn Industries Inc., 551 King Edward Road, Charlotte, NC 28211.

Plextol B-500, Rohm and Haas Germany Ltd., Postfach 4242, Kirchenallee, D-6100 Darmstadt, Germany.

Rhoplex AC-33, Rohm and Haas Canada Inc., 2 Manse Road, West Hill, Ontario, M1E 3T9, Canada.

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The Painted Tester Bedstead at Agecroft Hall

Elizabeth Howard Schmidt

It is not surprising that so little early English painted furniture exists today, considering the fragile nature of painted surfaces and the vagaries in taste. Understandably, therefore, the elaborately carved and painted tester bedstead at Agecroft Hall (ca. 1580–1630) (Fig.1), and its companion painted chest of drawers (ca. 1650–75) (Fig. 2), have created much interest both here and abroad.[1]

The Agecroft Association purchased the bed in 1974 at an auction on the grounds at Burderop House, Wiltshire, England. The chest of drawers, sold at the same auction to a private collector, was purchased by Agecroft in 1978.

With the assistance of a team of specialists, Agecroft began a research project in 1994 in an attempt to resolve many of the questions concerning the painted tester bedstead (a rare example of early English painted furniture): How and when was the bed constructed and what alterations have been made to it over the centuries? What are the carved decorative motifs on this unusual bed, and how do they relate to styles of the period? How was the bed originally finished, and when was it polychromed? How do the form and painted decoration of the chest of drawers relate to the bed? Finally, how does the bed relate to the early-seventeenth-century wall paintings found in the southeast bedroom of Burderop House in

Figure 1
Painted tester bedstead (ca. 1580–1630) from Burderop House, Wiltshire, England, now at Agecroft Hall, Richmond, Virginia.

Figure 2
Painted, joined chest of drawers (ca. 1650–75) at Burderop House, Wiltshire, England, a companion to the painted tester bedstead at Agecroft Hall.

Wiltshire, England? This article examines available evidence and confirms a date of the late sixteenth or early seventeenth century for the painted bedstead, and shows that Burderop House was probably the original setting for the bed and its companion chest of drawers.

Bedstead

Construction and alterations

The form of the Agecroft bed is typical of sixteenth- and early-seventeenth-century English tester bedsteads that belonged to the middle and upper classes of society. A great bed, furnished with rich textile curtains and coverlets, was usually the owner's most important possession. Rarely was there more than one elaborately decorated bed in a house.

Predominantly oak, the Agecroft bed is constructed in several sections—bedstock, headboard, tester, and two main footposts of six parts each. Although little is known about construction practices in this era, furniture such as the Agecroft bed, made by country joiners, was generally constructed with materials purchased "off the peg" (e.g., precarved molding) or with materials supplied by the owner (Chinnery 1979:48–50).

Each rail of the bedstock is attached by a mortise-and-tenon joint to the headboard. It is somewhat unusual that the foot of the bedstock, which has its own low, freestanding footposts with turned finials, is also tenoned to the main footposts supporting the tester. Tester bedsteads of this period had turned wooden stakes, known as *bedstaves,* placed around the bedrails to prevent the many layers of bedding from slipping onto the floor. The bedstaff holes, each 2.54 cm (1 in.) in diameter and 5.08 cm (2 in.) deep, are still visible along the top of the footrails on the Agecroft bedstock.

Changes made through time to the bed are significant in establishing a date. Most of these changes were made to the bedstock. The original support for the bedding was roping, attached to the bedstock on all four sides. Later, the bedstock was lowered 17.78 cm (7 in.), and the rope holes on the bed rails and the lower headboard were plugged and painted over. Presumably, at that time, a canvas support for the bedding was attached to the bedrails. Beneath the present canvas support, attached to the bedstock with nineteenth-century cut nails, are the cutoff remains of earlier forged nails.

When the bedstock was lowered, the bottom register of the headboard became more visible (Fig. 3). On tester bedsteads of the period, the lowest register usually was not decorated because the occupants slept propped on large bolsters and pillows (due to the belief that it was unhealthy to sleep lying down); therefore, this area would not be visible. The lowest register of the Agecroft bed, however, has a series of four arched panels carved in low relief, which are blue and white with a red-grained paint background. This red graining, covering the now visible plugged rope holes, indicates that the bed was painted after the bedstock was lowered. Household inventories indicate that canvas-supported bedsteads existed concurrently with roped bedsteads from the sixteenth century;[2] therefore, the conversion from roped to canvas support could have occurred early in the bed's history.

Decoration

Much of the charm of English furniture of this period is the unique character of each piece. Scholars have cited numerous Continental designers,

Figure 3
Detail of the headboard. The red graining and plugged rope holes on the lowest register provided clues to dating the paint.

including Hans Vredeman De Vries and Jacques Androuet Ducerceau, who produced pattern books in the sixteenth century as sources for the decorative vocabulary in English Renaissance architecture and furnishings (Wells-Cole 1981; Forman 1971). Certainly there are elements, including architectural motifs, terminal figures with baskets of flowers on their heads, and fantastic animals, that obviously derive from these sources. It is very unlikely, however, that a provincial artisan such as the carver of the Agecroft bed would have seen the pattern books in their original form. The carver, therefore, must have created another version of these exotic motifs.

The main register of the Agecroft bed has a decorative scheme that is seen frequently on overmantels, chests, and beds of the period. Three terminal figures are depicted: a dark-skinned male on each side and a fair, blond female in the center. Each figure terminates in an elaborate shield, decorated with a stylized, carved animal face (Fleming, Honour, and Pevsner 1976:283).[3] Three identical white baskets of stylized, pink fruitlike flowers with green leaves rest on the heads of the figures.

The two inset panels on the main register, framed by green acanthus leaves, contain arches supported by pairs of facing lions (smiling and winged), an ancient motif of heraldic symmetry.[4] Beneath the arches, a pair of inner panels depicts carved, stylized pink carnations in various stages of flowering. Although stylized flowers were often used in arched panels on furniture and other carved or inlaid decoration, these flowers have no known exact parallel.

An interesting feature on almost all beds of this type is the presence of satyr figures somewhere on the headboard. Could this ancient symbol of lust be reinterpreted here as a symbol of fertility? The satyrs on

the Agecroft bed rest on a cornice on each side of the main register. They have pointed ears, blond hair, large black eyes, red lips, and no arms. Their legs and hooves are like those of a goat, with carved and detailed, brown-painted hair on the flanks. Around each of their waists is a black belt with a curious rectangular-shaped boss on the front. The figures are finished only on the front and one side, indicating that they were carved as a flanking pair.

The third and top register of the Agecroft headboard depicts two large, green sea monsters with pointed white teeth, each one swallowing a fish. The heads of the two monsters are joined in the center of the bed by a carved tasseled cord. Each tail ends in a spiral attached to a red rosette that has been cut in half at each end of the panel.

A headboard quite similar to the Agecroft example is on the Great Bed of Ware, now at the Victoria and Albert Museum in London. This oversized bed, almost 3.35 m (11 ft.) square, has been the subject of much speculation since it was mentioned in Shakespeare's *Twelfth Night,* first performed in 1601 (Thornton 1976).[5] The terminal figures on the Great Bed of Ware are very similar to the Agecroft examples. The beds differ in that the figures (including the satyrs) on the Great Bed of Ware are painted, whereas the rest of the bed is unpainted.

Figure 4
Detail of a 1640 joined armchair (illustrated in Chinnery 1979:457, 86, fig. 4).

Like the sea monsters on the third and top register of the headboard of the Agecroft bed, the fire-breathing, interlocking dragons on the valance have spiral tails attached to red rosettes, and their heads are joined by a short cord.[6] Victor Chinnery, an authority on English oak furniture, notes that these particular animal decorations on the Agecroft bed are typical of certain decorative elements found primarily in southwest England, where Burderop House is located. Indeed, the motif of paired dragons with spiraling tails is a consistent feature on the crests of Gloucestershire chairs (Fig. 4).[7]

Figure 5
Detail of winged red-haired man with black mustache and blond beard from the Agecroft bed, underside of the valance.

The winged figures in the four corners of the underside of the tester are probably the most striking and unusual decoration on the Agecroft bed (Fig. 5). They are realistic male heads with flowing, flaming red hair, black mustaches, and short blond beards. The use of the tasseled cords and the technique of the carving suggest that the sea monster sections, the dragons on the valance, and the winged figures were carved by the same person. The traditional guilloche and acanthus-leaf decoration on the main footposts is less imaginative than the carving elsewhere on the bed. The footposts are somewhat atypical, however, in that each has two large bulbous turnings rather than the usual massive plinth surmounted by posts with a single bulbous turning.[8]

Chest of Drawers

Early-nineteenth-century documents from Burderop House list a painted chest of drawers in association with the painted bed. The chest is made in two sections with an assortment of wood—oak, walnut, elm, and pine—which leaves little doubt that it was intended from the beginning to be painted (Chinnery 1979:90–91, 207, 209). Although the chest is painted in a naive and cursory manner compared to the bed, the motifs—terminal figures, flower panels, and the barely visible tasseled cord between sea monsters—are obviously taken from the bed.

Although the form of the Agecroft chest of drawers is typical for the third quarter of the seventeenth century, many questions remain regarding the piece. From a purely visual examination, it is impossible to

determine the relative dates of the bed and the chest of drawers. A paint analysis in conjunction with a thorough structural study of the chest of drawers will help to provide insight into this question.

Paint Analysis of the Bed

The form of the Agecroft painted bed, its construction, and its decorative elements all suggest a late-sixteenth- or early-seventeenth-century date of fabrication. However, questions remain about the original finish and the age of the current polychromy. To better understand the surface history, Agecroft conservator, Sandy Jensen, and Colonial Williamsburg conservator Carey Howlett took small samples from various locations and made a preliminary microscopic analysis. James Martin, director of Analytical Services and Research at Williamstown Art Conservation Center, carried out additional microscopy and chemical analysis of selected pigments and binders. Martin analyzed samples using four microscopic techniques: stereomicroscopy, polarizing light/fluorescence microscopy (PLM/FM), Fourier-transform infrared (FT-IR) microspectroscopy, and scanning electron microscopy with energy-dispersive spectrometry (SEM-EDS).[9]

The stratigraphy of paint layers and coatings was first determined by examining samples in cross section. This layering was then related to paints and clear coatings present on a section of detached headboard molding. Minute samples were taken from the molding for analysis of specific pigments, coatings and binders.

The analysis revealed three historic decorative treatments that remained largely intact on most of the bed's surface: (1) an early transparent amber-colored varnish; (2) a thin layer of red paint; and (3) a more complex layering, involving a base coat of red paint, a graining glaze, and polychrome details (Martin 1995).[10]

The wood substrate and amber-colored varnish

In sample cross sections, the wood fibers adjacent to the early coating appear very dark, suggesting oxidation due to prolonged exposure to light and air. The amber-colored coating itself appears to be a tree resin, probably pine rosin (Martin 1995).[11] Though probably transparent when applied, it is now yellowed, somewhat discontinuous, and heavily fissured, typical of an aged coating. The oxidation of the wood suggests that the components of the bed may have remained unfinished for some time after their construction, then received a thin coating of transparent varnish. The poor condition of the varnish indicates that it served as the finish coat for many years prior to the application of paint. Carved elements support the hypothesis that the bed's maker intended the natural oak to be the show surface. The carver employed decorative punch work in the ground areas to heighten the contrast between the ground and the raised carvings. Such work is both unusual and unnecessary on surfaces designed to receive polychromy; painted contrasts are far simpler to achieve yet more dramatic in effect.

The thin layer of red paint

The earliest pigmented layer is a thin red paint applied directly above the deteriorated varnish (sample cross sections reveal the paint flowing into fissures in the old resin layer). The paint consists of red iron oxide and lead white in a protein binder (Martin 1995).[12] This layer was applied after the

bedrails were lowered and the mattress support was changed from a rope to a canvas support; the thin red paint is the earliest layer found on the wooden plugs that fill the original rope holes.

The final decorative treatment

The polychromy currently visible on the bed is the third (and final) decorative scheme. It is considerably more complex than the earlier coatings and consists of an ochre-colored base coat, two red-graining layers, polychromed details, and a final coat of varnish. The ochre-colored layer, composed of lead white and red iron oxide in oil, serves as the primer for the green, blue, black, red, and white elements, but it also appears as the visible ochre layer in many areas. The two red-graining layers were applied above the ochre and consist of a lower opaque layer of red lead, hematite, yellow iron oxide, and lead white (or litharge); and a transparent upper layer composed of red lake. The upper layers of polychromy await further analysis but include a blue made from lead white, indigo, and smalt in an oil binder. The varnish above this decorative scheme has been characterized as a tree resin—possibly copal (Martin 1995).[13]

Dating the three paint schemes

The date of application for each of the three decorative schemes remains somewhat conjectural. The initial resin coating may have been applied within a few years after the elements of the bed were carved—in the late sixteenth or early seventeenth century. The second scheme—the thin red layer—was obviously applied after the bed support was converted from rope to a canvas support. This alteration occurred as early as the mid–seventeenth century, a date consistent with the forged nails associated with the canvas support and the materials used in the red paint. The final polychromatic scheme was certainly applied a good while after the bed was made, as indicated by the weathered, deteriorated condition of the earlier coatings; however, all of the materials thus far identified (pigments, binders, and varnish) were in use in the 1600s, and it is conceivable that this decorative scheme dates from late in that century. Further analysis may provide more conclusive information about the age of the polychromy.

Burderop House: The Original Setting for the Bed and Chest of Drawers?

The unexpected discovery in 1978 of early-seventeenth-century wall paintings—during extensive alterations to Burderop House, where the bed and chest of drawers were acquired—may be significant in tracing the history of the pieces (Fig. 6).

The manor of Burderop existed as early as the fourteenth century under the holdings of the Abbot of Hyde. The Stephens family owned Burderop from the early sixteenth century until trustees for Thomas Stephens (IV) sold the house in 1619 to William Calley I, a wealthy Londoner with court connections. Documents indicate that a "new . . . Mansion howse" had been built on the property shortly before Calley's purchase; however, nothing is known of changes made to the house after he became the owner.[14] A drastic reconstruction in the Georgian style, both interior and exterior, took place in 1730, leaving little evidence of the earlier structure. When the present owners of the house undertook renovation in 1978, the removal of eighteenth-century paneling unexpectedly revealed wall paintings in four of the first-floor rooms.[15]

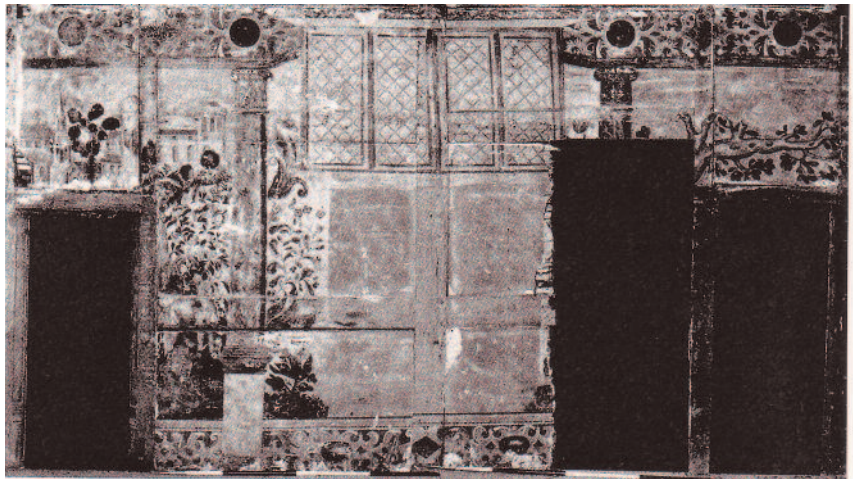

Figure 6
Photomontage of seventeenth-century wall painting, west wall of southeast room at Burderop House, Wiltshire, England.

The most complete wall paintings were found in the southeast bedroom, covering the west and the north walls. They depict a stylized landscape with animals, foliage, and buildings, divided by trompe l'oeil columns. An integral part of the decoration is the coat of arms of William Calley I painted above the fireplace on the north wall. This coat of arms is evidence that the wall paintings were applied sometime between 1619, when Calley acquired the house, and before his death in 1641.

The leaded-glass casement window, painted in the trompe l'oeil style in the center of the west wall, is strangely out of context with the landscape scene. The large blank area beneath this window measures approximately 173 cm by 208 cm, the same dimensions as the headboard of the Agecroft tester bed. An image of an earlier wall painting is barely visible beneath the surface of the blank area. This trompe l'oeil painting, depicting lozenge-shaped paneling, may have been the original setting for the painted bed, if a pre-1619 date for the bed is correct.[16]

Although the form and decoration of the Agecroft bed appears to be from an earlier date than the style of the more sophisticated wall painting at Burderop House, there can be little doubt that the wall painting was planned to surround a bed the same size as the Agecroft bed. The bed would have been placed in the center of the wall beneath the painted window. The wall paintings were designed to accommodate the doors at the extreme left and right of the wall. A second door on the right was inserted later, destroying most of the painted column and the foliage on that side.

A search for documents that refer to the painted bed and the painted chest of drawers has revealed little information. The earliest documented evidence of the presence of the pieces in Burderop House is an 1824 inventory of the contents. By that time, the bed and chest of drawers had been banished to the attic. They were located in room 21, which is listed as the "Image Attic." The bed is described as the "Image Bedstead," and the chest of drawers as "painted drawers with Key." The word *imaging,* an old term for painting and carving, suggests that the name had been attached to the bed early in its history.[17] According to an 1829 inventory, the bed and chest of drawers were still in the attic; however, the bed is described as the "Carved bedstead," while the chest of drawers is described as "painted Drawers and Key."[18]

The last nineteenth-century reference to the presence of the pieces in Burderop House is the 1882 inventory, which lists an "Antique

Four post Bedstead" and an "Antique Chest Drawers" in the "Blue Bed Room."[19] By this time, it appears that the bed and chest of drawers were returned to the first floor, possibly because of the late-nineteenth-century taste for Elizabethan and Jacobean furnishings. Correspondence in the file at Agecroft from the time of the 1974 auction states that the bed was slept in until the time of the sale.[20] The surviving relative, Sir Henry Langton, is quoted as stating that the bed and chest of drawers had been at Burderop House for many years, probably from the time the pieces were made (Warner 1974).[21] One may conclude that this statement is true, given the evidence from the nineteenth-century inventories and the bed's association with the early-seventeenth-century wall painting described here.

The painted tester bedstead at Agecroft Hall should be recognized as an extremely rare example of early English painted furniture. The form and construction of the bed and its decorative motifs are typical of the period and support the circa 1580–1630 date. Evidence from the bed's finishes does not contradict the proposed date. The paired dragon motif on the valance ties the bed to the southwest of England, the site of Burderop House, whose inventories from 1824, 1829, and 1882 link the painted chest of drawers and painted tester bedstead and place them together in the house. Wall paintings applied between 1619 and 1641 in the southwest bedroom reveal a space that is the same approximate dimension as the bed's headboard, suggesting that Burderop House was the original setting for the bed.

The Agecroft painted tester bedstead and its companion painted chest of drawers are worthy of further investigation. Research and paint analysis are ongoing on both of the pieces. A more thorough search of Burderop House family papers is being conducted to document the house as the original setting for the bed and chest of drawers. Continued research on the wall paintings may throw new light on their relationship to the painted tester bedstead.

Acknowledgments

The author wishes to acknowledge a number of people without whose assistance this project would not have been possible: conservators F. Carey Howlett and Sandy Jensen, who spent many hours examining the bed and the paint samples; scientist James Martin, who provided the information for the paint analysis section; and Margaret Taylor, who advised on the organization of this article. The staff at Agecroft Hall, Richmond, Virginia, has been an invaluable help, especially the curator of collections, Mary Anne Caton, and trustee Jane Paden. The Agecroft Association provided office support and the funds for the paint analysis of the bed and chest of drawers. In England, Victor Chinnery assisted and advised the author throughout this project. The staff of the Wiltshire County Council Conservation Laboratory, Frances Collard of the Furniture Department at the Victoria and Albert Museum, Nick Molyneux of English Heritage, and genealogist Pat Hughes have provided much useful information.

Notes

1 Agecroft Hall is a Tudor period house that was moved from Lancashire, England, to Richmond, Virginia, in the 1920s. It is now a museum furnished with a collection of English Tudor and early Stuart furnishings. The term *tester bedstead* is found in contemporary inventories; however, it is used interchangeably with the word *bed* throughout this article. *Tester* comes from the Latin *testa,* meaning covering.

2 Chinnery (1994a) substantiates that these means of support existed concurrently: "In sixteenth and seventeenth century inventories 'corded bedsteads' and 'canvas-bottomed' or 'sacking-bottom bedsteads' are found very much in parallel."

3 These human figures, the bottom halves of which end in pedestals, are called *terms*. Some authors refer to these figures as *atlantes* (male) and *caryatids* (female).

4 It is quite curious that the pair of lions on the proper left have the remains of what appear to be wooden dowels clenched between their teeth, and there are similar holes in the mouths of the other lions, where dowels would have been.

5 The reference to the bed speaks of a sheet "big enough for the bed of Ware" and appears in act 3, scene 2 of the play. The decorative scheme on the headboard is the same as the Agecroft example, except that the Great Bed of Ware, which is more refined in workmanship, has the female figure placed on the proper right side and not, as usual, in the center between two males.

6 The dragon panels appear to have been carved to fit this bed and are mitered at the corners.

7 There are comparable dragons over a stone doorway at University Farm House in the village of Moreton-in-Marsh, Gloucestershire, near Burderop House (Chinnery 1994b).

8 Other examples of footposts similar to those on the Agecroft bed are the well-documented bed at Montacute House, a bed at Athelhampton House (recently destroyed by fire), and the bed in the Rupert Room at Sudeley Castle.

9 Polarized light/fluorescence microscopy (PLM/FM) was performed at Colonial Williamsburg and at the Williamstown Center using an Olympus BH-2 polarizing light microscope equipped for epi-fluorescence illumination. Fourier-transform infrared (FT-IR) microspectroscopy was performed at the Williamstown Center using a Spectra-Tech IR Plan Research microscope coupled with a Nicolet Magna 550 optical bench; samples were prepared neat on Spectra-Tech diamond cells and analyzed for 32–512 scans at 4 cm^{-1} using Happs-Genzel apodization. Scanning electron microscopy with energy-dispersive spectrometry (SEM-EDS) was performed by the Williamstown Center using a Cambridge Stereoscan 100 SEM equipped with a Tracor (now Noran) EDS detector; samples were mounted on aluminum stubs, carbon coated for conductivity, and analyzed at 15–25 kV.

10 See also the chapter by Martin in this volume.

11 The coating, characterized by FT-IR, is rapidly soluble in acetone, causing later layers to release from the wood and presenting certain problems for solvent treatment of the bedstead.

12 The protein binder was characterized by FT-IR, and the pigments by PLM/FM.

13 Binders and coating were characterized by FT-IR; pigments were identified using PLM and SEM-EDS.

14 Pat Hughes in an unpublished manuscript, "The History of Burderop House," document 4, WRO 1178/38. Agecroft Hall.

15 The wall paintings, which were removed from Burderop House in 1978, are in the Wiltshire County Council Conservation Laboratory, where they are currently being treated.

16 Hughes, "Burderop House," document 8, WAM xxx 141/2. One can only speculate as to when the bed came to Burderop House. However, due to the apparent mental instability of Thomas Stephens (IV), the house was sold to Calley by trustees, and Stephens died in 1631 in the house of friends. It is certainly possible under these circumstances that furnishings were sold with the house.

17 Hughes, "Burderop House," document 4, WRO 1178/53. The items listed in the inventory indicate that these second-floor attic rooms were furnished for use and were not simply storage areas.

18 Hughes, "Burderop House," document 5, WRO 1178/53.

19 Hughes, "Burderop House," document 6, WRO 1178/411/3.

20 Further evidence of the bed's antiquity and importance is the exemption of the bed from death duties when the contents of the house were assessed upon the death of Major General Charles Pleydell Calley on 14 February 1932.

21 Warner quotes Sir Henry Langton, nephew of the late Miss Calley.

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Four Japanned Cabinets: A Variety of Techniques

Marianne Webb

The preparation for the opening of the second wing of European Decorative Arts at the Royal Ontario Museum has afforded the conservators and curators the opportunity to examine in detail many of the japanned pieces in the collection. This furniture has been in storage for many years because some of the pieces were considered unexhibitable due to their poor condition.

The type of japanning evidenced on these cabinets first became popular in the seventeenth century, as contacts with the Far East through the Dutch East Indies Company and the East India Company became more frequent. As the popularity increased, the demand could not be met by Asian lacquerwares alone. Early attempts to import the raw lacquer and to cultivate the trees that produce it failed, and, although it was being imported to England by the mid–eighteenth century, it was considered too dangerous for common use. Robert Dossie writes in *The Handmaid to the Arts* (1764:408), "Its poisonous qualities are almost constantly fatal to those who work with it any length of time and sometimes even on very slight meddling with it." New formulas were developed to produce a hard lustrous surface. This collection of four cabinets demonstrates several different techniques of japanning in use during the seventeenth, eighteenth, and nineteenth centuries.

English Seventeenth-Century Cabinet

This is a typical late-seventeenth-century japanned cabinet on an elaborate silver gilded stand (Fig. 1). Prior to examination by conservators, this cabinet was believed to be wholly from the seventeenth century; however, suspicions were first aroused when this piece was seen in good lighting. The exterior was severely damaged (Fig. 2), while the interior retained a smooth, refined surface (Fig. 3). The protection afforded by the closed doors was not sufficient to explain the drastic difference in condition. Also, under ultraviolet light the interior and exterior surfaces had their own distinct fluorescence. It was clear that the cabinet had been refinished, probably during the nineteenth century.

The cabinet was originally finished with a traditional European japanning technique, using shellac or seed lac as the resin. The decoration was completed by suspending gold and other metals within the layers of shellac. In some areas the metal powders appear to have been applied using a sprinkling technique, while in other areas the metal appears to have been mixed up as a paint, then applied. The molding between the

Figure 1
English japanned cabinet, dated 1695, as it appeared shortly after restoration in 1960.

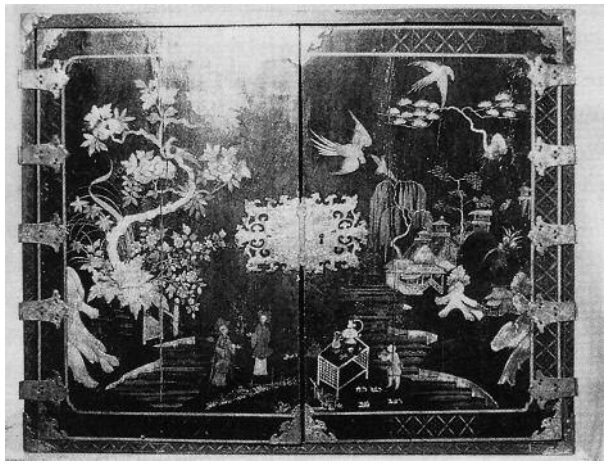

Figure 2
Front of the cabinet, showing the deteriorated state of the nineteenth-century finish. Note long vertical cracks through each door.

drawers and the interior of the drawers were speckled. The random distribution of the speckling suggests that the powders were applied by sprinkling, as opposed to brushing. The interior and exterior had been finished in a similar manner, except that there were also areas of raised decoration applied on top of the black shellac finish of the doors.

The designs are typical of the chinoiserie of the period, exhibiting Chinese landscapes, figures, and birds. While they are not exact reproductions of the designs shown in Stalker and Parker's 1688 book, *A Treatise of Japaning and Varnishing,* some of the landscapes and floral arrangements are very similar in appearance.

Examination and X rays were done in the Royal Ontario Museum's Conservation Department, and chemical analysis was carried out at the Canadian Conservation Institute (Miller and Moffat 1994), to reveal the history of the piece since its fabrication. Analysis revealed that the exterior of the cabinet was completely refinished in the nineteenth century. Cross sections showed that a heavy black-pigmented layer was applied over the original design; the cabinet was then redecorated using shellac and, in many areas, an oil medium. Instead of the fine technique of suspending gold powders in the layers of decoration, the gold leaf was simply stuck on in large patches with an oil mordant. Flakes of gesso and gold in the crevices of the stand suggest that the surface was regilded with gold leaf at this time. Evidence indicates that there was also a later restoration, probably just prior to the cabinet's arrival at the museum in 1960. The later gilding had been removed to reveal the original silver leaf surface. In

Figure 3
Interior of the cabinet in 1990. The original surface is in remarkably good condition.

addition, a poly(vinyl acetate) (PVA) varnish had been applied to the badly deteriorated front.

X-ray photographs were taken to determine if any of the original surface remained. Three images appear on the X-ray photographs: the image on the front of the doors, that on the back of the doors, and a third image hidden by the refinishing. Tracings on Mylar sheets were done of the front and back images. By superimposing the tracings, the differences between the original image and the nineteenth-century refinishing could be seen. In several areas, buildings were added where there had previously been delicate floral arrangements. Rocks and hills had been removed from the design, and figures were added in the foreground. In addition, the raised areas that had been decorated with plants were simply painted black, eliminating them from the overall scheme.

When the piece arrived in the lab, an evaluation of its condition was carried out. Shrinkage in the main body of the door panels had caused a large split through the center of each door, running from top to bottom. These splits had run through the entire thickness of the doors. In addition, numerous small splits were evident at the lower edges, where the horizontal cross pieces met the vertical panels. Losses in the surface layers on both sides of the doors were extensive along the edges of these cracks.

The interior and the exterior of the cabinet each had a distinct set of problems, due to their different histories. The interior sides of the doors and the drawer fronts presented surfaces that had been tampered with the least and were also in the best condition. On the interior of the doors, the surface was flaking badly in several areas. This appears to have been caused, again, by the overall dimensional change in the wood. Evidently, the flaking had been dealt with before by the application of a spirit varnish. On the surface of some drawers, losses had been infilled with this later varnish. The speckling on the moldings between drawers had been overpainted in heavy black varnish, probably shellac with lampblack. This later overpaint was delaminating in some areas, revealing the original speckled finish.

The exterior had undergone many changes, each of these leaving its mark on the surface. The overall appearance at the time the cabinet entered the lab was very "plastic," with numerous gray blisters caused by delamination of the PVA varnish. There were also numerous small losses where the nineteenth-century finish appeared to be separating from the seventeenth-century finish. This separation had been going on for some time, as the PVA layer had infilled many of the earlier losses. Some areas of decoration have been lost. The original raised gesso areas on the front are dry and crumbling with numerous losses, as well. In addition, the nineteenth-century oil gilding on the front and sides has been shrinking over time, leaving the gold decoration with an alligatored, patchy appearance. In fact, the oil gilding and bronze powder designs on the sides have deteriorated to the point at which much of the design can no longer be seen.

Before any consolidation was attempted, the surface was cleaned of loose dirt with a brush or soft cotton cloth. The PVA layer was removed, as it was delaminating and had failed to consolidate the flaking surface. Solvent tests confirmed that toluene would remove the PVA varnish without disturbing the underlying, earlier work. The doors were detached so this could be carried out horizontally by rolling toluene swabs over the surface within a portable fume hood.

Experiments were also carried out to determine the best method for consolidating the friable shellac finishes on the interior without disturbing the cabinet's appearance; additional consolidants would only serve to disturb the lustrous finish on the interior. Tests were conducted using a tacking iron with a 1 mm tip to soften the small flakes and then press the molten shellac back into place without the use of an adhesive. This method was used to adhere tenting and lifting on both the interior and exterior of the cabinet. The result is a sound surface that retains its original character. The raised gesso areas on the exterior were consolidated by brushing on a 5% rabbit-skin-glue solution, while the losses were infilled with 6% poly(vinyl alcohol) and whiting mixed with lampblack and raw umber dry pigments. The surface of raised area fills were sealed with 30% dammar varnish in toluene and mineral spirits (1:1), then inpainted with ivory black in the same medium.

Two small "windows" were made by lifting off the nineteenth-century finish with a scalpel; this revealed exquisite but incomplete decoration. Due to the brittle nature of the original finish, as well as X-ray evidence indicating an incomplete surface, it was decided that there would be no attempt to restore the previous seventeenth-century finish. The only other work that was carried out was to give the front of the exterior doors a coat of dammar varnish in an attempt to unify the patchy appearance of the finish. The dammar matches the surface of the piece much more closely than the former PVA varnish.

A Pair of French *Encoignures*

The second case is a pair of French *encoignures* dated to 1750 (Fig. 4). During this period it was popular in France to incorporate the use of Asian lacquer panels into the fabric of typical European cabinets. These pieces are a combination of Asian (probably Chinese) and European lacquer. The Asian lacquer panels have been split in half, the wood shaved down to a 2 mm veneer, bent into a curved shape, and applied to the doors. The curved doors are standard panel construction with a rigid frame and a fixed panel, both constructed of oak. The bent shape was achieved by a steaming-and-hardening process, as opposed to cutting the wood in a curve. In each case, the interior of the door was veneered in mahogany; the rest of the cabinet was fabricated around the door. The front of each cabinet was japanned in the style of the Chinese panel attached to it. It is interesting that the Chinese panel was completely repainted at the time of construction in order to better match the French japanning. The overpaint follows most of the design with surprising accuracy; for example, each needle of the pine trees has been precisely covered. However, in some areas there are design changes; certain trees have become rocks, and, in one case, a gold horse has been transformed into a dapple gray mare (Fig. 5).

Figure 4
One of the pair of eighteenth-century French *encoignures* before conservation. Note the difference between the condition of the door and the surrounding cabinet.

Samples from the doors and japanned panels of both cabinets were sent to the Canadian Conservation Institute (CCI) (Miller, Helwig, and Sirois 1994) for analysis to confirm that the overpaint on the doors was contemporary with the fabrication of the cabinets. Photomicrographs and pigment analysis confirmed that this is the case. Analysis also revealed that the major component in the japanning was the diterpene resin sandarac with a fairly large amount of larch resin added. The usual larch found in old recipes is Venice turpentine, the diterpene oleoresin from the

Figure 5
Detail of the door shown in Figure 4, illustrating the extensive cracking, as well as the abraded area around the edges. Note the French overpaint on the Asian panel, especially the repainting of the horse and the trees transformed into rocks.

European larch *Larix decidua;* however, as the larch diterpenes present in these samples are not found in the European larch, it may instead be the Siberian larch, *Larix siberica.* The triterpene resin elemi is also present, as well as monoterpenes characteristic of oil of spike. Oil of spike, produced from the lavender plant *Lavandula latifolia,* was used as a slow-drying solvent for lacquers and varnishes. Elemental analysis on the metallic powders used to produce the decoration indicated they were made from a variety of alloys. In one sample, there was a high amount of tin, which differs from the expected copper-zinc alloys usually used in this type of decoration.

The poor condition of these cabinets, primarily due to the original construction methods, was exacerbated by poor storage over the years. It is not surprising that the main carcass (framework) of the cabinets, and the japanning on them, have fared better than the panel doors. In the original fabrication of the oak frame doors, the wood was put under a great deal of stress to achieve a curved surface. This stress has been relieved in different ways on each door. On the door of the cabinet featuring a hunting scene (Figs. 4, 5), the stress has been relieved by a large split up the center of the door, and the vertical panel has warped inward along the split. In the case of the second door, featuring a landscape (Fig. 6), the curved horizontal pieces of the panel frame have straightened out. A difference of 10 mm between the vertical part of the panel and the horizontal member has caused the Chinese panel veneer to shred at the juncture point, as shown in Figure 6. The surrounding lacquer understandably has lifted, and much has

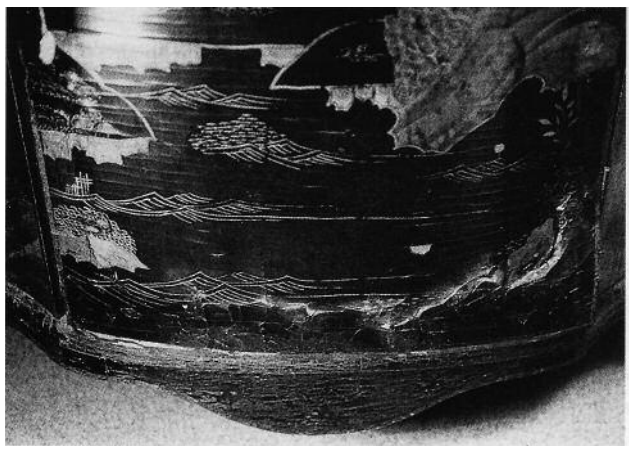

Figure 6
Detail of second cabinet of the pair of eighteenth-century *encoignures* before treatment. Warped door with landscape design shows large split in veneer panel and extensive overfilling to compensate for the damage.

been lost in all four corners of the panel. The damage to the wood veneer on the interior of the door is much the same, with splits and areas of lifting corresponding to the distortions of the oak base.

Both doors exhibit a series of tented cracks, at 5–10 mm intervals, running over the entire surface. This stress-cracking phenomenon has been well documented by Kenzo Toishi and Hiromitsu Washizuka (1987:170–72) on pieces in Japan. In the case of these two cabinets, the stress was undoubtedly induced, in each instance, by gluing a flat Chinese panel to a curved surface. The cracks in each of the doors cross the grain of the wood of the underlying panel. Figure 4 shows this cracking in the first cabinet running horizontally over the vertical wooden panel and vertically over the horizontal members of the oak panel. This problem has been observed on other examples of French furniture in which Asian panels were glued to a locally made carcass. The National Gallery of Art in Washington, D.C., has a number of pieces by Jean Desforges, all exhibiting the same stress cracking (National Gallery of Art 1993).

The carcasses of the French cabinets were in much better condition than their doors, primarily due to the original construction methods. The curved shape on each front section was achieved by cutting the wood into that form. There are cracks between the joins of the four pieces that make up the front, but this is to be expected. The numerous small losses of the original japanning run with the grain of the wood, indicating that they have been loosened over the years by repeated shrinking and swelling of the wood, not by stresses set up in the initial construction.

It is natural that cabinets exhibiting this inherent vice would have undergone repairs at some point prior to arriving at the Royal Ontario Museum. There was evidence of at least two previous restorations to the pair. At one point in time the edges of the Chinese panel were readhered to the oak panel on both cabinets. At this time, the surface of the panel was severely abraded in an attempt to flatten the lifting lacquer. There is a 3 cm strip around the edge of each panel, in which all the European overpaint has been stripped off and the Asian lacquer stripped back to the base layer. The abraded area was then overpainted in black varnish, with bronze paint to imitate the decoration. The particle size of the later bronze paint was much larger, and the execution did not match the refined technique of the one first used. During this first restoration, losses to the panel were infilled with gesso and inpainted to match the surface.

A later restoration was carried out during the 1940s at the Royal Ontario Museum, in which an attempt was made on each cabinet to reconcile the different levels of the warped panel. A water-soluble putty was applied to the corners of the cabinet to level out the distortions; unfortunately, much of the design was covered in this process. These crude fills and the surrounding area have extensive black overpaint with bronze paint decoration. The same restoration method was carried out on cracks between wood members on the carcass itself.

The conservation treatment of these cabinets was time consuming, but not particularly difficult. The doors were detached from the cabinets to better facilitate the work of removing the 1940s fills and overpaint. Once the surface of the lacquer was clear, the structural work could begin. The interior wood veneer was easily removed with a spatula, as the animal glue was very dry and brittle. The horizontal oak pieces could not be detached from the lacquer panel on the front, so reshaping had to be done in place. Several shallow cuts were made across the grain at the point of

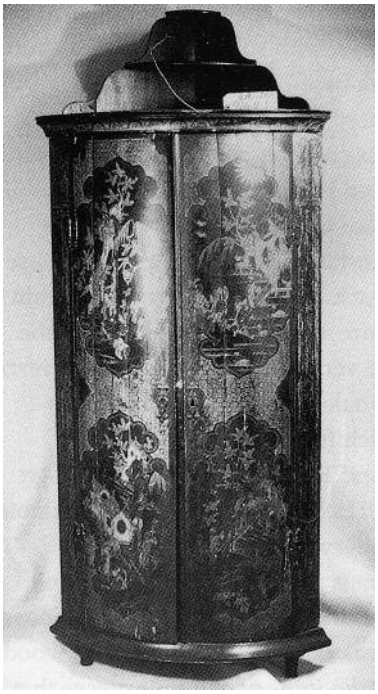

Figure 7
Eighteenth-century English corner cupboard.

maximum warp, until the oak board could be pulled back into its original curve. Cold fish glue was applied to the cuts. Then the piece was clamped into the new shape until dry.

Once the distortions were corrected, one could see the extensive damage that had been caused by the warp. The wooden portion of the lacquer veneer had itself been distorted, and in some areas the wood had been shredded. The lacquer surface, unable to accommodate these changes, had lifted and flaked off in great quantities, while the remaining flakes had cupped. In most cases, the lacquer was sufficiently pliable that it could be laid flat using clamps. Where it was too brittle to flatten without breaking, it was softened prior to gluing by using a thermal sheet controlled with a rheostat to about 50 °C. Cold fish glue, with 10% ethanol added as a wetting agent to facilitate the flow under the surface, was injected to hold down both the distorted lacquer and its wooden base. The consolidation took several months, as no more than a few square centimeters could be done in a single day. The lacquer has a powerful "memory" of its distorted state, so a great number of clamps were required. In addition, large quantities of fish glue could not be used at one time because an excess of moisture would cause marks on the oriental lacquer surface.

Following consolidation, the veneer was replaced, and losses were infilled using 8% poly(vinyl alcohol) and whiting. The surface of the fills were inpainted with Acrysol WS-24 (an acrylic emulsion) and aniline dye to imitate the oriental lacquer. The japanned areas were inpainted with Liquitex acrylic medium and mica-based pigments, instead of the metallic powders used originally. These mica pigments match very closely the effect of the metal powder but have the added advantage of not tarnishing over time.

An English Corner Cupboard

The fourth cabinet is mentioned only briefly here as a work in progress. It is an English corner cupboard, dated about 1750 (Fig. 7). Although it arrived at the museum with feet, it was originally a wall cabinet; the location of the drawer near the base, and holes to secure it on the wall, is clear evidence of its first purpose. It now looks like it was decorated in a black-and-gold chinoiserie style; however, again this was not its original appearance. The front has been revarnished many times; and over the centuries each of these layers has discolored, giving the background the dark brown color it now possesses. Close inspection of the interior drawer, which escaped revarnishing, indicates that the original color was much different. Although the old varnish has itself somewhat discolored, the initial blue color can be seen in the areas that have been protected by the gilding.

Analysis of the pigments and resins (Miller and Helwig 1994) with Fourier-transform infrared (FT-IR) spectroscopy, scanning electron microscopy (SEM), and microscopy at the Canadian Conservation Institute show that the ground layer was carried out using lead white and smalt (Fig. 8). The varnish layers directly on this ground layer were made using sandarac as the main resin, with additions of colophony and a small amount of larch resin. Traces of pinenes and verbenone would indicate that turpentine was used as a solvent. Smalt was added to this varnish recipe to make a type of colored varnish for the second layer, while subsequent layers contained the same varnish alone. A thin orange-red pig-

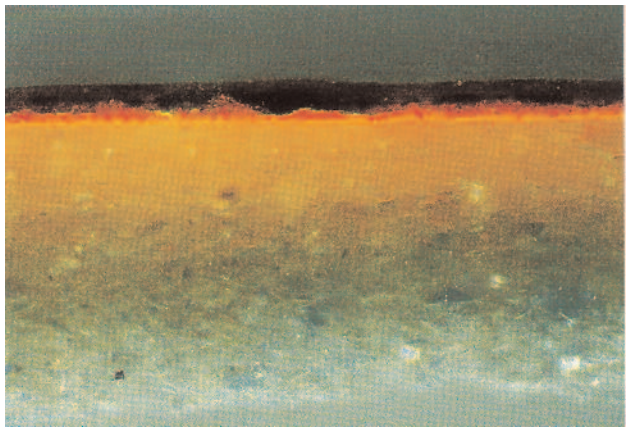

Figure 8
Photomicrograph of the various surface layers on the cabinet shown in Figure 7. From bottom to top, they are as follows: ground layer of smalt and lead white in an unknown medium, sandarac-based varnish with smalt pigment, clear sandarac-based varnish, thin red-pigmented layer under gilding, later shellac layer applied on top.

mented layer was found immediately under the gilding. This approach, and the resin used, correspond nicely to recipes found in the publications of both Stalker and Parker (1971) and Dossie (1764) for colored japanning. The later layers that had been applied at various times over the original finish were determined to be shellac, natural resins, and (in one area) linseed oil.

Unfortunately, time did not permit a complete treatment of this piece. The small losses of varnish that exposed the smalt and lead white base layer were toned in with Soluvar and pigment as a temporary solution until a complete treatment could be carried out.

Conclusion

Although it is not necessary to carry out detailed chemical analysis of every piece of japanning before beginning conservation treatment, in the cases discussed here it has been most beneficial. The additional information has helped decide the overall treatment approach, and has also given a greater understanding of the actual methods used in the history of these pieces.

It is readily apparent that a glossy black finish is not necessarily shellac. A great many natural resins were used to achieve the hard glossy surface of lacquer. A look at the literature of the time tells us to expect to find many complicated formulas. Indeed, they are often more complicated than the paintings of that time, for which we have a large body of knowledge.

These four cabinets demonstrate in concrete terms exactly how perplexing it can be to visually differentiate between the various formulas. If there are facilities available for the detailed study of pieces in one's care, that study should be encouraged in order to build up a catalogue of information concerning these finishes. It is time that these pieces of furniture be given the same consideration as is given to fine art. Certainly, the makers had the highest regard for their works; to quote Stalker and Parker (1971:10), "You must not expect to raise a noble piece from dross or rubbish; to erect a Louvre or Escurial with dirt or clay, nor from a common Log to frame a Mercury."

Materials and Suppliers

Acrysol WS-24, Rohm and Haas Co., Independence Mall Street, Philadelphia, PA 19105.

Poly(vinyl alcohol), BDH, 350 Evans Avenue, Toronto, Ontario, M8Z 1K5, Canada.

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The Hunnewell Cottage

Preservation and Re-creation of a Nineteenth-Century Exterior Paint Scheme

Andrea M. Gilmore

JOHN W. MASURY, in his book titled *How Shall We Paint Our Houses? A Popular Treatise on the Art of House-Painting: Plain and Decorative* (1868:18–19), describes the transformation in the painting of American buildings in the second half of the nineteenth century as follows:

> The business of house-painting has so outgrown its former insignificant proportions that its past and present features have almost lost their resemblance. Today, more money is expended on painting a single edifice than would have sufficed to paint every house in a respectable-sized town thirty years ago, and the amount of capital, skill and intelligence now required to conduct the business successfully in cities and large towns, was not dreamed of at the time.

The Hunnewell cottage in Wellesley, Massachusetts, designed by John Sturgis and built in 1871, exemplifies the zenith reached in exterior architectural painting in the second half of the nineteenth century (Fig. 1). The original paint scheme consisted of eight bold paint colors, selected to

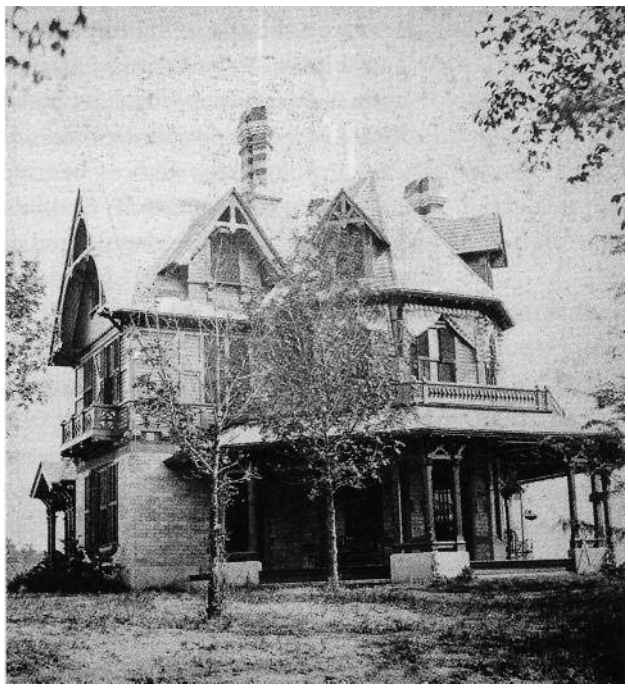

Figure 1
Hunnewell cottage, west elevation, Wellesley, Massachusetts, photographed before 1879. Original paint scheme.

highlight the wooden architectural elements of the cottage: visible "stick style" framing, bargeboards, gable overhangs, gable brackets, incised detail in the vertical board sheathing of the dormers, and the beveled edges of the porch columns and bargeboards. They also complemented the masonry of the first story and the glazed tiles set into the brick at the junction of the first and second stories. In his choice of paint for the Hunnewell cottage, Sturgis illustrated the integral role that paint color played in his design. His work clearly reflects the statement made in the Devoe paint book, *Exterior Decoration,* of 1885 (1976:19):

> Today, the architect, where he values his reputation and is desirous of giving his clients perfect satisfaction, is as solicitous of the color effect as of the general design of his work.

Exuberant late-nineteenth-century exterior paint schemes, such as that found on the Hunnewell cottage, often had relatively short lives. They were costly to maintain and repaint, and because these schemes arrived toward the end of the Victorian era, they fell out of favor within twenty to thirty years of their creation. In the case of the Hunnewell cottage, the original eight-color scheme was never repainted. When the library was added to the south elevation in 1879, the cottage was painted with the ever popular late Victorian scheme of red siding and dark green trim.

During most of the twentieth century, the important role of color in the design of Victorian architecture has been ignored. Grand Queen Anne and stick style houses have often been painted a single color, minimizing the effect of their ornamental architectural elements. In recent years, however, as interest in Victorian architecture has been rekindled, buildings are again being painted with the rich colors used in the second half of the nineteenth century.

Efforts to re-create appropriate and accurate exterior paint schemes for Victorian buildings have met with varying levels of success. The least accurate of these methods have used colors that are not appropriate to the Victorian period. The California "painted ladies" of the 1970s are representative of this type of pseudo-Victorian paint treatment (Moss and Winker 1987). Victorian schemes have been re-created more appropriately with colors specified in nineteenth-century house-painting guides. These recommend specific colors for different architectural elements and contain color chips that can be used to create alternative schemes. The most accurate restorations involve analysis of paint samples removed from a building to identify the original colors and the architectural elements on which they were used. This level of analysis was undertaken to identify the original paint colors on the Hunnewell cottage.

As re-created, the eight-color scheme documents the original, complex, late-nineteenth-century paint scheme. It reveals the important role that color played in the design of this cottage, particularly in the scheme's relationship to the masonry materials, whose colors it replicates, and to the architectural elements it highlights. Further, it illuminates the role color played in Victorian architecture in general, dispelling the mystery and myth that surround the selection of paint colors for Victorian buildings.

Historical Background

The appearance of elaborately colored Victorian houses in the second half of the nineteenth century coincides with dramatic changes that were

occurring in the American building industry. The rapid growth of the industries that produced building materials and the expansion of the railroads across the country transformed American house design and construction. The boxlike shapes of the timber-frame houses of the eighteenth and early nineteenth centuries were replaced with balloon-framed houses constructed with 5 cm (2 in.) dimensional lumber and wire nails. These houses had irregular floor plans, asymmetrical facades, and roofs formed by monumental gables that were punctuated with dormers, turrets, and towers. They were trimmed with mass-produced doors, windows, sheathing (shingles, clapboards, and vertical boards), and machine-turned or machine-cut ornamental trim. To accentuate the three-dimensional qualities of the design and the variety of materials used to sheathe and ornament the exterior surfaces, painters used the newly available, boldly colored, ready-mix paints on these houses.

Devoe, writing in 1885 about Queen Anne style houses, says the following about the use of paint colors to pick out exterior architectural features (Moss and Winkler 1987:26):

> It [the Queen Anne style] furnishes an opportunity for the greatest display of taste in coloring and exterior decoration. The many fronts, diversified as to materials, with visible framing shingle or smooth covering, the gables, the porches, etc., all provide a means for the employment of parti-colored effects, the most attractive and artistically valuable features of modern house painting, and one that the old box-pattern house, with its plain flat front, does not readily admit of.

The proliferation of nineteenth-century house designs and paint schemes was facilitated by the publication of architectural pattern books and house-painting guides. The pattern books provided house plans, detail drawings of architectural trim, and materials specifications for Victorian houses of varying size and style. The house-painting guides included chromolithographs of houses painted with combinations of colors. These combinations were chosen to illustrate how different paint colors could be used with varying architectural styles and how architectural details could be highlighted with different paint colors. The colors in the chromolithographs typically were keyed to paint-color chips that were also included in the house-painting guides. In Devoe's house-painting guide (1885), most of the houses shown have paint colors for four elements: body, trim, blinds, and sash. The notable exception is plate 2, which is painted with a combination of seven colors: first story body, second story body, trim, blinds, sash, peaks and side dormer, and roofs.

Conservators of nineteenth-century architecture are seeking, through paint research, to understand how the information in the pattern books and painting guides was put into practice. This work involves the detailed examination of houses that were built and the identification of their original paint colors. The Hunnewell cottage afforded an opportunity for a paint study of this type, which revealed a paint scheme that documents the use of Victorian design and colors found in pattern books and painting guides. However, the Hunnewell cottage paint scheme exceeds those specified in the house-painting guides in terms of the number of colors used and the complexity of their application. The cottage's complexity reveals the need for paint analysis to accurately document nineteenth-century exterior paint schemes. Furthermore, the integral relationship of

the original paint scheme to the cottage design and building materials makes a compelling argument for its careful conservation.

Paint Investigation

The identification of the original paint colors began with the examination of a photograph taken of the cottage around 1875 (Fig. 1). The photograph showed a polychromatic paint scheme in the varying tonality of the black-and-white image. It also showed the polychromatic effect of the different masonry materials used to construct the first story—cast stone, brownstone, brick, and granite, and banding in the slate roof and stripes painted on the chimney.

On-site work began during the summer of 1992 with a quick examination of the existing paint scheme. All of the wooden elements had been painted tan, and the shutters had been removed (Fig. 2). Craters made in the paint, examined with field microscopes, revealed an interesting but confusing layering sequence. Some of this confusion was eliminated by comparing the layers on the original house with that of the 1879 addition. The addition originally had a two-color paint scheme—a dark red and dark green design—which became a guide, both in the field and in the laboratory, for identifying the finish layers of the original scheme.

In the field, some of the general colors of the original paint could be identified—the tan on the clapboards, the red-brown on the trim, the blue on the underside of the gables, and the bright red-orange that was used to accentuate some of the architectural trim. More important, however, the field observations revealed the need for extensive sampling to identify the original locations of the many paint colors and the need to develop a system for keying the paint samples to photographs or drawings, so that the original design could be accurately reproduced. Ideally, when such an elaborate paint scheme is documented, measured drawings will exist for the building. Unfortunately, none of the Sturgis drawings for the Hunnewell cottage survive, so photographs had to be used to record the locations of the element samples.

In the laboratory, microscopic examination of paint-sample cross sections revealed that the original design had been created with eight different colors. It also revealed that the paints on the trim had been built up in layers, with the dominant red-brown trim color applied first, followed by the different colors used to accentuate the architectural ornament.

Figure 2
Hunnewell cottage, 1992, before the original paint scheme was restored. The cottage is shown with a monochromatic tan paint scheme, and the exterior blinds have been removed.

Samples of each of the finish paints identified in cross section were exposed with a scalpel and matched to Munsell color standards. Color matching did not involve any adjustment for color change over time, beyond a sampling strategy that located well-protected samples in thick layers that were judged to be the truest colors surviving on the cottage. The colors used to re-create the original paint scheme are given in Table 1.

Because it would have been prohibitively time-consuming and costly to sample and prepare a cross section for every architectural element, after the original colors were identified in the laboratory, field microscopes were used to confirm their location on many of the exterior surfaces. This proved to be a particularly important strategy for verifying the locations of different colors, as some of the high gables were available for examination only after the painting contract began and the gables became accessible from the ladders and scaffolding.

Field microscopes were also used throughout the contract to verify paint locations and to establish boundaries between the different colors. Identifying the boundaries was one of the more challenging tasks involved in re-creating the original scheme, since so many colors were used on such complexly shaped architectural elements. Boundaries were established by cutting a channel in the paint, approximately 3 mm wide, across the suspected boundaries of the different architectural elements and viewing the sides of the channels using a field microscope to identify where the color changes occurred.

The findings of the paint study were recorded in a report that documented the procedures used to identify the original colors. The report made recommendations for re-creating the original paint scheme of the cottage and was used to prepare the specifications for the job.

Re-creating the Original Paint Scheme

The re-creation of the original paint scheme posed several conservation and technical challenges. The conservation issues involved the question of how to preserve original paint evidence and how to prepare the surfaces for repainting. The technical challenges involved transmitting the paint color information to a paint contractor for accurate replication.

The existing exterior paint surfaces exhibited the typical aging characteristics of one hundred years of paint buildup (cross sections revealed that the cottage had been painted eight times) and weathering. Many of the painted surfaces were alligatored, and others were peeling;

Table 1 The eight colors used to re-create the original paint scheme on the Hunnewell cottage

Architectural element	Munsell color notation	Color
Clapboards	10 YR 5/2	brown
Wood trim (principal color)	2.5 YR 3/4	dark red
Blinds and window sash	5 Y 3/1	dark olive green
Underside of overhanging gables	7.5 BG 7.4	sky blue
Vertical board sheathing	25 Y 6/6	mustard yellow
Incised detail in vertical board sheathing	7.5 Y 4/2	olive green
Gable brackets	5 YR 2/4	dark red
Ornamental wood trim highlighting	10 R 5/10	orange

paint loss had fully exposed the wood of some elements. Most of the paint was lead based, adding a further consideration to all surface preparations.

Traditional restoration of an original paint scheme would have involved stripping all of the alligatored and deteriorated exterior paint. (It was estimated that about 90% of the painted surfaces would have had to have been stripped.) Stripping would have created a clean, smooth substrate for repainting. It would also have removed layers of paint that had filled in around the carved ornamentation and restored the depth and detail of the carving.

In recognition of the significance of the exterior paint scheme preserved on the Hunnewell cottage, however, it was decided that a much more conservative approach to surface preparation would be undertaken. Instead of stripping all of the aged paint surfaces, all of the well-bonded paint—even if alligatored—was preserved. Peeling paint was scraped by hand, and areas of paint loss were feathered into the adjoining paint edge and lightly sanded. The surfaces were then primed, and a finish coat of paint applied. The decision was made to apply only a single coat of finish paint, rather than the two coats traditionally used for a high-quality paint job, in a effort to minimize paint buildup. Since many of the trim elements were, by the nature of the paint scheme, to have multiple paint layers, limiting the base layers to two coats seemed an important long-term preservation decision. However, adequate coverage was not possible with one finish coat on the dark green of the sash and shutters; therefore, two coats were applied in these areas.

The level of surface preparation chosen balanced the goals of (1) preserving as much of the early paint as possible and (2) preparing the surfaces so the new paint would be adequately bonded to ensure a durable paint surface.

The next task was to prepare a specification so the work could be competitively bid, using a standard specification for exterior painting on a historic building. The bid was sent to three prequalified painting contractors. Each contractor was interviewed at the cottage to ensure that he understood the condition of the existing paint, the level of surface preparation specified, and the complexity of the paint scheme to be re-created. Contractors also were told that the contract would be supervised by the architectural conservator who had conducted the paint research and that the conservator would have access to the scaffolding so that paint color locations could be verified throughout the duration of the contract.

The contractor selected had extensive experience painting larger, multicolored Victorian houses. He also had an immediate understanding of the conservation goals as they related to the original paint scheme and surface preparation. Furthermore, he was sensitive to the need for field decisions based on the exposure of additional paint evidence during the course of the contract.

Because the groundwork for the contract had been carefully laid, the actual painting project went very smoothly. The degree of surface preparation was reviewed on each elevation of the building and tailored to the amount of paint deterioration encountered. Since Munsell color standards are not commercially available paint colors, finish paints were custom mixed and approved prior to application. Several colors required adjustment: the heavily pigmented colors found on the cottage were relatively challenging to re-create using the modern bases of commercial paints, and it took several attempts to achieve an accurate color match.

Figure 3
Hunnewell cottage, 1995. Original paint scheme re-created.

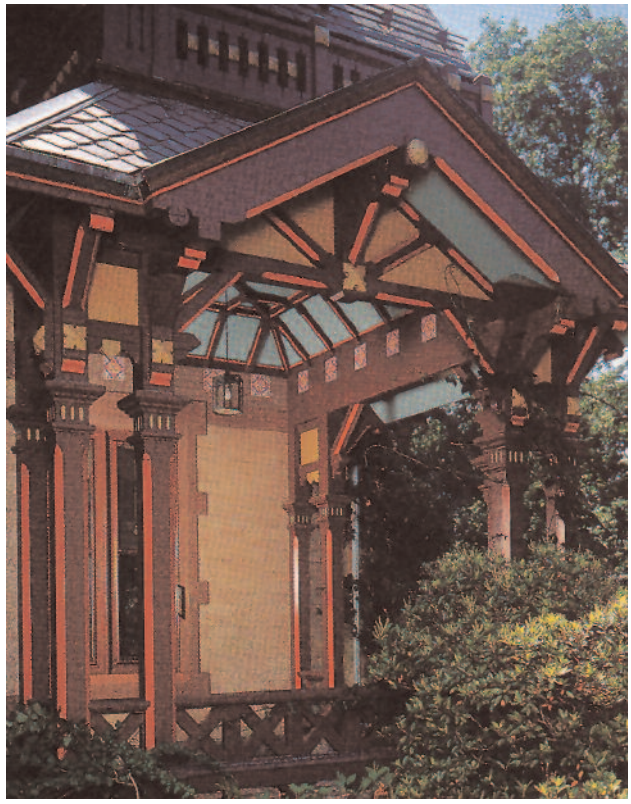

Figure 4
Hunnewell cottage, 1995. Detail of the entry porch column.

Biweekly meetings facilitated regular review of the placement of colors, making detailed drawings specifying color locations unnecessary.

The sequence of work was as follows:

1. Pressure washing of the surfaces to remove dirt and pigeon excrement. (Pressure washing is not generally recommended as part of paint preparation for a historic building; however, because of the pigeon excrement and general surface soiling, it was deemed necessary for this project.)
2. Scraping and sanding of the deteriorated paint. Sanded surfaces were wiped with a rag dipped in mineral spirits to remove dust prior to painting.
3. Priming with a gray oil-based primer.
4. Application of a finish coat of oil-based paint. As in the original painting, the principal exterior paint colors were applied, followed by the colors used to accentuate the architectural ornament.

Figures 3 and 4 show the completed paint scheme.

Summary

The paint study and the re-creation of the original paint scheme on the Hunnewell cottage revealed the important role played by paint analysis and the conservation of exterior architectural paints in the preservation of Victorian architecture. The full range and placement of colors on the cottage could not have been determined without the thorough sampling and analysis of the original paints, nor could the architect's full design intent have been understood without knowledge of the exterior paint colors.

The tan, monochromatic, prerestoration paint scheme obscured the incised detail in the vertical boards in the dormers; the beveled edges of the stick framing, porch columns, and bargeboards; and the ornamental brackets of the overhanging gables. Painted in eight colors, this architectural detail has now become an intricate three-dimensional design whose complexity is akin to the delicate pattern and colors found on the glazed tiles that Sturgis set in the brick band at the top of the first story.

Acknowledgments

The author would like to acknowledge Jane Hunnewell, who undertook the paint study and restoration of the Hunnewell cottage. Her intellectual curiosity and love for her family home provided the conservation team with the opportunity to retrieve this remarkable nineteenth-century exterior color scheme.

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Technology and Conservation of Decorative Surface Systems of Horse-Drawn Vehicles

Marc A. Williams, Merri M. Ferrell, and Jennifer Baker

In his book *House-Painting, Carriage-Painting and Graining,* John W. Masury (1881:243)[1] concisely describes the desired qualities of the carriage finish: "To show the best possible colors, the light must be reflected, not from a flat, opaque surface, but from a surface which has beneath it a depth of continuous colored particles reaching way down through the successive coats of varnish to the groundwork." This deep, jewel-like surface was achieved by selecting combinations of base colors and glazes that complemented each other. The use of colored varnishes and glaze layers to tone paint layers before varnishing was considered one of the more subtle aspects of carriage painting and one that separated experienced painters from amateurs. This was an area in which the painter's aesthetic abilities could be highlighted. One British writer (Shinnie 1902:480) complained that "the French and Americans seem to excel us in this. They operate with great daring in the glazing of contrasts, but with brilliant effects." Gardner describes glazing in the following way (1885:170):

> The art of giving a ground-color a different shade or richness by coating it with a transparent glaze or thin wash. The pigment, such as carmine, ultramarine blue, etc. is mixed with varnish to form a sort of colored varnish, not a solid covering, and then applied the same as varnish to a ground quite near the color of the glaze.

While there were some minor variations from shop to shop, the industry had fairly standardized methods for applying carriage paint. In addition to aesthetics, durability was a primary consideration. The finish had to stand up to the jarring shock of cobblestone or brick city streets without becoming too brittle and breaking off. Finishes were also subjected to extremes of weather. The process was both labor and materials intensive, involving the application of up to two dozen layers of slow-drying paint and varnish, many of which were almost completely rubbed off again, in order to obtain a flawlessly smooth finish. Trade literature from the close of the century shows that over the years the overall number of layers decreased, in an effort to cut costs and speed up the process. In his book, *The Carriage Painter's Companion,* Masury writes that it takes fifty days of labor to paint a coach (1871:182). In comparison, in *Automobile Painting and Carriage and Wagon Painting,* a paint sequence requiring only ten to twelve days is described (Vanderwalker 1917:150–53). A letter to the

editor in an 1880 issue of *Coach Painter* boasts of completing a successful paint job in only twenty-one days (Ferrell 1983:81). Also, most carriage painting manuals distinguish between "heavy work," such as coaches or drags, and "light work," such as buggies or sulkies, with the former requiring much more effort to achieve the desired finish. A direct correlation was made between the quantity of time it took to complete a paint job and its quality; this was something about which many painters felt strongly, as is evident in the following quote (Masury 1881:222–23):

> The case of the captive children of Israel has its parallel in the carriage-trade, and that the carriage-painter is oftentimes required to perform a labor more difficult of accomplishment than was required of the Jewish bondsmen by their Egyptian taskmasters. To make sun-dried bricks without straw may, so far as we know, be within the limit of human ingenuity; but to begin and complete the painting and varnishing of a carriage—so as to secure the best results as to durability—in the space of two weeks, is a feat beyond the skill of any man who ever yet painted carriages on this mundane sphere.

Materials and Terminology

By the last quarter of the nineteenth century, the commercial paint industry was well established, and carriage painters no longer needed to prepare their own paints or varnishes. However, many carriage painters continued to grind and mix their own formulas, and writers of manuals gave instructions on how to do this while also promoting their favorite brands (Gardner 1875:27). It was not unusual to buy proprietary compounds and mix them together to get various formulations for ground coats, or to alter paint colors by adding dry pigments or mixing paints together. Trade manuals contained long lists of how to mix and match different colors.

To understand the process involved in painting a carriage, it is necessary to become familiar with the materials and the terminology used. Many of the materials, such as linseed oil, are still available and require no explanation. Other terms, such as *keg-lead,* are specific compounds that no longer exist. Still other terms, such as *japan* or the all-encompassing *varnish,* cover an entire range of mixtures that seem to be kept deliberately vague by manufacturers trying to keep trade secrets, as well as promote their range of products. In *Modern Carriage and Wagon Painting* (1911:23), Frederick Maire writes, "Japans do not differ much from varnishes and under that name all kinds of liquid stuff is sold in the market which have nothing much in common but the name under which they are sold. The formulas for making them differ so much that it is really impossible to give a clear definition of them."

Also, different sources sometimes contradict each other as to ingredients of similarly named materials. Descriptions often contain terms that themselves are unfamiliar and go undefined. The following definitions are found in *Everybody's Paint Book,* by Franklin B. Gardner (1905:171–73):

> *White lead:* a pigment made by subjecting the metallic lead to the fumes, or corroding influences of vinegar, when it becomes a fine white powder. *Keg-lead, or tub-lead*: white lead ground in huge mills while mixed with linseed oil. *Rough Stuff:* a rough-grained paint designed to level over any hollows or imperfections. . . . It is composed of some cheap ochre or other hard and gritty pigment. . . . Take equal parts of dry-white lead and Grafton paint or

> English filling (an earth) and mix them with equal parts of rubbing varnish and brown japan; grind loosely through the paint-mill; then thin to a working consistency with raw linseed oil one part, turpentine two parts. *Japan Drier* or *Brown Japan:* a drier for paints made by boiling linseed oil with substances which give it drying properties, such as manganese, sugar of lead [lead acetate], red-lead, litharge, etc. and adding for a body, gum shellac or inferior varnish gums. *Black Japan:* a solution of asphaltum in linseed oil or varnish.

Linseed oil and lead white were probably the two most universal ingredients in carriage paint. Generally, raw linseed oil was preferred over boiled, especially for foundation coats. In his paper on carriage painting, Robert Shinnie writes (1902:478), "The use of boiled linseed oil has entirely disappeared." Gardner emphasizes only using raw linseed when making keg-lead (1875:22). In an 1880 article in *The Coach Painter,* "Liquids Employed in Painting," the writer states (Ferrell 1983:103):

> Linseed oil, which is the most common vehicle used for oil painting, is usually mixed with pigments in two forms—as raw linseed oil, and as a drying or boiled oil. . . . Experience has taught that it is better to give to the mixture a drying property with japan, than to boil the oil and thus increase its oxidizing power. And we find most painters have discarded almost entirely that black gummy material *Boiled oil,* from the paint bench.

By 1911, however, linseed oil is mentioned less favorably in the literature. Maire (1911:23) writes, "Linseed oil is sparingly used in carriage painting," and that "the old adage . . . 'oil is the life of paint' must be forgotten when it comes to carriage painting." He also states that the "principal and only use made of linseed oil is in the primary or foundation coats."

The term *japan* was one that was frequently used for a variety of meanings. As one of the above definitions indicates, *japan* usually referred to a metallic drying agent added to paint in order speed up the oxidation of the linseed oil. But *black japan* refers to a varnish layer that was frequently applied over gilded surfaces. There are several references to the use of asphaltum as a toning layer over gilding (Gardner 1885:35). Japan was also used as a size for gilding. In *Modern Pigments and Their Vehicles,* Frederick Maire writes (1908:214), "It is a very hard matter to give a true definition of what is really meant by the term *japan,* notwithstanding the daily use of it in the paint shop. . . . It is needless to say that japans vary as much in their composition as they do in their qualities." Maire goes on to give three different definitions for japan—one as a drier, as described earlier, and one as an enamel that is used for baked-on finishes. The third class, he writes, "which are for grinding and applying coach colors, are properly varnishes and of such are the gold sizes and coach japans, and in reality should be classed among the medium grades of varnish." An ad in *The Carriage Painter's Companion* (Masury 1871:14) lists "Coach Makers' Japan, For Binding and Hardening Paints," but adds, "It is made from the finest Shellac." This is one of the few references to the use of shellac in carriage painting.

The term *varnish* is the most general of all in the carriage trade. The success of the paint job depended on a high-quality varnish job to achieve a deep, glassy surface. Much attention was paid to the quality of varnishes and the skill of the artisan applying it. Once again, the composition and terminology are kept deliberately vague by manufacturers,

although the most commonly cited ingredients are linseed oil as a binder, copal as the resin, and turpentine as a solvent. Oil-resin varnish mixtures were by far the most popular type. One book states, "Quick drying hard varnishes, such as used on furniture is not suited to varnishing painted surfaces, especially if the work be exposed to the weather" (Masury 1881:181). *Everybody's Paint Book* defines carriage varnish as being "made by melting copal gum, mixing it with linseed oil and adding a drier to it, then thinning to the proper consistency with turpentine" (Gardner 1905:174).

Most manuals and magazine articles emphasized the importance of high-quality materials in both paints and varnishes. As one writer states, "Labor or wages bring the greater item of cost in carriage painting; it is not affected either way by the quality of materials used. The difference, if any, is in favour of the highest grade of goods being used. On the painting of one carriage the difference in cost is too small to be reckoned on" (Shinnie 1902:481).

Although few carriage painters mixed their own varnishes, they were encouraged to be knowledgeable about ingredients and manufacturing processes. The *Hub* magazine even ran a six-part series on copal, tracing it from its source through manufacturing. The articles suggest that the term was used for any fossilized resin found off the coast of East Africa that was insoluble in either water or alcohol. Conversely, gums were described as any water-soluble plant exudate (not fossilized); resins as any alcohol-soluble plant exudate; and gum-resins, such as myrrh and gamboge, as plant exudates that can only be obtained by bruising the tree. One article also suggests that, while copal is the most desired ingredient for high-grade varnishes, using other materials, such as dammar, kauri, animé, and sandarac, was acceptable for lower grade varnishes (Houghton 1871:132, 156).

Manufacturers also made a wide variety of varnishes for any conceivable application. Whether there were any differences inside the cans, or only in the labels, is unknown. An advertisement for Murphy and Company varnish makers lists six different varnishes and one japan for finishing. The varnishes have names such as "wearing body," "hard drying body," and "elastic carriage," each with a specialized function (Masury 1871:14).

Painters were aware of the yellowing effect of the varnish, even when new, and complained that it made blues and blacks appear greenish. To reduce this effect, varnishes were also used as vehicles for pigments in carriage painting. All the layers of varnish except the last one would be toned with pigments and were referred to as *coloring varnishes,* which were different from glazes in that they could be rubbed out between coats, and glazes could not.

One place where there was some variation in varnish ingredients was over white paint. Although paleness in color was considered an important quality of a high-grade varnish, carriage painters complained that white still turned yellow under the standard varnish. As a remedy, Gardner recommended substituting dammar for copal (1905:7). Sometimes whites were left unvarnished. Instead, the varnish was mixed into the final two coats of paint to make it glossier, and then polished with pumice stone when dry (Schriber 1891:69).

Carriage painters had the same wide range of natural, commercial, and synthetic pigments that were available to other painters at the end of the nineteenth century. Books were divided between those that advised using prepared colors (frequently published by paint companies)

and those that recommended grinding and preparing colors from dry pigments, linseed oil, turpentine, japan, and varnish. In *The Complete Carriage and Wagon Painter,* the author, Fritz Schriber (1891:17), lists twenty-five different pigments and instructions for grinding and mixing them to make a wide range of colors. Schriber states, "Prepared paints are perhaps to some a blessing, but he who would use economy in his own work must surely mix and grind his own colors." In *The Carriage Painter's Illustrated Manual* (1875), Gardner also lists a sample of thirty-six pigments (in *How to Paint,* 1885, he lists forty-six), with directions on how to grind them in the same manner as in Schriber's book. Gardner also recommends the use of prepared colors from Masury and Whiton, Globe Lead Works (1875:27), "as superior to anything else of the kind I ever tried."

Painters were advised to know about pigments and their origins, mainly in order to be on constant guard against adulterated and impure materials. Many of the long-established naturally derived pigments, such as earths and lakes, continued to be popular alongside the newer synthetically derived pigments (*Hub* 1889:352). Carmine was the most expensive pigment that was widely used by carriage painters, and because of its price, it was only used in glaze coats. Made from cochineal, it cost about US$3.50 an ounce in the 1880s, whereas other pigments were sold by the U.S. pound, pint, or gallon, costing anywhere from $2.00 to $8.00 per pound. Consequently, other red lakes, such as Munich lake, were often substituted to save money. Carmine was frequently applied over vermilion for a deep brilliant red.

There was no uniform nomenclature for describing pigments, especially synthetic ones. An article in the *Hub* complains that recipes copied from English carriage publications contain color terminology unfamiliar to Americans in the trade, such as Berlin blue, Cassel earth, and Paris red. Also, tertiary colors and tints, such as "drabs, buffs, olives, browns," varied from one painter to the next (*Hub* 1888:422).

Trade magazines also had articles on how to do fancy work, such as scrollwork, monograms and crests, gold-leaf striping, faux caning, using transfer ornaments, and bronze powder stenciling. Good carriage painters were expected to be skilled in all of these techniques. Monograms and heraldry, in particular, were an area of carriage painting that became a subspecialty within the trade, and their design and layout was a favorite topic for paint-shop columns.

Paint Stratigraphy

One of the primary goals of a good carriage paint job was to unify an assortment of parts, made of a variety of materials by different departments, into a harmonious, aesthetically pleasing unit. The body panels of a carriage required more extensive attention than the gear of a carriage. In larger companies, the two separate components might be painted in different departments. Although the gear—which was always part metal and part wood—required fewer coats of paint, they also required skill and effort to make the two different materials appear as one component and to build up layers on complex shapes.

There were two prevailing methods of carriage painting during the second half of the nineteenth century, the "old" method, which used keg-lead and linseed oil to fill the grain, and the "new" or "putty knife" method, which used a proprietary compound known as PWF (Permanent Wood Filler or Patent Wood Filler, depending on the source), containing

silicate or mineral pigments in linseed oil as a thick putty. Most carriage-painting books described one or both of these methods, and there was constant argument in trade publications as to which was superior. Although painting guides varied somewhat in number of layers, drying time, or proportions, general methods and materials were fairly consistent.

The "old" method of carriage painting started with several lead coats, five being a typical number. The first two were primers, the third a "putty" coat to fill any depressions. The coats were made up of varying proportions of linseed oil, lead white, japan drier, turpentine, and varnish. The putty coat also contained whiting. The first coat was primarily linseed oil, which was gradually reduced as more japan drier and lead white were added with each successive coat. The process was similar for the body and the gear up to this point, except that the gear was sanded, as the next series of coats was applied only to the body (Masury 1881:198–200).

The next several (five to seven) coats were known as the *rough coats* or *rough stuff*. These were made of *English filling* (an inexpensive earth pigment such as yellow ochre), lead white, varnish, japan, linseed oil, gold size, and turpentine. The amount of oil was reduced with each successive coat. The final layer was known as a *guide coat*. A layer of yellow ochre was mixed with japan and turpentine, applied, and allowed to dry. Then the entire coat was removed with pumice so any imperfections would show up. These were filled and sanded. The rough coats were applied only to carriage bodies, not to the gear (Masury 1881:200–202).

After all of this surface preparation, the final color layers (termed *color coats,* in that period) were actually quite thin. Typically, two layers of paint were applied. As they became available, commercially prepared paints, with their much more finely ground pigment particles, quickly replaced hand-mixed paints. Striping coats could be applied either over or under the final varnish, depending on their width and color (Burgess 1881:120).

Varnishing was considered the most critical part of the carriage finish. The body usually received five coats—four *rubbing coats* and a final varnish—and the gear received two. The rubbing coats were usually pigmented to reduce yellowing and were rubbed out between coats.

Most of the materials used in carriage painting required very long drying times. The lead priming coats usually required three to four days per coat, and the remaining coats were always allowed to dry overnight, if not longer. This was one reason why painters were constantly looking for ways to shorten the painting process.

The "new" method of carriage painting, also called the *American method,* differed from the above method in that the first five lead coats were replaced with one or two coats of PWF. This was a proprietary compound that was sold ready-made, starting around 1867. It saved time because fewer coats were needed, and the painter did not have to spend time running it through the paint mill. Silica, flint, or earth pigments were substituted for lead white as the wood grain filler, although it still may have contained some lead component. In an ad in the *Hub,* PWF was promoted for its "simplicity of application—uniformity of work. Non-injury to health, cleanliness, economy of time, labor and cost" (*Hub* 1878:313). Another ad in the *Hub* boasted that it was safer, and prevented "painter's colic" (*Hub* 1893:87). Many articles in the "Paint Shop" column of the *Hub* make references to the hazards of lead, indicating that workers were aware of its toxicity. Painters

were advised to wash their hands before eating lunch, not to eat in the paint room, and not to wear paint-covered clothing home.

Repainting

In studying the techniques of carriage painters, it is necessary to also become familiar with repainting techniques. Repainting and revarnishing of vehicles was very common, and many manufacturers did a brisk business in carriage maintenance and upkeep. Carriages could be repainted as often as once a year, although it was probably more common to just revarnish annually and repaint after two to five years, depending on use and color. Certain colors, particularly those made with lakes, were especially fugitive. A table in *The Art and Craft of Coachbuilding* (Philipson 1897:148) rates the durability of different paint colors after either two or five years. Scarlet lake is described as "dull pinkish red," and crimson lake is described as "almost gone." In contrast, madder red, true Naples yellow, and artificial ultramarine are listed as having no change of hue.

Both magazines and trade manuals made numerous references to repainting and revarnishing. A variety of different techniques were used, depending on the degree of damage to be repaired and the customer's budget. A letter to the editor in the *Hub* asks about the best way to remove varnish without damaging the paint. The response gives three choices of chemicals: spirits of ammonia; strong potash water or lye; or a mixture of carbolic acid, creosote, and turpentine (*Hub* 1878:286). *The Complete Carriage and Wagon Painter* also gives instructions on revarnishing, but recommends removing the old varnish mechanically with pumice, instead of chemically (Schriber 1891:152).

There were many ways that carriages were refinished. The most drastic method was to take a hot iron and burn off the old paint down to the wood. Gardner (1875:67) recommends the use of a "furnace patent lamp" to remove old paint. The carriage was then repainted in the same manner as new carriages. Other methods were to sand off the varnish and color coats, leaving the rough and primer coats; or to just sand off the varnish, but leave the color coats, and apply new color coats and varnish. These methods were more economical for the customer. Frequently, the body of the carriage was stripped down to the wood by either burning or sanding, but the running gear was only sanded down to the rough coat and then repainted. As time went on, less and less effort was put into surface preparation and repainting. A less professional repainting job would be to apply just a coat of black to the entire vehicle.

A chart of sleigh repainting prices, from Brewster and Company of New York City (1897), shows the choices available for repainting. Eight different options are listed, priced according to the amount of labor required. The most inexpensive option ($0.25) was "blacking off" the iron work, or repainting it black to hide the rust. Other choices listed were paint runners and touch-up all over—$2.00; touch-up and varnish body—$3.00; japan stripe and varnish body—$5.00; recolor, japan, stripe, and varnish body—$7.00; burn off and repaint body—$7.00; paint runners, touch-up, and varnish gear—$3.00; paint runners, recolor, stripe, and varnish gear—$7.00; cut down, repaint, stripe, and varnish gear—$9.00. The prices listed are for a cutter (a small sleigh), and show the amount of labor for each operation. For larger sleighs, the prices increased accordingly.

Another chart gives prices for repainting and restriping gears. The choices are to "cut down" or "scrape off" the old paint, with scraping being the more expensive option. Also, separate prices were given within each of these two options as to with or without a final rubbing varnish. Brewster and Company's "Revised Price List for Painting C.P's. April 10, 1897" lists four options. The prices, given for comparison, are for "Drags or Perch Breaks": new price without any striping—$35.00; repair price when less rubbing coat, not striped—$31.00; paint rims, touch-up, and varnish—$16.00; recolor; striping additional: 1 coat— $26.00, 2 coats—$28.00. The price list for the body work is similar, with an additional column for "Addl. cost burning off old bodies."

The Concord Coach

While general painting materials and techniques were applied to a wide variety of vehicles, the examination and conservation treatment of a Concord coach (ca. 1866) provided an opportunity to examine specific methods. In 1813, Lewis Downing moved to Concord, New Hampshire, from Lexington, Massachusetts, and began making modest buggies (Concord and gig wagons)—vehicles with no springs and the bodies fastened to the rear axle. In 1826, he contracted with J. Stephen Abbot of Salem, Massachusetts, a journeyman coach-body builder, to build several coach bodies. These were the prototypes for what became known as Concord coaches. Their primary design feature was the use of leather thoroughbraces as a method of suspending the body from the running gear. This softened the ride considerably, allowing comfortable transit over quite rough roads. With the success of these vehicles, the partnership of Downing and Abbot was formed.

In 1847, the partnership dissolved. Downing formed Lewis Downing and Sons. Abbot worked alone until 1852, when he united with his son as J. S. and E. A. Abbot. The two firms merged in 1865 as Abbot, Downing and Company. In 1873, a corporation was formed, also absorbing the competing firm of Harvey, Morgan and Company. The new incorporated name was Abbot-Downing Company. By the second quarter of the twentieth century, pressures from both the railroad and the automobile had greatly reduced the demand for their products, and the Abbot-Downing Company closed its doors.

The Concord coach body generally was primed in a thin lead primer to allow penetration into the wood. This was followed after drying with a coat of lead primer, then with four or five coats of *rough stuff*. After sufficient drying, it was rubbed as smooth as glass with lump pumice and water, then thoroughly washed and dried. Two coats of ground color were applied to this surface. A coat of quick-drying varnish was applied next and was allowed to dry for several days. It was rubbed with ground pumice in water, and the body was ready for ornamentation.

Ornamenters were skilled painters, often filling their spare time with the painting of portraits or landscapes for private patrons. The most well known was John Burgum, a young Englishman, who joined J. S. and E. A. Abbot's shop, eventually working for Abbot, Downing and Company after the merger. His career lasted until the early twentieth century, and he was responsible for factory decoration on many of the surviving Abbot-Downing coaches. As was the practice of the time, ornamenters usually painted only the decorative panels on the doors and on the driver's seat riser. These were popular or unique images that could be determined by

the purchaser of the coach. The letterers were responsible for the scrollwork, much of which was quite ornate, as well as for striping and lettering. Following an appropriate drying time for the paint, one or two coats of protective varnish were applied.[2]

Stony Brook's Concord Coach

The Museums at Stony Brook's collection of 250 carriages includes five vehicles made by Abbot, Downing and Company: a Standhope gig; a Hack passenger wagon; a twelve-passenger coach and companion mountain wagon; and a nine-passenger Concord coach, which underwent conservation treatment (Fig. 1). Because of their famed strength and durability, Concord coaches were a primary means of most public overland travel prior to the advent of an extended railroad system. Following the completion of the transcontinental railroad and the more prevalent use of the rail system as a means of long-distance travel, the ubiquitous Concord coach was utilized again for short-distance transportation by commercial lines to service hotels, towns, and areas not accessible by rail.

Perhaps more than any other vehicle type, the Concord coach holds a special place in the collective American experience. Although they were made in New Hampshire and used throughout the United States, South America, Australia, and other regions requiring rugged overland transport, they are most closely associated with the romance of the American West. However, Concord coaches in original, historical condition are increasingly rare. Because of their romantic appeal, they have been collected and restored to suit individual tastes without strict respect for authenticity. Many eastern coaches have been repainted and remodeled to conform to a western prototype, and their history and integrity as artifacts have been permanently altered or distorted. Alarming numbers of historic vehicles were destroyed from overuse for television and movie productions of Westerns.

The Museums' Concord coach was donated by Webster Knight II in 1962. Its serial number, 124, corresponds to the Abbot-Downing Company order book (1866)[3] that records the following description:

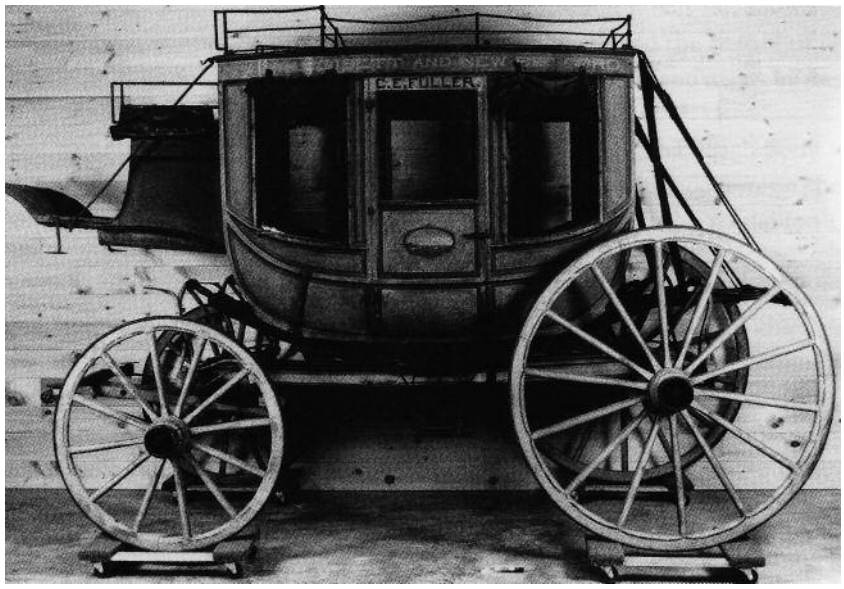

Figure 1
Overall view of the Museums at Stony Brook's Concord coach before treatment, proper left side.

> One Nine Passenger Stage Coach 3 seats inside 3 on a seat middle seat 3 fold. . . . Paint Body Green Carriage Straw Letter "Allen House" (on Top Rail) "Sam Allen & Son" (on false sill to foot board) Neat orniment on Door & Foot board panel No border but striped. Same as City Coach Lined Russet Lea(ther) Lined. Damask head & fringe En. lea(ther) Curtains Damask lined Leather apron. Top and Rack Canvas. Done sure (completed) June 1st 1866"

The coach was used by Charles E. Fuller, who worked as a stage driver from 1865 to 1882 for the Fall River Stage Line and Pauldings' Express, both of which were based in New Bedford, Massachusetts. Between 1883 and 1901, Fuller was the proprietor of the Mattapoisett Stage Line, also in New Bedford. It is believed that during this time period, the coach was acquired secondhand by Fuller, and the body was repainted its current straw color. This was enhanced on the body panels by broad striping of black and Indian red. Finer striping of green and red traced the broader striping. The paintings on the door panels depicted a lighthouse and a seascape on one door and a stagecoach under attack by Indians on the other. This ornamental painted surface is typical of the artistry applied to coaches and other public or commercial vehicles.

Unfortunately, the Museums' coach had suffered from outdoor exposure, most likely during a time of abandonment when the importance of such vehicles as cultural artifacts had not yet been recognized. The coach underwent conservation treatment between 1991 and 1993 at the Fremont, New Hampshire, studio of American Conservation Consortium, Ltd.

General Conservation Concerns

A primary concern in the conservation treatment of a horse-drawn vehicle is the determination of the historic presentation surface. Does the original painted surface survive? Do later paint schemes relate to the historic period of use? Is relatively recent repainting important or significant? Ideally, these sorts of determinations are made by the curator, if the vehicle is owned by a museum, after reviewing the results of analysis and testing. However, if the vehicle is privately owned, the conservator often must function in a quasi-curatorial role, attempting to guide the preferences of the owner toward a responsible choice.

Once a determination of the historic significance of each paint scheme is made, the condition of each of these layers can have an important contribution to the design of a treatment. A later repainting that remains in good condition may be preferred as the aftertreatment presentation surface. Remember, the vehicle was repainted for a reason. Often, this was due to degradation of the earlier layers. In addition, earlier layers may have been damaged in the surface preparation for the newer paint. Of course, exposing an earlier layer will require destruction of the later, but still historically important, paint.

A final consideration is the technical feasibility of removing later layers from earlier ones. Often, the materials used are very similar in their composition. Separating a more recent sandarac-based paint layer, for example, from a similar earlier one can be extremely tedious and prohibitively expensive, or even technically impossible. Since the vast majority of surviving horse-drawn vehicles dates from after 1850, the diversity of materials used in their decoration leads to equally diverse conservation challenges.

Conservation Treatment

The Museums at Stony Brook's Concord coach presented many of these challenges. While the coach was in rather good structural condition, its surfaces were both degraded and complex. To the eye, it appeared that two complete paint schemes survived from the period of use. There were also several repaintings of specific areas that were of uncertain time periods. Paint crazing, cleavage, and loss were extensive, particularly on the running gear. The surface varnish layers were embrittled, discolored, and friable, lending the coach body an uneven orangy appearance. Was this color due to the effect of aging of the coatings or did it represent an intentional coloration or glazing by the painter?

To assist the curator and the conservator in understanding the history and sequencing of the layers, as well as to provide technical insights into the painting materials, seven small paint samples were taken for microscopic examination. The samples were taken at the edges of existing losses to minimize the aesthetic impact. They were mounted in resin cubes, polished, and examined by means of fluorescence microscopy by Richard Wolbers.[4]

Photomicrographs and a report of the analysis permitted several significant determinations to be made. They confirmed that the body of the coach had been painted twice during the period of its historic use. Primer layers were inconsistent from one sample to another, but they appeared to be black over blue over light red. This concurred with the shop tradition of using as a primer whatever color was left over from another job. The earliest body color was a dark (almost black) green. This corresponded to the description of the coach in the Abbot-Downing order book when it left the factory. On top of this green were six varnish layers, each with characteristic weathering fissures and entrapped dirt, indicating that they each had been separated by an interval of time. A thick layer of straw-colored body paint was found directly over the sixth layer of varnish, and it had penetrated into the fissures. Six more weathered varnish layers were applied over the straw-colored paint. There was no evidence of revarnishings or repaintings after the period of use (Fig. 2).

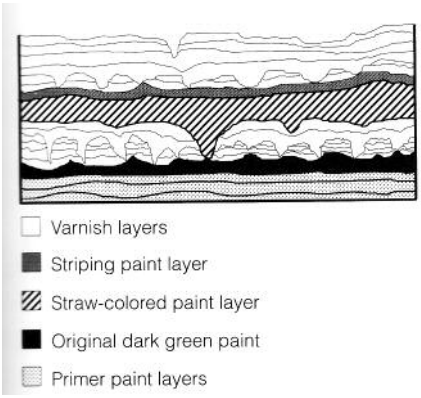

Figure 2
Schematic diagram of cross section viewed in UV light, from an area of red striping on the Stony Brook Concord coach. Note the original paint on the bottom, with six weathered varnish layers over it, then the thick straw-colored paint, over which are the striping and six more weathered varnish layers.

The cross sections revealed that the six most recent varnish layers over the straw-colored paint did not contain pigments or other colorants. Therefore, it was concluded that the orangy color was due to weathering, aging, and discoloration of the varnish layers, and that it was not intended by the coach painter. The nature of the varnish layers and the nature of the striping were very similar, both identified as natural plant resins in the cross sections.

Three of the samples related to specific areas of the coach body. The sample taken from the green border of the seascape medallion on the central panel of the door shown in Figure 1 indicated that the medallion was painted on top of five of the varnish layers over the straw-colored paint. The sixth varnish layer was applied over the medallion, indicating that the medallion was added near the end of the period of use of the coach. It also indicated that special care needed to be taken around the medallions during treatment, as any solvent that would remove the varnish layers would also remove the paintings on top of the varnish. While a sample was not taken from the stagecoach medallion, it appeared to have been applied at the same time and in the same manner as the seascape medallion.

Visual examination in combination with the cross section from the driver's seat riser showed a gray primer beneath dark green paint that was consistent in color with the rest of the body. On top of the green paint was a slightly transparent red paint that appeared to be in a varnish medium. An eagle was painted over the red layer at the center of the panel. Two orangy varnish layers were applied over the red paint and eagle. Visual observation showed three faint striping lines around the perimeter of the riser panels. These were on top of the dark green paint layer but beneath the red layer. All of the layers on the riser appeared to date from the historic period of use. However, it was not possible to determine exactly when the red paint was applied. It was clear that it did not exist at the time of manufacture, since it obscured the original green paint and striping.

The sample from the top frieze lettering, "MATTAPOISETT AND NEW BEDFORD," showed multiple layers of paint, indicating that the names had been repainted a number of times. Colors included yellows, reds, blacks, blue-greens, and whites. It was not possible to establish a comprehensible sequence of lettering and backgrounds from the sample.

The cross section taken from a wheel spoke on the proper right side indicated that eight straw-colored paint layers existed. While there were some slight variations of the shade of straw, this represented a conscious attempt to maintain the same running-gear color throughout time. Each of these layers had its own unique striping pattern, both in design and color, varying primarily from brown to black. One to three weathered varnish layers were over each paint layer, all appearing to belong to the historic period of use. Losses in the paint layers penetrated to different depths, and each subsequent repainting flowed into these losses. This created its own set of treatment concerns.

The information gathered from the paint samples suggested several general treatment approaches that were discussed by the curator and the conservator. A primary consideration in the treatment of the coach was the discovery, interpretation, and presentation of the various paint histories. Since all of these dated from the period of historic use of the coach, all had valid historic integrity. Unfortunately, it was not technically possible to reveal earlier decorative surfaces without destroying the later overlying paint. This paradox is common to many horse-drawn vehicles, as well as to other painted decorative objects. The history of changes in decorative preferences throughout time can be, in itself, as significant as the original appearance of an object.

Several potential solutions existed for the coach. First, it could have been stabilized only and preserved in its pretreatment condition; however, the existing mottled orange color was created only by the discolored varnish over the straw-colored paint. This was not an intentional effect, and it greatly distorted the appearance of the coach as it had been when owned and used by a known historic figure, Charles E. Fuller. A second option was to return the coach as closely as possible to its appearance when used by Fuller. This would have required removal of the degraded upper varnish layers and inpainting of losses into lower layers to fully re-create the straw-colored paint scheme. A third choice was removal of all of the six upper varnish layers, the straw-colored paint and the six lower varnish layers to reveal the original dark green paint on the body—a solution that appeared to be technically feasible. However, the straw-colored paint corresponded to ownership and use of the coach by Fuller; this layer

was in relatively good condition, and the overall condition of the lower green layer was unknown. Although the coach could have been photographed before treatment in extreme detail, this approach would have destroyed the straw-colored paint history. A fourth option that fell midway between the latter two was to preserve the straw-colored paint on one side and expose the green paint on the other side. A partial history of the straw-colored paint would have been preserved, but the coach as a whole may have appeared disjointed, and this option would clearly have been inaccurate as a representation of the coach's actual appearance when in use.

The approach that was chosen was a variation on the second option. The later degraded varnish layers were removed. Areas of natural wear were preserved, however, complete with naturally revealed earlier decorative paint. In addition, several "windows" were opened into earlier layers at appropriate locations, while still preserving the overall unified appearance of a straw-colored coach.

The first treatment step taken after analysis and photography of the coach was the setting down of loose and lifted paint. On the running gear, this was done with dilute, hot hide glue brushed around the entire circumference of loose areas and losses with an artist's brush. This was chosen because the paint layers in composite were quite thick and stiff, and a strong adhesive was needed. Loose paint on the body was reattached with Acryloid B72 (approximately 20% in toluene). B72 was selected due to its reversibility, stability, thermoplasticity, and workability. Where necessary, lifted paint was set down with gentle pressure from a heated spatula and tacking iron. However, many of the lifted areas of paint overlapped neighboring paint due to shrinkage of the wood beneath it. It was not possible to return paint in such situations back to plane. This was most prevalent on the wheel spokes.

With the painted surfaces stabilized, the next treatment step was the removal of the six degraded varnish layers over the straw-colored body paint. These natural plant resins were soluble in many organic solvents, including denatured alcohol and acetone, as well as abietic acid soap. This implied that they were rather pure resins without the addition of potentially cross-linking components, such as oils. Unfortunately, while the varnish was readily soluble, the varnish layers beneath the straw-colored paint were equally as easily dissolved. As the solvent reached the straw-colored paint surface, it penetrated to the underlying varnish through the extensive cracks and crazing in the paint, removing the straw-colored paint at the crack edges. Even the use of gelled solvents did not prevent this problem. A second concern was that the narrow red and green striping on top of the straw-colored paint was executed using a similar varnish-based medium. As the surface of the straw-colored paint was reached, the striping was in danger of being dissolved along with the overlying varnish.

Initially, alternating applications of denatured alcohol and acetone on cotton pads and swabs were used to remove the body coating. This proved to be less than satisfactory, however, as the length of time the solvent needed to remain on the surface to dissolve all six varnish layers also caused a slight softening of the varnish beneath the straw-colored paint, with subsequent paint loss. The only alternative was to leave part of the discolored varnish in place over the straw-colored paint. This resulted in a perceptibly mottled color due to varying varnish thickness. The appearance was judged to be acceptable by the curator but was not ideal. Continued experimentation indicated that better results could be obtained

with a more aggressive solvent that removed the varnish much more quickly. Thus, less manipulation of the surfaces was required and the solvent was in contact with the surfaces for a much shorter time. Use of an aggressive solvent allowed more complete removal of the varnish layers with less disruption through the crazing. The solvent n,n-dimethylformamide (DMF) proved to be highly effective and was used for varnish removal on the coach body.[5] Varnish layers on the narrow horizontal panel below the rear window on the proper left side were not removed but were allowed to remain undisturbed as a record of the pretreatment condition of the coach (Fig. 3).

Since the red and green striping on the body panels had been applied in a varnish medium similar to the varnish layers that were removed, special care was required. A band of varnish on and around the striping was left undisturbed during the overall varnish removal with DMF. Varnish was removed extremely carefully from the striping with denatured alcohol on swabs. Residual varnish was left in place rather than risk loss of the striping by attempting to remove all of the varnish. The color shift caused by the remaining varnish was unobtrusive. This process was extremely tedious and delicate but was successful in preserving the striping, while also creating a harmonious appearance of the coach body.

The painted medallions on the door panels had been applied on top of five of the six varnish layers. Therefore, a border of about half a centimeter of varnish was allowed to remain around the medallions. This was done to prevent solvent from softening the varnish beneath the paint due to capillary action, which would cause paint loss. The final border of discolored varnish around the panels was removed mechanically with a scalpel. The presence of the five layers of discolored orange varnish beneath the medallions somewhat distorted the paint colors, especially in areas of crazing. Fortunately, the distortion was very minor and was visually acceptable, as there was no known method of treatment to remedy this problem.

Tests of varnish removal on the running gear were not successful. Processes that removed the darkened varnish layers also removed the striping. This was due in many areas to the presence of striping on top of the

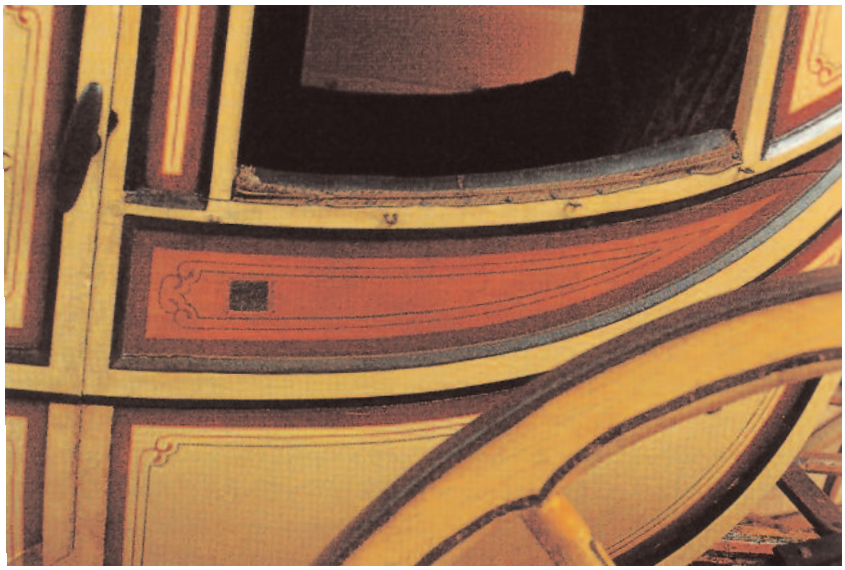

Figure 3
Detail of the proper left rear of the coach after treatment. The degraded varnish was left intact on the narrow panel. Also, a small "window" was opened to the earliest dark green paint layer.

varnish. Another contributing factor was the numerous layers that were concurrently exposed, allowing solvents to work on lower, exposed varnish layers and removing paint above them. For these reasons, the varnish layers were left intact on the running gear. The relatively undistorted straw-colored paint color, due to fewer varnish layers on the running gear, harmonized with the body color of the coach after its varnish was removed. Running gear surfaces were cleaned with distilled water on cotton pads and swabs. This was chosen in preference to a detergent because it would not leave behind any residue that required rinsing. The unevenness of the surfaces would have made rinsing detergent residues very difficult. In addition, tests indicated that cleaning with distilled water alone was as effective as cleaning with a detergent. The varnish was removed with DMF in limited areas where the varnish layers were thicker and created darker orange discolorations.

Two coats of B72 in toluene (approximately 20%) were brushed onto the painted surfaces of the body and running gear. These served as an isolating barrier to separate inpainting and later protective varnishes from the original surfaces. In addition, it consolidated areas that suffered from fine crazing and potential paint insecurity. B72 was chosen not only for its well-known properties of reversibility and stability but also because it was insoluble in mineral spirits—the intended solvent for the protective varnish to be applied in a later treatment step.

Paint losses were inpainted with artists' acrylics by Nancy Garrison, a decorative painting specialist. These totaled thousands of areas. After the approximate base color was applied, each area was toned individually to harmonize with the subtle nuances of color surrounding it. This was particularly complex on the running gear, where previous losses and repaintings to both the paint and varnish layers had created a multitude of shades. As requested by the curator, lower decorative paint that showed through, including striping, was not inpainted. This created a slight patchwork effect, but allowed a glimpse into earlier paint histories. In addition, areas of natural wear from use were not inpainted.

As a final protective coating on all painted surfaces, two coats of Acryloid B67 (approximately 20% in mineral spirits) were brushed on. B67 was chosen specifically to provide a solubility that was different from the B72, thus allowing for its future removal, while leaving the B72 undisturbed. In addition to protecting from dust and dirt, this coating optically saturated the paint colors of both the original paint and the inpaint. It created a gloss that approached the original level, although the effects of crazing and losses of the paint resulted in a surface that was less smooth and probably less glossy than a factory finish. Since the coach was now a museum artifact that reflected both its previous use and the passage of time, this was an appropriate presentation appearance.

Several "windows" were opened at strategic locations on the coach. On the proper right side, a "window" exposed the lower layers of the frieze between the letters W and B of "NEW BEDFORD." The most recent lettering was light yellow on a darkish red background. Beneath this could be seen the ghosted image of a previous application of "NEW BEDFORD" in a slightly different location. Removal of the latest paint revealed a bright orange-yellow letter on a black background. Further removal showed a lower layer of a straw-colored letter on a darkish red background. It was not possible to determine which letters were present, as only a small area was visible.

A small square "window" was opened with denatured alcohol through the straw-colored paint and underlying varnish layers to the dark green paint on the narrow panel beneath the rear window of the proper left side, which had had its varnish layers left intact. The green paint was heavily weathered, with straw-colored paint in the network of weathering fissures (Fig. 3). Although it could not be confirmed that the paint over all the surfaces was in the same condition, this discovery supported the decision not to remove the straw-colored paint in an attempt to return the coach to its earliest appearance.

The window units in the doors of the coach had ghosted pinstriping beneath a black surface paint. In areas of wear, it was apparent that the original dark green paint was present beneath the later black paint. The black paint was removed from the outside of the proper right window. The revealed off-white striping was in good condition. Also discovered was broader black striping around the perimeter of the door, as well as around the perimeter of the panel. This was in subtle contrast to the dark green background.

A "window" was opened on the proper left driver's seat riser to reveal a complete pattern of the lower dark green paint with striping (Fig. 4). The newly visible paint was in surprisingly good condition. The central of the three striping lines was a red color, with the outer lines white. During examination of the seat riser for treatment, a barely perceptible raised image of "U.S. MAIL." was discovered on the bottom of both sides of the seat riser beneath black paint. The black paint was removed to reveal yellow letters on a dark green background. Beneath the current "U.S. MAIL." was a ghosted image of an even earlier version of the same lettering.

The upper paint layers on the running gear were removed on the two rear panels flanking the center of the rear axle (Fig. 5). The proper left panel showed the second most recent paint sequence and was marked with a small "2" in artists' acrylics. The top of the proper right panel was the paint on the third level beneath the surface ("3"), and the bottom of this panel was the fourth level ("4").

Figure 4
Detail of the proper left driver's seat riser after treatment. The lettering "U.S. MAIL." was discovered beneath black paint. In the lower right corner, the red varnish-based paint was removed to show the original dark green paint and striping.

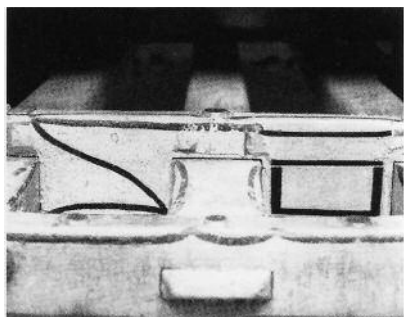

Figure 5
"Windows" were opened into the second, third, and fourth paint layers from the top on the rear axle, revealing their unique striping patterns.

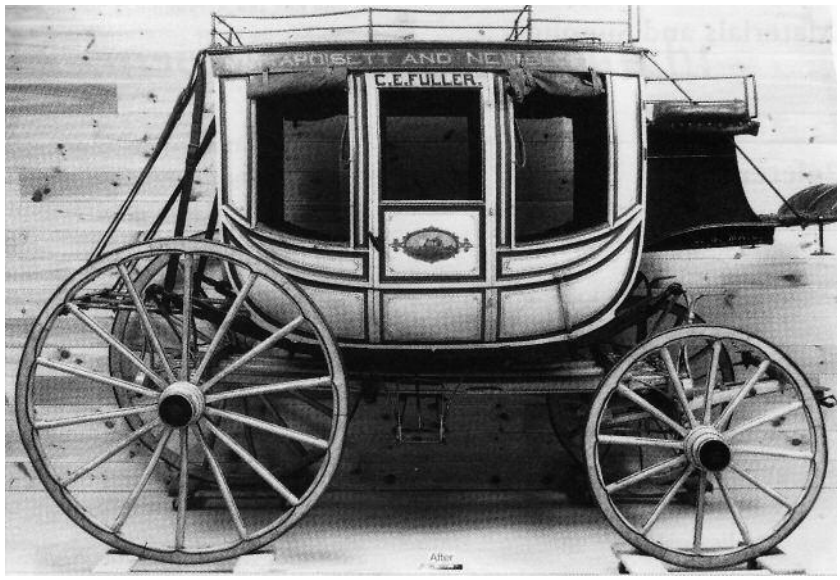

Figure 6
Overall view of the coach after treatment, proper right side.

Conclusion

The conservation treatment of the Concord coach was successful in meeting its objectives. The surfaces of the coach were stabilized, a more accurate historic presentation appearance was provided, information about previous surface histories was gathered, and glimpses of the earlier decorative paint schemes were revealed (Fig. 6). The success was a result of effective communication between the conservator and the curator. Analysis and testing provided information on which decisions could be based. In addition, unexpected discoveries were made, which required further discussion and the choosing of alternatives. Rather than an exception, this experience appears to be common in the treatment of horse-drawn vehicles. The diversity of materials used and the varying repaintings and pretreatment conditions of such vehicles create an endless range of treatment needs and options, which is responsible for both the anguish and the joy of working on these unique cultural artifacts.

Acknowledgments

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Notes

1 The majority of the reference books for this article are from the Carriage Reference Library at the Museums at Stony Brook.

2 Much of the information for this section was taken from the writings of Edwin Burgum, the son of the ornamenter. New Hampshire Historical Society, Archives and Manuscripts, Burgum Papers, ca. 1939.

3 The authors are indebted to Jim Wilke for providing this information.

4 Richard Wolbers, 4 Furness Lane, Wallingford, PA 19086. Wolbers is one of the pioneers of selective staining of paint/varnish cross sections to allow not only for determination of stratigraphy, but also for gross material characterization.

5 DMF and most other organic solvents are toxic. Appropriate safety precautions should be used, including ventilation, respirators, and gloves.

Materials and Suppliers

Acryloid B67 and Acryloid B72, Rohm and Haas Co., Independence Mall Street, Philadelphia, PA 19105.

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The Importance of Conservation to Research: A Case Study

Merri M. Ferrell

The Grace Darling, an omnibus 7 m long, was also called a barge because of its size (Fig. 1). The largest vehicle of this type, the Pride of the Nation, was 11 m long. These types of public conveyances were used in urban and resort areas in the United States to transport large numbers of people and were decorated profusely with ornamental, painted motifs, such as landscapes, scrollwork, striping, and other popular pictorial motifs. It was a common practice to name vehicles used for public transportation; similar vehicles included the Concordia, the Pride of the Nation, and the Hiawatha. The Grace Darling was named after an English lighthouse keeper's daughter who was instrumental in the 1838 rescue of survivors of the shipwrecked *Forfarshire.* Grace became a national heroine in England. Her fame precipitated many forms of commemoration—from poetry to pottery—and her name was applied to steamships, locomotives, and horse-drawn carriages.

The Grace Darling was built around 1880 by the Concord Carriage Company, a carriage-making firm that occupied the old state prison shops in Concord, New Hampshire. The firm was listed in *The Leading Business Men of Concord* as the manufacturer of "Heavy Trucks, Wagons, Caravans,

Figure 1
Overall view of the omnibus Grace Darling, built ca. 1880 by the Concord Carriage Company, Concord, N.H.

Barges, Furniture, Job and Express Wagons" (Bacon 1890). The company was in business for fifteen years (1875–90), a relatively short time for a carriage-making establishment. The firm employed some of the more skilled or specialized workers from the Abbot-Downing Company. The Grace Darling was made for and used by Simeon Parsons Huntress (1846–1923), who operated a livery service from the 1880s to 1904 in South Berwick, Maine. The vehicle was listed in the *Dover (Maine) Enquirer* (1880) as a "six horse passenger barge of S. P. Huntress of South Berwick. It bears the name of Grace Darling, and will accommodate 45 persons, it is on easy springs, is beautifully painted and richly upholstered. It is to be used for beach or excursion parties, and can be had at reasonable rates."

The Grace Darling was acquired in 1925 by Saint Paul's School, a preparatory school in Concord, New Hampshire, which used the omnibus for many years as a means to transport athletic teams to local sporting events and other school functions. In 1952, the vehicle was donated to the Museums at Stony Brook, New York (then the Suffolk Museum and Carriage House), through the efforts of its curator, Richard Gipson, and Saint Paul's faculty member Coolidge Chapin. Museum records from 1952 to 1982 attribute the manufacture of the vehicle to the Abbot-Downing Company, also in Concord, a firm that was famous for making overland vehicles such as stagecoaches. It remained in storage for more than thirty years, during which time a continuous debate concerning its relevance to the collection and its restoration ensued among museum staff members. As early as 1953, curator Richard Gipson was asked to improve the appearance of the piece through total restoration. He advocated the preservation of the original painting and materials on the barge, as well as on other vehicles in the collection. His reply to this persistent request was (Gipson 1953a):

> You did tell me that you thought it might be better to clean down the barge and start over again. However, this is a very expensive operation in the first place, and I fear that, in a carriage of this character, we may be seriously injuring its antiquarian value and impairing its antiquarian interest.

There are no records identifying the type of solvent Gipson used, although he did report to his supervisors that after "much experimenting" he had found a way to preserve the paintings on the barge (Gipson 1953b).

By 1961, Gipson had retired and moved to Vermont. His successor, George Isles, continued the debate concerning the restoration of the paintings on the Grace Darling. He wrote to Gipson (Isles 1963):

> We have the barge "Grace Darling" at Wood farm. As you know, the paintings, scrollwork, and lettering are the work of an artist, the like of which it would be very difficult if not impossible to have reproduced today. I would very much like to restore or perhaps I should say preserve the art work on this vehicle. Some of the paintings and scrolls are badly damaged and more will be lost or damaged in the cleaning. The undergear was originally red and probably richly striped. This should be cleaned down to bare wood and redone as original. On the body the paint could be removed from the seat up and lettering and striping re-done as original.

Correspondence refers to the size of the vehicle as a "problem"(Murphy 1973). It was too large to display in the existing museum building and costly to store. At that time, the vehicle was kept in a shed off-site and was

eventually moved to renovated lumber sheds that were adapted in 1976 as permanent on-site storage for the carriage collection.

In 1982, a committee of consultants was engaged to evaluate the scope and content of the carriage collection as part of a five-year plan associated with developing interpretive exhibitions for a new carriage museum. In keeping with a growing trend in the museum profession, the retention of only "typical" artifacts that reflected "normative patterns of ownership and use" was advised. Curatorial opinion was based on collections' survival, as well as on the preservation of documents referring to the production and use of a class of objects, without considering earlier prejudices that may have led to the wholesale disposal of a quantity of similar objects that would posit the few existing artifacts in a classification deemed "typical." The mere size of the Grace Darling, as well as its profuse ornamentation, seemed extraordinary and atypical; a recommendation followed to dispose of the vehicle. The recommendation was not followed, and research was conducted to justify retaining this type of vehicle. The research revealed that thousands of these types of vehicles were made and used for public transportation, but as their usefulness abated, the desire and means to retain them and the respect for them as artifacts diminished. The size of these objects—and particularly the expense and the amount of space required to store them—as well as their obsolescence and their demoted status as useless nonart, contributed to their destruction. The famous Pride of the Nation, made by John Stephenson, was hitched to a tractor during the 1920s and pulled around the country as a type of sideshow object until it eventually disintegrated. Another example, the Maplewood, had its pillars and roof sawed off to fit it through a low doorway in a storage facility. Many other carriages either were left outside to disintegrate or were simply destroyed. This type of object thus became rare not because few were made but because so many were destroyed, and the records of the industry documenting their manufacture and use were discarded or lost. The dearth of these types of artifacts and their societal and technical function also have been misinterpreted, thus further influencing institutional commitment to acquisition and preservation.

Advocacy for Conserving Horse-Drawn Vehicles

Through research, the Grace Darling was identified as a significant vehicle type, and this influenced the decision to place it prominently in the new carriage museum. To prepare the vehicle for exhibition and to improve its appearance, it was decided that it should be conserved. The conservation of the Grace Darling was a departure from the more common practice of restoration. The term *restoration,* when used by carriage collectors or restorers, means the removal of original materials and the replacement of those materials with modern equivalents. This practice, whether by default or intention, results in a series of compromises based on the availability of materials and the interpretation of fabrication methods, as well as the application of these components to specific vehicles. The profession of carriage restoration is crowded with amateurs ill-equipped to interpret the objects they restore. If carriages were simply constructed craft objects manufactured by hand, the reproduction of parts and materials would be relatively easy to accomplish. Carriages were, however, complex, composite objects created by an industry composed of subdivided labor and subindustries that supplied the primary industry with metal and wood parts, fittings, textiles, and other materials. The majority of horse-drawn vehicles

in American museums today were made and used during the last half of the nineteenth century. They were manufactured in factories, and the specialized machinery and conditions of manufacture are difficult, if not impossible, to reproduce. The woodworking machinery used for the body and undercarriage, the large Jacquard looms used for weaving thousands of yards of coach lace, and the mass production techniques and patterns for the manufacture of malleable cast iron parts are no longer available. Because the primary industry is no longer viable, the multiple subindustries that produced the auxiliary products were also phased out. Restorers are challenged to find compatible materials and to interpret the existing materials on their vehicles. It is typical for the silhouette to be preserved but for the original materials to be destroyed. By subtracting construction details and original materials from the general body of preserved material available for study, the restorer robs the vehicles of significant historical content, diverse expression, original aesthetic intention, and mechanical ingenuity. Unfortunately, third- and fourth-generation restorations have become the standard by which the authenticity of horse-drawn vehicles in original condition are measured.

Vehicles in original condition speak volumes about the technical and aesthetic details expressed by carriage manufacture. The details that are preserved reveal much about their fabrication, as well as the tastes of the designer, finisher, or owner. Carriages, like other objects that represent the material culture of a particular period, offer complex information on the general aesthetic of the people who made and used them. The types of materials—from textiles to interior fittings—that were used in constructing an individual carriage are part of its aesthetic. Carriage painting, ranging from simple color application and striping to complete pictorial programs and gold-leaf scrollwork, was an important aspect of the trade. Painting protected the wood and metal structure and unified or emphasized the various parts and materials, giving the vehicle its overall aesthetic character. As recorded in the Henry Baird publication *The Painter, Gilder, and Varnisher's Companion* (1870:20), "in ornamenting and striping a carriage, it requires considerable taste and judgment . . . to preserve and show in the most graceful manner the workmanship of the builder."

Carriage painting was a specialized skill and an integral part of the larger system of carriage manufacturing. Prospective painters entered the trade as apprentices and became familiar with their materials through the repetition of rigorous tasks, such as grinding pigments, preparing surfaces, and applying and rubbing down successive coats of varnish. Additional instruction in the trade was available through technical schools and numerous instruction manuals and periodicals that were published for the industry. Instruction could vary from practical topics—such as recipes for "rough stuff" or filler, or processes for applying color and varnish coats—to advice on how to keep the painted surface glossy and smooth. Aesthetic instruction was available in written descriptions, accompanied by printed images, of an array of decorative devices that offered painters a rich vocabulary of ornamentation to apply to sleighs, wagons, and commercial and public vehicles.

Nineteenth-century carriage ornamentation was as varied and as eclectic as decorative arts. In particular, commercial vehicles were elaborately decorated in order to satisfy their dual function as mobile advertisement and conveyor of goods and services. One author (Hillick 1906:109) wrote that painting trade vehicles was

> a limitless art, resourceful, restive, responsible to an admirable degree to the ever-varying side lights of technical skill. All that art can be anywhere the broad surface of the modern business vehicle invitingly offers to display. Its worth as an advertising medium, as an agency through which business stability and enterprise may be widely heralded, has been fully learned. Thus the evolution of the present elaborately painted and decorated business wagon has come about.

Vehicles were decorated with simple or elaborate designs, striping, and borders in various styles: letters; numbers; faux finishes imitating caning, wood, or plaids; landscapes, people and animals. Within the profession of carriage painting, the ornamental painter was the highest paid and most respected because of the skill and specialization of his trade, and commercial vehicles offered the best opportunity to show the painter's artistic abilities. In describing the requisites of the commercial vehicle or "wagon" painter, M. C. Hillick (1906:110) wrote,

> He must know well how to build a beautiful and durable surface. He should be a first-class colorist, understanding all the features of color mixing and fully conversant with the lays of harmony and contrast. He will likewise find it necessary to be an unexcelled master of the varnish brush, a skilled striper, wagon letterer, and decorative painter of established ability.

Unfortunately, because of contemporary attitudes about horse-drawn vehicles—which are influenced by factors such as size, obsolescence, or utilitarianism—examples of carriage painting have perished due to neglect or to total restoration. The artistry of the decorative surface of the Grace Darling omnibus had been acknowledged since the *Dover Enquirer* first recorded its service in 1880, but total restoration had been considered numerous times since the acquisition by the Museums at Stony Brook.

Conservation Treatment of the Omnibus

The Grace Darling omnibus was structurally sound and did not require physical stabilization. However, much of the detail of the paintings was obscured by layers of the historic varnish and successive layers of various coatings and dirt that had accumulated for decades. The first challenge of the project involved finding a conservator who would work on an object of this type. The size of the vehicle required conservators to work on-site in less than ideal conditions in a storage shed. Numerous interviews with painting and objects conservators were conducted before a professional conservator willing to work on the Grace Darling was secured. All candidates supported the project in theory, but were unwilling to undertake the work. In 1983, the Museums at Stony Brook contracted with Fine Objects Conservation—a group of conservators and assistants supervised by Linda Merk-Gould—to perform the work. The first step of treatment was to identify a solvent or combination of solvents to remove the accumulated layers of varnish, shellac, linseed oil, and grime from the original paint, without disturbing the glaze coats of transparent pigments that contributed to the unmistakable depth and hue of the vehicle's painted surfaces. These layers had combined over the years to form a dark, reticulated surface that did not respond to initial solvent testing. Paintings conservator Rustin Levinson assisted in this phase of the project. Cross-sectional analysis was not used at this time.

Figure 2
Detail of the painting on the Grace Darling. Shown are the letter G and scrollwork on the proper left side after conservation.

Figure 3
Detail of female figure painted on the proper left side of the seat in the Grace Darling, after conservation.

Conservation treatment produced dramatic results. The presentation surface of the lettering before conservation was dull and monochromatic. The background color appeared to be dark brown, and the letters a drab green. After treatment, the brilliant blue and gold leaf of the double block letters were visible, as were the subtle highlights, glazing, and shadings that gave dimension to the lettering (Fig. 2). The accuracy of the color that was evident after conservation was an important aspect of the project. If the vehicle had been restored, and the replacement colors had been based on what was visible before conservation, the entire color program of the restoration would have been inaccurate. Cleaning the darkened coatings showed the painter's skill of combining numerous colors to achieve a more pleasing effect. The border around the letters was gold leaf enhanced by a stripe of dark transparent red (carmine), which was accentuated by a fine stripe of dark brown. The figures on the seat risers had been barely visible prior to treatment. Removal of darkened coatings revealed exquisite painting of idealized young women in 1880s dress and coiffure (Fig. 3).

The paintings on the exterior of the rear door depicted a woman in mid-nineteenth-century costume with a bow and quiver, the latter being a reference to Huntress, the owner and operator of the livery service (Fig. 4). This painting was adapted from the central figure in John Sartain's (1808–97) engraving *Cheerfulness* (illustrated in *Memory's Gift* n.d.).[1] The adaptation of this engraving explained the dress of the figure, which was anachronistic to the vehicle. Below this figure was a small and beautifully executed painting of a stag and a hound. The interior pictorial program consisted of a bouquet of flowers and the manufacturer's name. Although the name of the maker, the Concord Carriage Company, was painted on the inside of the door, it had been totally obscured by multiple layers of darkened coatings; it was not until the coatings were removed as part of the conservation treatment that the actual origin of manufacture was known. After cleaning, the painting of flowers and the maker's name, framed in a decorative border on the interior of the door, were visible.

The rounded corners of the body of the vehicle were decorated with still-life and figurative paintings. The painting on the proper left rear corner medallion was an adaptation of Edwin Landseer's (1802–73) *Monarch of the Glen* (Fig. 5). The proper right rear panel depicted a hawk. The two front medallions represented a still life of fruit (proper left) and flowers (proper right). These paintings were framed in a broad gold-leaf border that incorporated shaded and highlighted scrollwork and various

Figure 4
Overall view of the rear door of the Grace Darling, showing the lettering and vehicle number, and the figure adapted from John Sartain's engraving, *Cheerfulness*.

Figure 5
Detail of proper left rear corner of the Grace Darling, showing the adaptation of Edwin Landseer's *Monarch of the Glen*.

forms of striping. The intricate red and blue striping of the undercarriage had been covered with yellow paint. This style of striping was popular from around 1875 to 1880 for business wagons. Patterns for this style of striping appear in numerous trade journals and painting manuals. The red and blue striping on the off-white undercarriage complemented the similar paint scheme on the seat rail.

Uncovering and Preserving the Evidence

The interior paintings were obscured completely by dark varnish and other coatings. These paintings had not been detected until they were conserved. The paintings were divided by the roof pillars and consisted of a program of twelve landscapes and seascapes in ellipses framed by a gray, Eastlake-style border (Fig. 6). These paintings provided the first evidence leading to identifying the artist who painted the Grace Darling. Initial research for an exhibition on preeminent American carriage makers, that

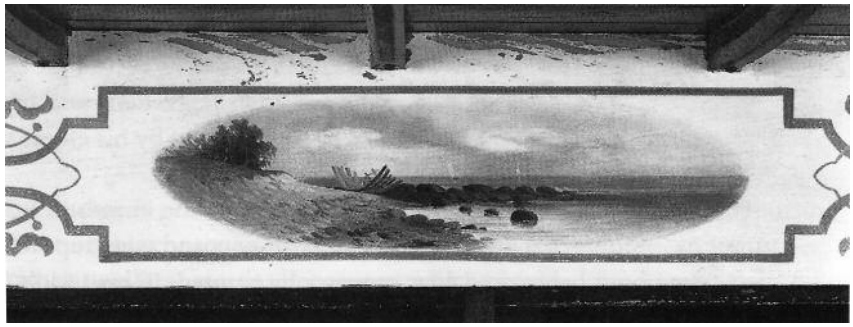

Figure 6
Detail of painting in the interior of the Grace Darling, after conservation. This is the work that led to identification of John Burgum as the carriage painter.

included the Abbot-Downing Company, led to the first encounter with the extensive archival holdings at the New Hampshire Historical Society.[2] During the review of the company records, the sketchbooks of John Burgum were consulted. Burgum's sketchbooks showed a series of sketches made in 1879 and 1880 of landscapes that were dated, with notes on the location. One particular sketch of a wreck was identical in composition and format to one painted on the interior of the Grace Darling. Unfortunately, this was not accepted as irrefutable proof of the authorship of the paintings, although labels and related museum texts written after this discovery attributed the paintings to him.

John Burgum, Carriage Painter

The Grace Darling was placed on exhibition in the carriage museum in 1987. In 1991, with funding assistance from the Early American Industries Grants-in-Aid program, researching the work of John Burgum continued. The archives of the New Hampshire Historical Society in Concord, New Hampshire, include the diaries, sketches, and paintings of John Burgum (1826–1907), who was the chief ornamental painter for the Abbot-Downing Company. Burgum was born in Birmingham, England. He served his apprenticeship with clock-dial painter Christopher Wright, who provided his early training as an ornamental painter. He came to the United States in 1850 and became a coach painter in Boston and in Concord, New Hampshire, where he worked for the Abbot-Downing Company (Camden 1982).

Burgum's diaries (1863–1900) chronicle his daily activities and expenditures. Some entries are accompanied by sketches. Burgum's primary occupation was with the Abbot-Downing Company, which specialized in trade, overland, and public vehicles that required extensive decoration as commercial vehicles. His diaries indicate that he expanded his trade to the painting and decorating of fire-fighting vehicles for the Amoskeag Manufacturing Company in Manchester, New Hampshire; the Concord Carriage Company and Harvey and Company, both in Concord, New Hampshire; and the Union Carriage Shop and Cobb and Company of Queensland, Australia. He also painted portraits, banners, and small paintings on rocks and shells, which he executed during summer camping trips to Rye Beach or the White Mountains in New Hampshire. In addition, he taught an art class to pupils who were mostly young women. He regularly visited the Boston Museum of Fine Art, where he derived considerable inspiration, as well as ideas, for his coach work. During his trips to Boston, he purchased art supplies and periodicals. He copied images found in lithographs or engravings onto horse-drawn vehicles. In his diaries, he referred to taking some of his images from published material as "hunting up designs." Others he painted from life. He also purchased a variety of painter's instruction manuals. He extended his ornamental painting to furniture, and his diaries record the painting of blanket chests, chair backs, and trays. In 1874, he became a member of the Art Association, and by 1878 he was assisted by his eldest son, Edwin, who also trimmed carriages and made sails.

Many of the images in Burgum's ornamental vocabulary became stock ornaments and were repeated on the vehicles, pebbles, shells, and canvases he painted. In his 13 July 1879 entry, he recorded that he made sketches of Little Boar's Head, the rocks at Major Stott's, and the wrecks

on the beach. Several of his designs and sketches from life were converted to prick patterns to be transferred onto vehicles. Among these were the local landscapes and places of interest that he sketched from life, as well as copies of the works of Edwin Landseer, especially *Monarch of the Glen,* which he painted on at least four vehicles. He often mentioned Landseer by name, such as, "worked down at the shop on foot board to Stewarts Hotel Coach, laid in Landseers group of dogs" (Burgum 1878). In the entries of his 1880 diary, he wrote (Burgum 1880):

> June 30, 1880—worked on the Barge 19 hours. Painted Monarch of the Glen on the corner and put the lights on one corner and painted flowers in another.
>
> July 7, 1880—worked on the Barge 10½ hours, finished the figures on the door and foot board.
>
> July 8, 1880—worked on the barge 9½ hours inside putting in landscapes and seaviews.
>
> July 12, 1880—A cool pleasant day. Finished Huntresses Barge, worked 4 hours on it. Edwin traced the ornament on the 5th wheel sized and gilded it. I put the first coat of asphaltum on.

This entry provided irrefutable evidence that John Burgum painted the Grace Darling. It was indeed a "Barge," and featured *Monarch of the Glen* and flowers on its body panel corners. Landscapes and seascapes that were painted in the interior were clearly visible after conservation. The reference to "Huntresses" barge is a direct reference to Simeon Parsons Huntress, the name of the proprietor of the livery service who commissioned the manufacture and decoration of the omnibus.

It took John Burgum 142 hours to paint the Grace Darling. The vehicle was much admired during its many years of service, from its original function as a livery vehicle to its role as a conveyor of students and young athletes well into the age of the automobile. As a museum artifact, its preservation became an issue of debate, and the vision and advocacy of Richard Gipson kept the paint intact, if covered by experimental coatings. Conservation returned the piece to a condition in which its original artistry could be visible and appreciated and ultimately led to the discovery of the artist responsible for its extensive ornamentation. The Grace Darling remains one of very few horse-drawn vehicles in original condition whose artist is known and documented. Countless other examples of the carriage painters' art have been stripped and sanded from their surfaces. Regardless of how an object is presented, interpreted, or described, its authenticity and physical integrity are what make it a powerful material document and give it the potential to inspire and educate. It is fortunate that an example of the artistry of carriage painting remains to inspire others to a higher regard for original paint and to seek conservation methods rather than restoration as an ethical and desirable way to preserve the historic integrity of horse-drawn vehicles.

Acknowledgments

The author is grateful to the Institute of Museum Services for supporting a part of this conservation project, and to the Early American Industries Association Grants-in-Aid program, which provided funding for the research that identified John Burgum as the artist of Grace Darling.

Additional thanks to Linda Merk-Gould, Carol Warner, Deb Brown, Aaron Stoltzfus, and others who worked on this challenging project; and to Lynton Gardiner, whose photographs communicate the artistry of the piece to a larger audience.

Notes

1 The author is indebted to Martha Pike for this reference.

2 Burgum Family Papers and Abbot-Downing Company Records are on file at Manuscripts Division, New Hampshire Historical Society, Concord, New Hampshire.

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The Treatment of Painted Wooden Folk Art

Stephen L. Ray and Julie A. Reilly

In the early twentieth century, the first assemblages of folk art were gathered by collectors who found great aesthetic appeal in the sometimes quaint and often curious expressions of artists who worked outside the mainstream of art. Abby Aldrich Rockefeller was a pioneer in the collecting of American folk art. She began collecting during the 1920s when folk art was mostly ignored by others. In 1935, she loaned a large part of her collection to the Colonial Williamsburg Foundation, and in 1939, this loan became a gift. The Abby Aldrich Rockefeller Folk Art Center (AARFAC) was constructed at Colonial Williamsburg in 1957 by John D. Rockefeller Jr. as a memorial to his wife.

The AARFAC collection contains more than 3,300 objects from the eighteenth, nineteenth, and twentieth centuries and reflects the innate creative skills of many craftspeople and artisans. The collection includes banners, toys, furniture, sculpture, decoys, figures, signs, weather vanes, whirligigs, carousel animals, tools, and advertisements.

In early 1987, the curatorial and administrative staff, in collaboration with Foundation conservators, selected 182 objects to go on a traveling exhibition to nine cities across America. The purpose of the exhibition was to share AARFAC's exceptional collection of American folk art with a broader audience while its building was closed for expansion and renovation. After the chosen objects were surveyed, those requiring treatment prior to travel were sent to the various laboratories in the Department of Conservation. The treatments ranged in complexity from simple superficial cleaning to more complicated structural stabilization and cosmetic reintegration. After the traveling exhibition, these objects were returned to Williamsburg in 1991. Along with 250 additional objects, they were installed in the new wing at AARFAC, which added an additional 1767 m^2 (19,000 sq. ft.) of exhibition and storage space to the museum. This additional group of objects was also surveyed, and conservation treatment was performed on those with the greatest need.

In total, 155 of the objects treated were of painted wood, and the survey and subsequent conservation produced a prodigious amount of documentation. A review of the treatment records made it clear that there were relationships between construction methods and current condition. It is this information that forms the basis for this article.

General Technology and Condition

Discussions of treatment of folk art frequently begin with a multitude of definitions to convince the reader of its complex and varied nature. Folk art objects *are* complex and varied, and so is their conservation. Bottle caps, house paints, shells, ribbons, discarded bits of tool, and swirls of candle soot are but a few of the materials encountered as components of these objects.

Folk art often displays the creativity of the maker in unique and intriguing decorative schemes—direct outgrowths of the artist's experience and imagination. This creativity can be expressed in varied imagery with decorative elements often composed of uncommon and inherently short-lived materials, many of which have proved incompatible with the underlying structure or surface finishes. For example, soot or smoke used for decorating surfaces is inherently fragile.

The aesthetic sensibilities of collectors like Mrs. Rockefeller inform our understanding of the objects and the way they appear in collections today. *New, shiny, clean, complete,* and *smooth* are not words that describe the objects that folk art collectors assembled or expected to see in dealer salesrooms or museum exhibitions. Rather, early collectors preferred objects that were unchanged by restorers or museum professionals, with evidence of use and age being an integral part of the objects' appearance.

Because it was often functional as well as decorative, folk art usually reflects a repair-and-maintenance history. For example, decoys were repaired and touched up, weather vanes and whirligigs were flattened and repainted, and trade figures were repaired after repeated mistreatment or were repainted in more fashionable colors (Fig. 1). There is a subtle distinction between a *repair* and *ongoing maintenance*. Whether successful or not, both strive to prolong the functional nature of the object, and both usually involve the application of additional materials. Maintenance tends to comprise additions that reflect the history or function of the object over time—additions that may be worthy of preservation. Repairs, by contrast, particularly those made after an object attains "collectible" status, sometimes consist of alterations or additions that not only disturb the appearance of an object but may misrepresent its historical context or function. Examples of maintenance techniques and repairs are discussed on the following pages.

Figure 1
The Race Track Tout, tobacconist figure, during treatment. H:184.78 cm. This figure had up to four additional layers of paint applied either as routine maintenance or to change its color scheme. Mechanical excavation under the microscope revealed the colors exposed on various parts of the figure (AARFAC, 56.705.3).

As viewed today in an exhibition, a folk art object represents more than simply an aesthetic creation, the product of the hand and eye of its maker working in a specific time and place. It also represents a collective history of use, beginning with its maker and continuing with its owners and subsequent collectors, dealers, curators, and patrons. The object's function over time is an integral part of its interpretation and is a feature that is as important to preserve as the object itself.

Construction Techniques and Condition

Although it is risky to attempt to place all folk art into generalized categories, an evaluation of the objects examined revealed four primary means of construction: solid or *log* construction, hollow construction, board construction, and joined construction. Construction types are often mixed within a single object (e.g., a toy may consist of both solid and joined construction). However an object is made, a correlation exists between the construction method and types of damage found on its painted surface. The following paragraphs explain the categories of construction, then address paint-surface problems commonly associated with each type. Paint

problems independent of construction type, such as abrasion from mishandling, functional damage resulting from the wear of moving parts (e.g., whirligigs, weather vanes, or toys), or inherent deterioration of the paint, are outside the purview of this article.

Solid or "log" construction

Objects in this category are made from a single, solid block of wood or a solid block composed of several pieces of wood. In the latter case, the techniques for joining the various blocks include dowels, pins, mortise-and-tenon joints, glue joints, nails and screws, and various combinations of these techniques. Examples of objects in this category include decoys, toys, trade figures, and other decorative sculptures.

Damage typically appears in these objects in the form of radial splits and checks. The splits can manifest themselves as barely visible hairline cracks or as large openings. They may move very subtly with environmental changes (i.e., opening and closing as the wood responds to changes in relative humidity). Similar damage may occur at the interface of joints and laminations, particularly if the grain of one piece of wood is at right angles to another piece. Other damage includes breakage of projecting elements, dents, scrapes and scratches, and worn and abraded surfaces.

Historically, repair and maintenance techniques have varied. Shims were often inserted into large splits, and other filling materials, such as plaster or commercial wood fillers, may have been used. Broken elements were reglued. Nails, screws, and other metal hardware, such as angle irons or "L" brackets, were used as supporting or fastening devices. These traditional repairs generally disguised the symptoms of structural failure without addressing its underlying cause: the inherent instability of wood. As a result, the structural problems encountered in these objects today include not only the initial unstable cracks, but additional shrinkage, splits, and breakage associated with added metal hardware and rigid or unstable shims.

Damage to the paint is most obvious adjacent to splits and cracks, where the film is broken and chipped. However, damage may also appear elsewhere on the surface. This occurs because, in log construction, the paint may be stressed by the extremely uneven dimensional response of the log's outer surface to fluctuating relative humidities. Around its circumference, the log may experience pronounced dimensional change (tangential shrinking and swelling), while dimensional change will be imperceptible along its length. The paint, on the other hand, experiences a slight dimensional change that is equal in all directions. The differing responses of the two materials place stresses upon the paint, which may cause it to tent, lift, or check across the grain of the wood (see Mecklenburg, Tumosa, and Erhardt herein).

Conservation of these types of objects relies on skills ranging from woodworking to paint consolidation. Treatment may include leaving the object as is; removing old fills, shims, and hardware; or replacing old nails and screws with less invasive materials. Fills can be replaced with more stable, conservation-quality materials (i.e., microcrystalline waxes, bulked epoxies, vinyl spackling compounds, etc.). If necessary, paint surfaces can be consolidated, and losses inpainted.

The Race Track Tout, a tobacconist figure (Fig. 2), illustrates damage related to radial cracks, as well as previous repairs. This figure was sent

Figure 2
The Race Track Tout, tobacconist figure, before treatment, showing the radial split that ran the entire length of the figure. Remnants of a wooden repair shim remain wedged inside the split. It was uncertain if the shim had ever been glued in place. Paint loss is visible along the edges of the split.

to the Objects Conservation Lab for an investigation of the remains of a wood shim inserted in the back, and for repair of damage to the feet and base. The curators were also interested in what changes had been made to the original paint scheme. With the exception of the arms, the figure had been carved from one "log." A radial split on the back of the figure ran from the top of the hat downward through the head and body and into the crotch. The split appeared again in the base, and another radial split ran at right angles to it. This caused the base to break into four sections and resulted in extensive damage to the feet and ankles. The entire figure rested on an original stand composed of four wide boards nailed together to form a box. As a result of the splits and shrinkage, the figure had collapsed into its stand. Repair attempts had been made using numerous nails. In addition, the proper left arm was broken at the elbow, and it had been reattached using nails and an angle iron fastened with screws.

The treatment of this figure involved removing all nails, screws, and the angle iron, and regluing the separated elements with hot hide glue. Two 6 mm wooden dowels were inserted through existing nail holes in the elbow as additional support in this area. Because large gaps remained in the base, which prevented proper alignment of the four sections, it was reassembled using a carvable epoxy paste to fill gaps and to provide added strength. The original stand was too fragile to support the weight of the figure; therefore, a wooden insert was constructed. The insert, a box, was fitted inside the original stand to hold the figure at the proper height in relation to the sides of the stand. The sides of the stand were tacked to the sides of the insert with a hot-melt adhesive. The split on the back of the figure was filled with a wall of microcrystalline wax (Victory White Wax) approximately 6 mm thick. No attempt was made to fill the entire gap. In addition, all later paint layers were removed. This was accomplished using various solvent systems and mechanical methods.

Hollow construction

Objects in this category are made from blocks and/or boards joined to form a hollow cavity, with a carved outer surface. This method of construction reduces some of the problems noted in log construction. Not only does it reduce the weight of large objects, but hollow construction permits a more even dimensional response of the wood to environmental changes. Splits and separations in the wood tend to be common but are typically narrower than those found in objects made from solid blocks or logs. The techniques for joining the wood components include mortise-and-tenon or lap joints, glue joints, nails, and screws. Characteristic examples in this category are carousel figures.

Structural damage is characterized by separation of the joints, with associated distortion and occasional misalignment of the wooden components. Projecting elements can be loose, detached, or missing, and the high points of the carving may be very worn or abraded.

Traditional repairs on objects of this type of construction include attempts at filling the gaps, adding shims, replacing carved sections, and reworking mortise-and-tenon joints. Nails, screws, and different types of bracing were added to stabilize separations and breaks. Additional glue was applied to old damages, and internal repairs were made. The nature of the structure and attempts at repair affect the condition of the paint. Cracked and lifted paint is often found at the interface of joined pieces

because of differences in the movement of the various components. Paint damage is also commonly caused by poor repair techniques, such as the use of incompatible or rigid gap-fillers or the improper addition of nails, screws, or dowels. Finally, paint loss is associated with the reworking of misaligned components.

Conservation treatment for this type of object may include leaving the object as is, adding fills, removing old fills and replacing them with more stable materials, separating and realigning poorly repaired joints, or removing nonoriginal nails and screws. Paint surfaces may be consolidated and inpainted, with the extent of treatment guided by a sensitivity to the historic use of the object. Since these objects no longer serve the function originally intended, the conservator has the option of making repairs that are not as strong but also not as structurally invasive as earlier repairs may have been.

A carousel figure of a lion illustrates the problems associated with hollow construction. The body and head are hollow, and the legs are carved from solid blocks made from several joined pieces of wood. Join methods include glue and large wood screws. The screw heads were countersunk and covered with wood plugs.

Due to long-term usage, exposure to weather extremes, and repair and maintenance practices, there were numerous separations between the various wood joints, and the legs were loose. Attempts had been made to repair and stabilize the figure with numerous finishing and common nails, and splits and losses were associated with these repairs. Remnants of a filling material were found in some of the gaps and nail holes. Some sections of the wood forming the body had been reshaped to fit the misaligned sections more closely together. Lost portions of the object had been replaced. The front legs, originally extended forward to give the lion a leaping effect, were cut at the knees and reworked to place their upper and lower sections at right angles. This probably was done to reduce the length of the figure to fit in the home of a collector. The painted surface was in an extremely degraded condition, showing evidence of past repainting and stripping of paint using mechanical and chemical means.

Treatment of this figure included removal of all nails and other past repairs and realignment and regluing of the joints. The front legs were disassembled, and new wood added and carved in order to return the legs to a more natural position. Photographic evidence of similar figures was used as the basis for this decision. The painted surface was consolidated using an acrylic resin.

Board construction

Objects in this category are made from joined boards or planks. Techniques for joining the boards include butt joints, lap or dovetail joints, and metal or wood battens. Nails or screws may also join elements. Examples of objects include trade signs, weather vanes, and decorated storage boxes.

Structural damage includes splits and separations at the joints, cracks at the sites where battens have been attached, and varying degrees of warpage. Scratches and dents are common, as is damage to the corners.

Traditional repairs usually involved methods to secure the boards. Regluing and attaching additional battens or straps on the reverse were common techniques, and fill materials were often added to larger gaps.

These repairs and fills frequently exacerbated problems, restraining the natural movement of the wood and resulting in additional splits, warpage, and paint loss. Additional paint loss may be associated with the species of wood and the manner in which the board was sawn. Plainsawn boards are often found in this type of construction, and a distinct earlywood/latewood pattern may become apparent because of poor paint adhesion to the denser latewood of a species such as yellow pine. Though losses from latewood may be extensive, the paint remaining on the earlywood surface may be very stable because of strong adhesion.

Techniques developed for the treatment of panel paintings sometimes apply to the conservation of folk art objects made of joined boards. Treatment options may include the removal of added restraints; the design of new nonrestraining supports; and the consolidation, filling, and inpainting of paint losses. Provision for maintaining the object in a controlled environment is a highly recommended practice, as it is for all folk art objects.

As an example, the painted Sutton fireboard in the AARFAC collection (AARFAC, 56.110.1) had been constructed from four random-width boards. Two original battens were attached to the back with iron nails, and two thick iron straps were later attached adjacent to each batten with a screw into each board. The restraint placed on the boards by the battens and the added iron straps resulted in extensive splitting along most of the length of the top board. The splits emanated from the screw sites and resulted in paint loss and some planar distortion. In an attempt to relieve some of the restraint, treatment included removal of the iron straps. Where possible, damage was stabilized by injecting hot hide glue into the splits.

Joined construction

Objects in this category are made from numerous pieces of wood joined in various ways, depending on the function of the object. Such objects include whirligigs, toys, and small sculptural figures. Join techniques include the use of nails, screws, metal plates, and other hardware; glue joints for fixed connections; pins, dowels, mortise-and-tenon or lap joints, et cetera.

Repairs seen on these types of objects include additional nails and/or screws to secure split or separated elements, and replacement of detached and lost components. Past repair attempts may have also rendered the object nonfunctional by restraining its moving parts.

Damage encountered includes loose joints, misaligned and/or missing parts, replacement parts made of incompatible materials, and added fasteners. Paint loss may have occurred at joins and in areas associated with repairs. Mechanical wear from friction of moving elements may have resulted in structural instability. Damage to the paint also occurs at the interface of the joined elements. In those objects where one part rubs against another (as in the case of a whirligig), abrasion to the paint surface is usually encountered. Damage is also found at the site of metal fasteners where star-shaped or circular crackle patterns in the paint define the heads of nails or screws. In some cases, the nail or screwhead has been pushed out of the wood to some extent, with associated loss to the paint layer.

The Politician (Fig. 3), a small sculptural figure, is constructed of a number of joined elements. The radiograph (Fig. 4) shows numerous nails, most of which were used to assemble the object. The screws securing the arms at the shoulders, due to their suspected modern manufacture, may be replacements. A merganser decoy (Fig. 5) illustrates how a previ-

Figure 3
The Politician, before treatment. H:60.64 cm. This small figure is an example of a joined construction object. The buttons, bow tie, and cape are made of painted leather (AARFAC, 63.705.1).

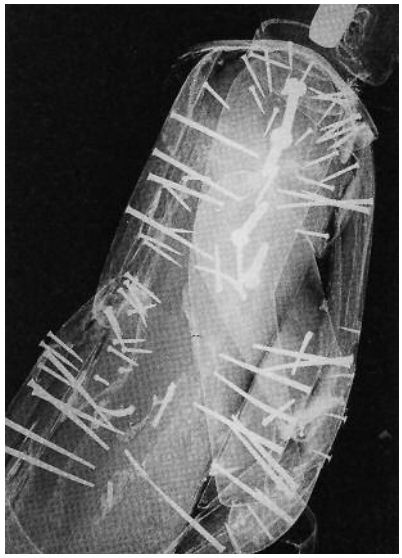


Figure 4
The Politician, during treatment. Radiograph illustrating the large number of nails used to fasten the various components. The large white block in the head area is a dowel used to secure the hat to the head.

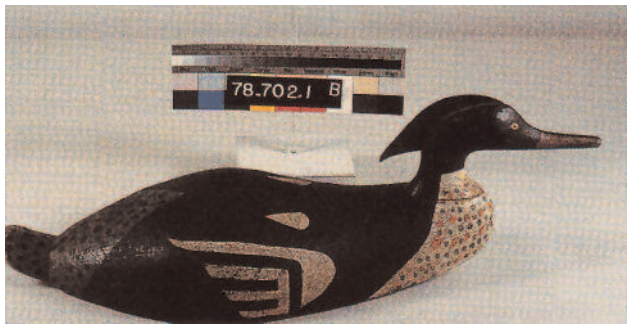


Figure 5
Merganser drake decoy, before treatment. Note the slight misalignment at the interface of the neck and breast (AARFAC, 78.702.1).

ous repair can cause misalignment of joined elements. The normal light photograph shows the slight misalignment at the interface of the neck and breast. A radiograph of this decoy showed that the addition of an internal iron pin and nails held the neck out of alignment with the breast.

Various techniques are utilized for the conservation of these objects. Treatment options may include leaving the object as is, designing and attaching mechanical supports and mounts, or applying additional adhesive to weakened joints. Old repairs or added fasteners may be removed and replaced with more stable materials, although great care must be taken to distinguish original materials from later additions. Protruding nails may be pushed back into place if the condition of the paint allows. Paint surfaces damaged by repairs or later attachments may be consolidated, and losses filled and painted. Areas abraded by the friction of original moving parts, however, are evidence of historic usage and should not be inpainted.

Case History

Given the variety of materials and techniques utilized by folk artists—many of which are fragile and unstable—it is impossible to standardize treatment approaches and materials. Furthermore, the repair and maintenance history of these objects complicates treatments because the preservation of evidence of repair and maintenance is frequently desirable. Thoughtful discussion among curators, owners, and conservators is essential in developing a sensitive treatment plan.

Figure 6
The Clown, tobacconist figure, ca. 1860, before treatment. H:187.32 cm. This figure may be a portrait of George L. Fox, who was a clown and an actor. The figure was used to advertise cigars named after George W. Childs, a publisher and philanthropist (AARFAC, 56.705.2).

The Clown, a polychromed tobacconist figure (Fig. 6), was carved from a solid piece of eastern white pine. The head was carved separately and inserted into a large recess in the shoulders, and the outer elbows are additional pieces of wood that were laminated to the main "log" of the body. The base, a replacement, is composed of five thick pieces of wood nailed together to form a box approximately 46 cm square. Two 42 cm long iron bolts had been inserted through the underside of the base into holes drilled into each leg, to secure the figure to the base. Nuts were secured to the ends of the bolts through mortises carved into the calf of each leg. The mortises were filled with plugs of wood. Additional support was provided by a tree branch nailed between the rear top edge of the base and the crotch of the figure.

Although the figure was in relatively stable condition, several features caused concern for curatorial and conservation staff. The head portion was loose, and fill material in the base of the neck was insecure and crumbling. The head seemed to be out of proportion to the rest of the figure, and an old repair on the side of the nose was loose. The color and character of the head was also inconsistent with the remainder of the figure. In addition, areas of darkened overpaint up to 7–8 cm in diameter were visible on the higher points of the figure. Both feet were heavily damaged and had been nailed back together; the nails had caused additional splitting of the wood, and the pieces were very poorly aligned.

Further examination revealed two large radial splits, filled with a hard puttylike material, running through the left side of the body from the base of the neck to the crotch. The splits had enlarged the recess in the shoulders, allowing the head to shift position. There was also a radial split on the rear of the head (Fig. 7). This split and a large loss on the top of the head had been filled with the same material that was used at the base of the neck. Through visual inspection, the material appeared to be plaster. Apparently the head became detached at some point, possibly as the result of a forward fall (such a fall could also explain the broken feet and damaged nose). In a poor attempt to repair the damage, the head was improperly reattached in the position seen in Figure 6.

Microscopic examination of the paint layers at the edges of losses and cracks showed the presence of a white ground layer. Above the ground, the legs and portions of the costume were painted red, and then various colored details were added. A clear coating, now very yellowed, had been applied over the paint. Examination revealed that the darkened areas of paint on the high points were areas of retouching applied to camouflage losses and abrasions to the original paint layers. Tests with various solvents showed that the head had been completely overpainted, presumably to hide the fill materials and to brighten the overall appearance. Overpaint matched the color of the original paint as altered by the discolored clear coating (e.g., areas originally painted blue had turned green because of the yellowed varnish; these had simply been overpainted with green).

During treatment to extract the crumbling fill material, the head was removed (Fig. 8). This revealed additional fill material from a past restoration: crumpled brown paper bags and plaster stuffed into the neck cavity. Because the figure had been used outdoors, water had seeped into the cavity and had caused extensive damage to the wood. After a thorough cleaning of the cavity to remove loose debris, the deteriorated wood was

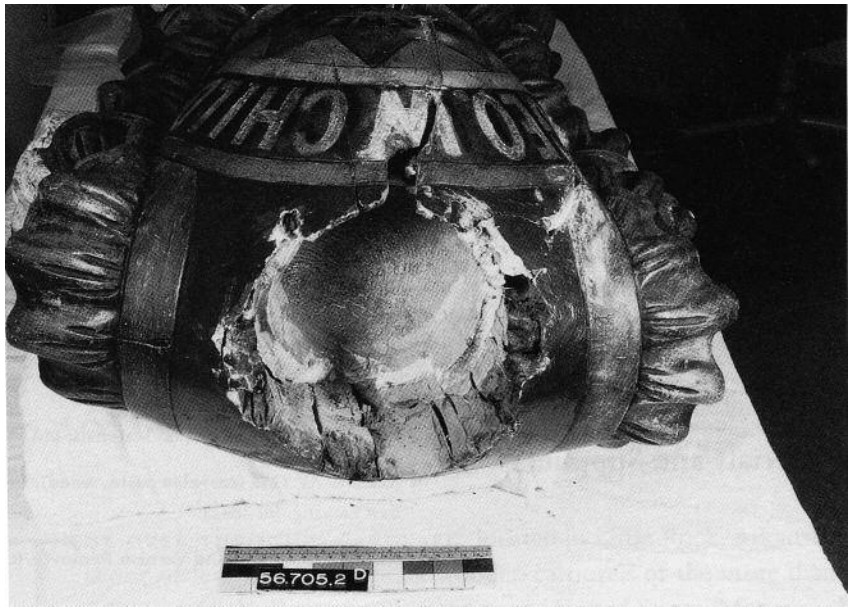


Figure 7
The Clown, during treatment. This photograph shows the detached head with a radial split and associated fill material, as well as damage to the neck.

Figure 8
The Clown, during treatment, showing fill material and extensive damage to the neck cavity as a result of water infiltration.

consolidated with Acryloid B72, and the head was reattached in its proper position with a carvable epoxy paste (Araldite AV 1253).

To stabilize the figure, it was detached from the base by first removing the tree branch, which was determined to be a twentieth-century addition and inappropriate for current exhibition purposes (it was placed in storage). The wood plugs on the calves were then removed; the bolts were extracted through the underside of the base, and the base removed. The nails that held portions of the feet to the legs were then extracted. The split, misaligned feet were reassembled and adhered with hot hide glue. Two 5.08 cm (½ in.) diameter stainless steel pins, 40.6 cm in length, were used to secure the figure to the base instead of the iron bolts. The pins, which had a 10.2 cm square plate welded to one end, were inserted through the bottom of the base, and wood screws were used to fasten the plate to the underside of the top of the base. The figure was then lowered onto the pins, and the wood plugs were adhered in position with hot hide glue.

Solvent tests were conducted to determine the solubility of the paint layers. Based on these tests, the overpaint was removed with acetone or propanol in a methyl cellulose gel and, when necessary, a commercial paint stripper for the more intractable areas. During this process, the discolored coating was also removed. This proved to be an advantage in the cleaning of the head, which retained nearly intact, stable, original paint, with disturbed areas adjacent only to the split and loss. The losses and cracks exposed by removal of the overpaint were filled with Perma-Fill Ready Mixed Spackling Paste. Fills were sealed and isolated with Acryloid B72 and inpainted with Bocour Magna Colors (see list of Materials and Suppliers at the end of this article).

Conclusion

This discussion of construction methods, repair details, maintenance history, and current condition has demonstrated that construction features can be used to loosely categorize painted wooden folk art for the purposes

of understanding current condition and developing potential treatment options. Objects of a particular construction type ("log," hollow, board, or joined) exhibit definite patterns of maintenance practice, repair history, and loss and deterioration, which are evident in both the structural elements and paint surfaces. Although knowledge of these patterns can aid in the evaluation of problems affecting any folk art object, treatment options rarely fall into standardized approaches. Each object, due to its unique material and aesthetic nature, warrants individualized thought and attention from experienced conservators and knowledgeable curators for the formulation of appropriate conservation treatment methods.

Materials and Suppliers

Acryloid B72, Conservation Materials, Ltd., 100 Standing Rock Circle, Reno, NV 89511.

Araldite AV 1253 (carvable paste, wood), Ciba-Geigy Corporation, 4917 Dawn Avenue, East Lansing, MI 48823.

Kwik Marine Paint and Varnish Remover, Klean-Strip division of W. M. Barr, Inc., Memphis, TN 38101.

Magna Colors, Bocour Artist Colors, Inc., Garnersville, NY 10923; distributed by Conservation Materials, Ltd.

Methyl Cellulose, Talas, 213 West 35th Street, New York, NY 10001.

Perma-Fill Ready Mixed Spackling Paste, Bondfast Company, Bridgewater, NJ 08807; distributed by Conservation Materials, Ltd.

Victory White Wax, Conservation Materials, Ltd.

Jeffrey: Horse of a Different Color

Rick H. Parker and Peter L. Sixbey

The over-the-jumps carousel, located in Little Rock, Arkansas, is one of fewer than 180 intact wooden carousels of the more than 5,000 carousels that once operated in the United States (Morgan 1994). It is the only surviving example of an undulating-track carousel manufactured by Spillman Engineering Corporation in the 1920s in North Tonawanda, New York. It was a familiar sight on amusement ride circuits, including the Arkansas State Fair. In 1942, the forty hand-carved wooden horses and four chariots found their way to War Memorial Midway in Little Rock, where the carousel continued to operate until 1991 (Anderson and Story 1989). During its forty-nine-year period of operation, up to thirty layers of "park paint" were applied to the carousel animals as part of ongoing maintenance. Recent conservation surveys and treatments indicate that most of the original paint layers remain intact (Parker 1994).

Roads to extinction are often paved with good intentions. Numerous well-intended preservation attempts have compromised the integrity of many wooden carousels; very few retain original painted surfaces beneath restoration colors, and even fewer survive intact with their original surfaces exposed.[1] Indeed, restoration efforts have put existing original paint surfaces and designs on "the endangered list." Carousels have a long and important tradition in many cultures; we should apply the highest conservation standards to the increasingly rare intact examples of this unique, painted wooden art form.

Carousels: A Brief History

The first visual record of a carousel device appeared in a Byzantine bas-relief fifteen hundred years ago (Fried 1964:13). The word *carousel* is a derivation of *carosello,* a seventeenth-century Italian word meaning "little war," which described a game that originated in twelfth-century Arabia in which horsemen rode in a circular pattern throwing clay balls filled with scented water at one another. This game of equestrian skill was probably the ancestor of today's familiar merry-go-round. In the royal courts of France, the carousel evolved into a game in which lance-bearing horsemen riding at full speed attempted to spear gold rings. This variation led to the tradition of "catching the brass ring." To train for these events, knights mounted crude wooden horses attached by beams to a center pole. Servants or horses provided the turning power (Manns, Shank, and Stevens 1986:9).

Englishman Frederick Savage's adaptation of the steam engine in 1870 to power the machinery that rotated the carousel platform heralded the beginning of the modern merry-go-round (Manns, Shank, and Stevens 1986:11). Savage is also credited with the invention of the overhead cranking device that gave the familiar up-and-down motion to carousel horses known as *gallopers* in England and *jumpers* in America (Fried 1964:33). This improved ride appeared all over Europe.

In America, an advertisement for a wooden horse "circus ride" appeared in a Salem, Massachusetts, newspaper as early as 1800 (Dinger 1983:10). But it was not until 1867, when German immigrant Gustav A. Dentzel opened a cabinetmaking shop at 433 Brown Street in Philadelphia and constructed his first carousel (a simple bench seat, horse-powered machine), that the era of hand-carved carousels really began in the United States (Fried 1964:51–52).

The carousel industry grew in late-nineteenth-century America. Many skilled immigrants, familiar with carousels produced in Europe, settled on America's East Coast and supplied the industry's work force (Manns, Shank, and Stevens 1986:11). As America industrialized, expanded leisure time and disposable income gave workers the means to enjoy these new forms of entertainment. City parks, a manifestation of a developing interest in public recreation, proliferated in the larger urban centers. Transportation companies, motivated by financial self-interest, supported amusement centers at such parks, which were generally located at the end of rail or trolley lines. The amusement centers featured increasingly larger carousels as the parks flourished (Weedon and Ward 1983:70; Manns, Shank, and Stevens 1986:70).

Carousels were not only accessible to large urban centers; the outdoor amusement industry expanded into smaller cities and rural communities as well, with traveling amusement ride circuits, still popular today. Traveling carousels generally suffered more damage than the larger, more ornate stationary versions because of constant assembly, dismantling, travel wear and tear, and less substantial shelters from the weather.

Over-the-Jumps History and Description

Over-the-Jumps was manufactured in North Tonawanda, New York, at Spillman Engineering Corporation (ca. 1924). Sometimes called "Lumber City" or "Carousel Capital of the United States," North Tonawanda was a magnet for woodworkers and carvers (Manns, Shank, and Stevens 1986:175; Fried 1964:121). Spillman Engineering was one incarnation of a dynasty of four closely related carousel manufacturing companies, the others being Armitage-Herschell, Herschell-Spillman, and the Allan Herschell Company. These four companies spanned the years from 1890 to 1955 (Table 1). During the "golden age of carousels" (ca. 1905–25), the Herschell companies (including Spillman Engineering) produced more carousels than any other firm in the United States and played a major role in the development of the simpler, smaller, and more mobile traveling, or "county fair," carousels.

An early Spillman Engineering Corporation sales catalogue (1924) described Over-the-Jumps (Fig. 1) as

> a circular track ½" × 4" × 4" [1.27 × 10.16 × 10.16 cm] angle iron mounted on adjustable jack stands made of 2 inch [5.08 cm] black pipe with quick locking attachments to receive the track. There are 24 sweep arms connected to a

Table 1 History of the carousel in the United States and the Herschell factories

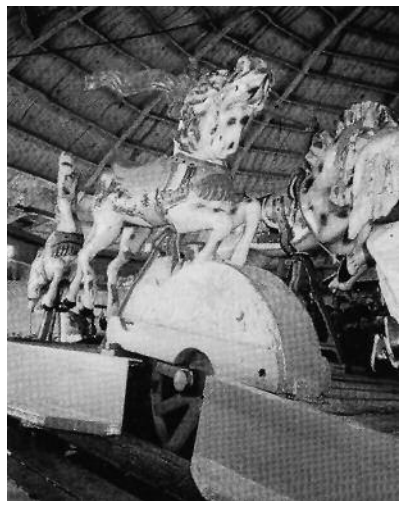
1800	Advertisement for a wooden horse "circus ride" in Salem, Massachusetts
1867	Gustav A. Dentzel constructs his first carousel
1870	Frederick Savage adapts steam engine to power carousels in England
1873	Allan Herschell/James Armitage form Tonawanda Engine and Machine Company
1890	Tonawanda Engine and Machine reorganized as Armitage-Herschell Company
1903	Allan Herschell/Edward Spillman buy out Armitage-Herschell and form Herschell/Spillman Company—largest manufacturer of carousels
1915	Allan Herschell establishes Allan Herschell Company
1920	Herschell/Spillman reorganized as Spillman Engineering Corporation
1924	Over-the-Jumps manufactured by Spillman Engineering (ca. 1924)
1905–25	Golden age of the carousel in the United States
1945	Spillman Engineering Corporation bought out by Allan Herschell Company
1955	Allan Herschell Company goes out of business

ballbearing center; on the other end a series of 24 special built wooden wheels with ⅜ inch [0.95 cm] steel tires, and equipped with Timken roller bearings.

The diameter of Over-the-Jumps is 12.2 m (40 ft.) with a center pole. According to the sales catalogue, "space required is 56 feet [17 m], 4 to 5 hours time for erecting; [and] for space on a show train, it can be carried on three 18-foot [5.49 m] wagons." The stationary walking platforms surround the mobile riding platform, and both are constructed of wood planks. The riding platform is sectioned into 1.5 m (5 ft.) segments (twenty-four in all), with one wooden wheel between each segment (twenty-four wheels) (Fig. 2). Each wheel between the segments is approximately 61 cm (24 in.) in diameter, with thick wooden spokes, a cast-iron

Figure 1
According to the company's sales catalogue, "The track has several dips and hills, leaving the participants riding the device in a perplexed state."

Figure 2
In the latter days of the carousel's operation in War Memorial Park, in Little Rock, Arkansas, the twenty-four wooden spoke wheels were frequently soaked with water to expand the wooden components in order to help secure the cast-iron rims.



hub and a cast-iron rim. Each wheel is covered with a wood well above the riding platform "to protect the ladies' dresses from any grease that is frequently collected by wheels from the track." Each segment carries two horses or one chariot, with one chariot occurring between each set of ten horses. Beneath the riding platform is a cast-iron undulating track, along which the wheels of the riding platform move the horses in an up-and-down galloping motion. Horses are mounted on the riding platform with triangular stands. For power, the carousel requires a 10-horsepower electric or gasoline motor. The sales catalogue describes a "4 cylinder, one piece removable 'L' head heavy clutch tractor type motor, $3\frac{1}{4} \times 5$. It is equipped with an American Bosch magneto, Zenith carburetor, duplex governor and Oakes ballbearing fan." The earning capacity of Over-the-Jumps was $220 per hour (Spillman Engineering Corporation 1924).

Over-the-Jumps made its initial appearance at the Aurora Exposition and Fair in Aurora, Illinois, on the C. A. Worthem World's Best Shows, 15 August 1924. It is probable that no more than five Over-the-Jumps machines were produced. References have been found to as many as four to five companies that owned a machine: C. A. Worthem World's Best Shows; Rubin and Cherry Shows (Fig. 3); J. J. Jones Exposition; Royal American Shows; and possibly Siebrand Brothers (Dahlinger 1994).

The traveling circuit of amusement rides that brought Over-the-Jumps to Little Rock remains unknown. Nonetheless, the carousel found a permanent home in the city's War Memorial Park in 1942, under a domed wood-frame structure that helped protect it from the elements. It operated until 1991, when it was dismantled for restoration. In 1989, the carousel was placed on the National Register of Historic Places by former Governor Bill Clinton. In 1991, a nonprofit organization, Friends of the Carousel, formed to purchase the historic carousel and return it to operation after learning that, despite its listing on the National Register of Historic Places (Anderson and Story 1989), the carousel was in danger of being sold to out-of-state interests.

Figure 3
An Over-the-Jumps carousel as it appeared in a Rubin and Cherry Show in the mid-1920s.

Wood-Carvers, Painters, and Horses

Most of the forty vertical jumping horses on Over-the-Jumps are typical of those produced by Spillman Engineering Corporation in the 1920s. The horses were generally more elaborate than their predecessors; jewels were added and intricate relief carvings appeared with more frequency on the trappings (Dinger 1983:90). Identifiable features of Spillman horses (from 1920 to 1945) include long heads; small, high-set eyes; pointed rumps; full, wavy manes; intricate ornamentation; high cantles and pommels; large nostrils; jewels; and figures in relief. The *romance* sides of the horses (the sides facing outward) were elaborately carved, in contrast to the inward-facing, less-detailed surfaces, which were limited to mostly painted decoration.

The following is a description (Fried 1964:121) of the Spillman Engineering Corporation carving shop:

> The carving shop is just above the carpenters shop. Bodies, legs, heads, and tails of the different animals are piled about in orderly profusion; also parts of chariots, shields and cornices all of which are handcarved and very beautiful. One of my first impressions of detail was the discovery that each foot of the marvelously natured little horses was shod with a real horseshoe.

The Herschell companies, including Spillman Engineering Corporation, used basswood for most of the construction, although some animals were made with poplar. The wood was planed smooth and glued up into boxes in a technique referred to as *coffin construction* (Schroeder 1980). A standard animal consisted of six to seven boxes, with a box serving for each major body part: the body, head, each leg, and possibly the tail (some animals had realistic tails made from horsehair). This type of construction allowed the wood to expand and contract with minimal splitting. Coffin construction also reduced the weight of animals, thus simplifying the transport and assembly of traveling carousels.

After assembly, each box was *roughed out* to approximate the form of the body part. Master sketches of each animal being carved were kept on the walls of the factory. Each animal was drawn life-size, and the drawings often included side, front, and rear views to help the carvers establish dimensionality (Brick 1994).

The factory carvers were divided into three distinct groups: apprentices, journeymen, and master carvers. The apprentices, many of whom began learning their craft as early as age five, worked almost exclusively on the legs, a fairly simple and undetailed part of the body. Journeymen worked on the bodies, carving the shoulders and saddles and simpler decorative elements. Master carvers modeled the heads and fine details, oversaw the finishing process of the entire animal, and effected a transition between the work of various carvers once the components were assembled into the complete animal (Fraley 1983:13). The style of the simpler "county fair animals" associated with traveling carousels was influenced by the need for ease of packing, portability, and large-scale production.

Production was greatly increased with the introduction of a duplicating process that used a pantographic cutting apparatus, which allowed one wood-carver to turn out vast amounts of woodwork in a year. In North Tonawanda, the carving machine, which could rough out four bodies at once, was first used in 1913 (Fried 1964:119). After figures came off

the machine, skilled artisans completed the work by chiseling out details and hand carving important features.

The animals were then taken to the paint shop, where various painting, japanning, and gilding techniques and materials were used. The animals generally received a protective coating of shellac after painting (Brick 1994). Very little information exists on the various color schemes and decorations that were used, since few records remain today.

The work of carousel carvers and painters represents a most important phase of American wood carving and painting, although historians have generally failed to document it or acknowledge it as a contribution to American art. Unfortunately, much information about carousel artists has been lost; company books were not always kept and records that once existed have been destroyed or lost in fires or reorganizations. Many of the artists were known only by their first names, and very few signed their work (Fried 1964:117).

Carousels have been categorized as both folk art and fine art, and arguments have been made on both sides of the issue. Fried (1964:118) states:

> The term "primitive" is generally used to designate unschooled, crude, naive, or unsophisticated art. Most of our carousel carvers were unschooled in sculpture, naive and unsophisticated in their art understanding, but it can hardly be said that theirs was a "primitive art" nor because of its large commercial use, can their art be termed "folk art." Nor were there any signs of crudeness in the products of the carousel manufacturers after the 1900s.

Carousel historian Tobin Fraley, in *The Great American Carousel* (1994a:70), echoes this notion of the carousel craftsperson as artist:

> Although the basic motivation to produce carousels may have been the need to make a living, the drive to create, for these craftsmen, must have gone well past the bounds of just making money. There is no doubt that the sculpting of wooden figures represented an expression of the maker as an artist. The exacting detail, the sweeping flamboyance and the serious grace and beauty of many of the figures created by these men reveal an ambition beyond the creation of a seat on an amusement park ride.

An example in Over-the-Jumps is the painstaking effort taken to create details such as dappling and other hand-painted decoration.

Many wood-carvers employed by America's industry were, in fact, very sophisticated not only in technical ability but in their understanding of design and art in general. Most received training through intensive apprenticeships beginning at an early age, and some enrolled in art classes to enhance their careers. Carousel artists recognized for their exquisite designs and detailed carvings include Salvatore Cernigliaro, M. C. Illions, John Zalar, Daniel Muller, Harry Goldstein, Soloman Stein, Charles Carmel, Frank Carretta, Charles Leopold, Eugene Drisco, and many others whose names are now lost but whose work remains as a testament to their outstanding technical and artistic abilities (Fraley 1994b).

As with any other art form, no single label accurately describes or defines carousel art. The degree of artistic sensibility in carousel figures ranges from the very naive to the highly sophisticated. Nonetheless, museums have generally relegated carousel figures to folk art galleries and have failed to adequately exalt the finer examples of carousel art. This charac-

terization of the carousel as "folk" art has influenced the approaches used in past preservation attempts. Current debates about the position of carousel art within the spectrum of artistic expression will undoubtedly impact future conservation efforts.

Past Restorations

Past restoration efforts have greatly compromised the integrity of numerous wooden carousels and carousel figures, in many cases resulting in the complete destruction of original painted surface coatings and decoration. Because carousels were built to turn a profit, repairs to the figures were generally executed as quickly and cheaply as possible. Nonetheless, well into the 1940s, a high level of restoration work was often performed by the same highly skilled artisans who constructed and painted the wooden figures. As this generation of artisans passed away, the quality of carousel restoration declined.

At the advent of a carousel revival in the United States during the 1960s and early 1970s, original paint was disregarded, and stripping, sandblasting, and hot-bath dipping (which often separated glue joints) were standard restoration methods. In the late 1970s, commercial strippers and cold-bath dipping were commonly used, and the carousel figures continued to be stripped to bare wood. Common repair materials included polyester resin (auto body fillers), epoxy adhesives and fillers, and automotive paints.

An oil-based enamel paint (referred to as "park paint") was applied in-house to carousel figures as an ongoing maintenance procedure for operating carousels. It was a cheaper option than contracting with carousel companies for repainting (Walker n.d.). Paint analysis on the Over-the-Jump horses indicates that up to thirty layers of paint were applied over the years. Park paint was generally applied by relatively unskilled workers who had neither the time, desire, nor talent to duplicate original colors and painting techniques. Consequently, the original artists' intentions were completely obscured. These heavy, multiple layers of visually unimpressive park paint have, however, provided the protection necessary to preserve the original paint layers.

Standards for fine arts conservation have rarely been applied to carousel preservation. When Friends of the Carousel, the organization formed to save Over-the-Jumps, contacted well-known U.S. carousel restoration companies and requested restoration proposals and cost estimates, no company submitted a proposal that included preservation of the original paint. A standard procedure appears to be the documentation of original colors and designs, stripping the figures to bare wood, and complete repainting.

Recently, some restorers have used a more sensitive approach, in which windows are opened in various areas of the figures, original colors and designs are documented, and the figures are repainted in the original colors and design over a stable layer of park paint. This method retains the original paint beneath the protective layers of park paint (Ragan 1988:31–32).

The conservation of culturally important objects such as Over-the-Jumps, which by tradition or necessity exist as functioning artifacts outside a proper museum environment, presents formidable challenges. In 1992, a general conservation survey of the forty carousel horses of Over-the-Jumps was conducted by Parker Restoration and Conservation Services, who then carried out treatment of "Jeffrey," one of the forty

Figure 4
Jeffrey, before treatment.

horses on the carousel (Fig. 4).[2] Though the carousel project has only begun, the initial efforts on Jeffrey have already provided a wealth of information. Future study and conservation of this increasingly rare object—an intact wooden carousel—promise to fill many of the gaps in our knowledge of original carousel colors and design schemes, as well as the painting techniques and materials used in the 1920s by Spillman Engineering Corporation on this most impressive artifact, Over-the-Jumps, the Arkansas carousel.

The Treatment

In 1992, the Friends of the Carousel contracted Parker Restoration and Conservation Services to examine Over-the-Jumps for evidence of original factory paint schemes. Proposals already received from carousel restoration firms recommended the removal of paint to the bare wood prior to repainting, so the Friends wished to document the original scheme while it was still possible to do so. If early colors were found, the information could improve the accuracy of the replication.

A cursory examination revealed many layers of park paint covering the horses, but very little serious structural damage. The paint layers were in poor condition and were covered with a thick, clear coating, possibly polyurethane varnish. When applied, this coating had penetrated fissures in the paint on each horse, allowing solvent to reach an early varnish layer and cause it to swell. This produced considerable disruption in the upper paint layers and resulted in islands of separated paint. Flaking, tenting, and crazing paint; abrasions; and paint loss were common problems on most of the horses.

Despite these problems, the condition of the horses looked very promising. Several were randomly chosen for elementary tests, and a basic examination was undertaken to search for early decoration beneath the park paint. Solvent action was relatively unsuccessful in removing upper layers, but dry scraping with a surgeon's scalpel seemed successful in revealing the earliest coatings. Because it seemed possible to recover much of the factory paint scheme, the board of directors of the Friends of the Carousel agreed to deliver one of the horses to the laboratory for further

exploration. After a review of the condition reports, Jeffrey, a horse exhibiting a range of the surface problems encountered on all of the horses, was chosen as the best example for study.

The horse arrived at the laboratory in the spring of 1993. Upon arrival, six representative cross sections were taken from various portions of the horse. Up to thirty layers of paint and varnish were present in some areas, while as few as fourteen were found in areas of wear. Visible light microscopy and ultraviolet light microscopy, with the use of stains,[3] indicated that the paint layers were all lead-based, oil-bound paints. Solvent tests demonstrated that all of the paint binders had similar solubility parameters. The samples revealed the original coatings in the following order: first, several layers of lead white primer were applied to the wood; a paint layer, believed to be the original factory paint, lay directly over the primer in each sample; over the paint layer was a heavy varnish coating, which appeared to consist of several thin coats of similar solubility, since each successive layer had coalesced with the previous one.

With as many as thirty coats of paint visible in the samples, a brilliant array of color emerged beneath the microscope, yet the recovery of the factory paint remained the absorbing task. Solvents proved to be unsafe; while effective in swelling the upper layers, they penetrated the cracks between the islands of paint and swelled the early layers at the same time. Several promising solvents were gelled in an attempt to control their activity, but this also proved unsatisfactory. Several scraping techniques were tried, but the paint was too thick and extremely brittle, and the techniques were too time-consuming, considering the limited budget for the project.

However, the scraping trials confirmed that sound, intact early layers existed, and revealed interesting information about the factory paint scheme. Prior to examination, one authority suggested that only the more visible, outward-facing sides of the horses would exhibit elaborate decoration, but this proved false. While the outer side certainly displayed more jewels and other carving, the inner side bore intricate painted trim and detail executed in small, deft brushstrokes. Small painted elements emerged all over the horse—pinstripes, painted patterns, and realistic dappling. The placement of the final detailing was surprising; areas expected to show decoration were sometimes plain, while areas assumed to be undecorated often contained fine ornament.

The scraping worked well in some areas, revealing interesting undocumented details at every test site. As work progressed, however, it became apparent that past exposure to water in some areas had made the primer layer very fragile and subject to damage; therefore, scraping was halted, and the primer consolidated where necessary using rabbit-skin glue.

So far, all trial techniques showed some success, but none proved efficient and consistently effective. An attempt was then made to locate someone who had dealt with a similar problem. Most literature regarding previous carousel restorations reflected the standard commercial approach—a cold-tank immersion to "get rid of the old paint," thereby producing a stable ground for repainting in appropriate colors. As this was an unacceptable alternative, several objects conservators were consulted for more sensitive methods of dealing with the numerous paint layers. Although some techniques worked, none proved suitably efficient for the treatment of forty horses.

As a workable plan had yet to be achieved, the cross sections were reexamined in a search for other possible approaches, and several more samples were taken to aid in the study. When cross-section photographs were compared, the thick varnish over the factory paint stood out in each sample (Fig. 5). If this layer of varnish could somehow be manipulated, the factory paint could be preserved.

The scraping had produced one helpful clue. The thick coating of varnish was very soft, while the layers of overpaint tended to be extremely brittle. From looking at the cross sections, it seemed likely that heat applied to the surface would further soften the varnish, allowing it to be manipulated beneath the overpaint. Areas 7.6 cm (3 in.) square were masked off with blotting paper, and a heat lamp was aimed at the exposed surface. Using a scalpel, it was possible to work into the softened varnish layer and lift all of the overpaint at one time.

Feelings of elation were premature, however, as concerns arose about the absorption of heat by the original paint, as well as by the wooden body of the horse. A hot-air gun, selected as a more controllable heat source, worked somewhat better but was cumbersome. It was difficult to use the heat gun, put it down, pick up a scalpel, and work the island of paint free. This process produced an extremely brief window of time in which to manipulate the softened varnish, and as a result there was a tendency to apply too much heat to increase the working time. The next attempt, using a commercial hair dryer, worked fairly well, but prolonged heat exposure was still an issue.

At this point, Robert Pennick, a colleague with considerable experience in commercial paint removal, was consulted. A period of brainstorming produced a successful two-person technique: one person handled a heat gun, while the other used a scalpel to lift the islands of paint. At first, this process varied in success, but it soon developed into a comfortable rhythm and gave very acceptable results. Surface temperature was controlled by varying both the distance of the gun from the horse and the duration of exposure. The heat gun operated at a lower temperature than the heat lamp, yet it warmed a larger area. Very little heat was required to remove the upper layers of paint from the thick varnish. When an island of paint began to move but resisted lifting, the heat was decreased just enough to keep the varnish warm (about the consistency of thick molasses). This permitted the removal of small sections of the paint with either forceps or the scalpel.

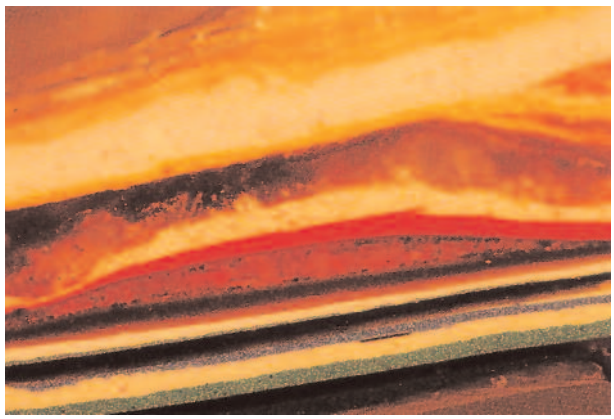


Figure 5
Photomicrograph from the saddle blanket of Jeffrey, showing the thick varnish layer over the original factory paint (yellow coating over the lead white primer layer).

Because of wear, areas such as the saddle and knees had little or no varnish, and the later paint lay directly above the factory coatings in these areas. They were carefully scraped at room temperature because the heat required to move the upper layers would also damage the original paint. Although there was considerable wear to paint in the saddle area, the color scheme remained clearly visible.

An object is usually repainted for a reason. As the overpaint was removed, additional wear was evident on Jeffrey. Though in good condition considering this horse's hard life, the factory coating on the flanks of the animal was worn by the mounting and dismounting of countless riders. Improper storage and handling also had caused considerable damage, and the legs were damaged at points where they bore the weight of the horse in storage. The horse had also been stored on its sides, resulting in numerous abrasions. There was evidence of water damage and exposure to the elements.

It is interesting to note that the first overpaint on top of the factory decoration was a very good reproduction of the original. Great pains had been taken to replicate not only the color scheme but the articulated brushstrokes; the stippled pattern of the horse's coat was expertly handled. Each successive coating, however, received less attention and appeared more sloppy, culminating in the final coating, where a spray can was used to shade the knees, tail, and mane.

The heat gun/scalpel process worked extremely well and was economically comparable to the "dip, strip, and total repaint" method mentioned earlier. Control of the heat gun permitted the execution of very delicate work. Often considered a rather brutal and crude tool, the heat gun produced remarkable results in the removal of overpaint from Jeffrey, and it suggested interesting possibilities for future applications.

After removal of the paint, considerable dark, thick varnish still remained on the horse. A series of solvent mixtures with acetone, devised using a Teas diagram, was used to clear the varnish. While the varnish was easily cleaned from the body of the horse, several underlying painted elements (including the orange saddle trim, the dark green saddle blanket, and the orange breast trim) were also easily lifted by this solution. A mixture with less acetone was devised to clear the varnish residue from these areas.[4]

By this point in the process, the treatment deviated considerably from the initial objective: finding the factory paint scheme prior to repainting. In the beginning, there was little to indicate that intact paint schemes might be found. Now, although the recovered surface coating was by no means in pristine condition, it was apparent that the original painted decoration, complete with previously undocumented details, could be saved. A conjectural replication was unnecessary.

One of the early stated goals of the Friends of the Carousel was to return the carousel to operation. Presented with new possibilities for treatment of the horses, there were now mixed feelings by the board members as to what should be done. All realized that subjecting Jeffrey to the normal wear and tear of a functional carousel would jeopardize the survival of his fragile, newly revealed original painted decoration. The entire board made the journey to the laboratory to view the horse prior to any filling or inpainting. Some felt the horses should remain untouched, to be displayed in "as is" condition, while others felt strongly that the public supporting the project would not properly understand the horses if

damage were allowed to remain visible, that filling and inpainting should be done to make a better public presentation. Above all, there was the aforementioned concern that these original surfaces would be damaged if the carousel was returned to operational status.

The ultimate fate of the carousel now hinges upon the resolution of a dilemma; the desire to use and enjoy Over-the-Jumps as a functional carousel conflicts with the desire to preserve it as a historic and artistic work. One of the charms of the carousel is that it is a one-of-a-kind ride; an integral part of the experience is the ride itself. While some on the Friends of the Carousel Board would like to see the horses displayed as objects of art, others propose treating the carousel in a manner similar to a historic home: permitting limited use with the expectation of some wear and tear. If this plan is adopted, the horses will require a protective coating that is durable in order to withstand use by the public, clear so that the colors are visible, and reversible (to meet conservation standards). Even so, a coating alone will not prevent damage if the carousel is returned to operation. Clearly, the dilemma of usage versus preservation requires careful deliberation by the board of directors.

As a result of the laboratory visit, the board authorized limited filling and inpainting of areas on Jeffrey where significant, visually distracting damage had occurred. Acrylic gesso, smoothed with xylene, was used to level the major areas of loss, resulting in an immediate visual improvement to the horse. Dammar varnish was applied to saturate the colors before inpainting. On the sides of the saddle (Fig. 6)—which was previously considered too damaged for anything but repainting—a very faint shadow of a painted pattern simulating tooled leather was barely visible. This saddle area was given a barrier coating of poly(vinyl acetate) (PVA AYAF) in methyl alcohol and left as is for the time being.

Other than the saddle, roughly 85% of the horse retained original paint. The original artist obviously had a highly developed color sense, producing a diversity of colors by intermixing a limited palette of pigments. For example, the saddle brown is a mixture of dark green (phthalo cyanine green) and cadmium orange. The dapple, which closely approximates hair, is a dry-brush, stippled technique that has a far different character than the airbrushed dapple used on many newly restored carousel horses. The paint scheme was very carefully planned and executed, reflecting a skillful artist's knowledge of colors and mixing.

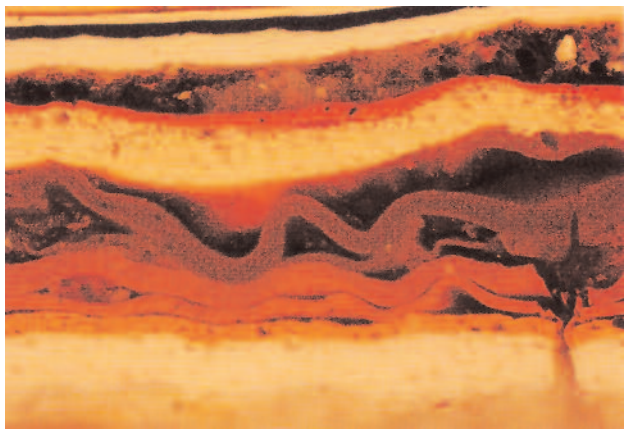


Figure 6
Photomicrograph from the saddle area, showing the lack of heavy varnish over the original factory paint (brownish yellow over the lead white primer) and the convoluted paint layers above it.

Inpainting of Jeffrey was done with an Acryloid B72/xylene mixture and Maimeri Colors (with the exception of the phthalo cyanine green, which was a Magna Color, used because it produced a closer color match).[5]

After most damaged areas of the horse were inpainted, the saddle received further attention. The shadow pattern of the tooled design was inpainted to enhance the definition of the overall pattern. Because of the extent of damage on the outer portion of the horse, however, the inpainting in this area is somewhat conjectural. As more horses are treated, the complete pattern may appear elsewhere, allowing exact replication in a future treatment. Of significance is the fact that this simulated tooling is not documented in any of the literature researched thus far. If these horses had been cold-tank stripped, patterns such as these would have been lost forever.

After the inpainting was done, a protective coating of orange shellac was applied over the entire surface to simulate the amber appearance of the factory varnish. This is by no means a final varnish, but a proper formulation has not been decided upon at this time.

As a result of the work on Jeffrey (Fig. 7), treatment of a second horse, "Swift," has begun. The work done on Jeffrey has been fruitful, as the conclusions drawn from the initial treatment apply equally to the second horse, and therefore treatment of the outward-facing surface of Swift proceeded quickly. On the inward-facing surface, however, the heat/scalpel process proved ineffective, probably because the horse had lain in water, which seriously damaged that side. Heat, even used minimally, was too damaging to the original layers; consequently, the entire side had to be carefully scraped with a scalpel to remove the upper coatings.

Figure 7
Jeffrey, after treatment.

The knowledge gained from the work on Jeffrey will aid in the formulation of future treatments for Over-the-Jumps horses. Each horse will be examined microscopically to discover pertinent problems and to determine the color scheme prior to treatment. The second and third horses already exhibit hidden art comparable to that on Jeffrey, and there is reason to expect the emergence of additional remarkable ghosts from the past as the project progresses. Meanwhile, plans for a long-term home for Over-the-Jumps are being prepared by the internationally known architect E. Fay Jones of Fayetteville, Arkansas. The pavilion, to be located on the grounds of the Little Rock Zoo, will be a work of art designed to complement the treasures it will house.

Notes

1 In the United States, the best example of a carousel with its original decoration intact is Philadelphia Toboggan Company no. 6 in Burlington, Colorado. See Morton (n.d.).

2 As part of a fund-raising campaign established by Friends of the Carousel, "Jeffrey" was named by his "adoptive pony parents."

3 All samples were taken by scalpel and mounted in Extec clear polyester resin. The samples were polished using successive grades of Micro-mesh abrasive from 60 to 12,000 grit. Samples were viewed with a Nikon Alphaphot 2 ultraviolet light microscope. The stains used were triphenyltetrazolium chloride (TTC) to identify carbohydrates; fluorescein isothiocyanate (FITC) to identify proteins; Rhodamine B (RHOB) to identify lipids; tetramethyl Rhodamine isothiocyanate (TRITC)—Texas Red—to identify proteins; and antimony pentachloride (APC) to identify natural plant resins (see Materials and Suppliers).

4 For the Teas diagram, see *Predicting Resin Solubility* (1984), a technical bulletin available from Ashland Chemical Company, P.O. Box 2219, Columbus, Ohio.

Acetone	45%	Acetone	50%
Diacetone alcohol	25%	Toluene	50%
Mineral spirits	30%		

Acetone	30%
Diacetone alcohol	30%
Mineral spirits	40%

5 PVA AYAF, Acryloid B72, and Maimeri Colors are still available; however, the Magna Colors have been discontinued.

Materials and Suppliers

Acryloid B72, Conservation Materials, Ltd., 100 Standing Rock Circle, Reno, NV 89511.

Extec, Excel Technologies, 99 Phoenix Avenue, Enfield, CT 06082.

FITC, RHOB, TRITC, TTC, Sigma Chemical, Box 14508, St. Louis, MO 63178.

Maimeri Colors, Conservation Materials, Ltd.

Micro-mesh abrasive, Micro-Surface Finishing Products, Box 818, Wilton, IA 52778.

PVA AYAF, Conservation Materials, Ltd.

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