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Insights into the Materials and Techniques of James Castle

ABSTRACT

Identifying the materials of works of art and determining methods of execution through technical study deepens our understanding of an artist's body of work. Conservators, scientists and historians often have endeavored to identify the materials and techniques of mainstream artists and to develop precise language to articulate their findings. However, this approach rarely has been undertaken for self-taught artists, such as Boise, Idaho, native James Castle (1899–1977), who used primarily unconventional and found materials. This paper derives from the first detailed, systematic studies of Castle's art, which were undertaken for a 2008 retrospective of his work at the Philadelphia Museum of Art (Ash and Homolka 2008; Price et al. 2008). It discusses his work in terms of technical connoisseurship and the scientific investigation of his materials, which provided new insights into his artistic output and informed the lexicon that was developed to describe Castle's unique creations for the exhibition and accompanying catalogue.

INTRODUCTION

James Castle's art—drawings of soot and spit, complex constructions, idiosyncratic books, and whimsical color renderings—embodies a deeply personal vision and artistic language. Previous descriptions of his materials and techniques have been based on his family's limited recollections of watching him work[1] or on scholarly inference, but these descriptions are incomplete, since Castle—who could not hear, speak, or write—left no written records and rarely allowed visitors into his studio. Castle found his subjects in the everyday objects around him. His materials, too, were the stuff of daily life, and give us a glimpse of period life in rural Idaho: discarded packaging from the week's groceries, the homework papers of his nieces and nephew, soot from the wood-burning stove, and matchboxes—dozens of them—from decades of a family going about its daily routine. His family supported his artistic endeavors and saved his designs and other related materials left in his workroom following his death in 1977. Today, many of these items are maintained in archives at the J Crist Gallery in Boise, Idaho, and the Boise Art Museum (figs. 1a, 1b). In the jar lids and coffee cans that contain residual soot and color; in old candy boxes filled with wads of cotton, cloth, and colored tissue used for applying color; and in the oddly shaped wooden sticks employed as pens and the pocketknife used to sharpen them, an artist's palette unfolds. By sifting through these materials and closely examining the works of art, insights on Castle's techniques and clues to his working processes emerge.

Fig. 1a. Ephemera from James Castle's studio; James Castle Collection and Archive; Courtesy of the J Crist Gallery, Boise, Idaho

The technical study of works of art, often essential to understanding an artist's output in historical context, involves identifying that artist's materials and determining the methods of execution. For someone like Castle, who worked primarily on or with paper, this is achieved through close visual examination of the physical qualities of his paints, inks, colorants, and supports, and by the identification of their constituents

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Fig. 1b. Whittled sticks and nails the artist used as drawing implements; James Castle Collection and Archive; Courtesy of the J Crist Gallery, Boise, Idaho

through scientific analysis. The instrumental techniques used in our study to characterize the materials found on Castle's works and in his studio were Fourier transform infrared microspectroscopy (MFTIR), gas chromatography mass spectrometry (GCMS), high-performance liquid chromatography with photodiode array detection (HPLC-PDA), laser desorption ionization mass spectrometry (LDMS), x-ray diffraction (XRD), and scanning and transmission electron microscopy (SEM, TEM) with energy dispersive spectroscopy (EDS). Castle's soot-and-spit drawing medium and colored media (pigments, dyes, and binder components) were among the materials examined.

CASTLE'S DRAWING MATERIALS

As stated above, the primary goal of our technical study was to identify Castle's materials and methods and to develop detailed and meaningful descriptions for the exhibition catalogue. Castle's drawings had been classified broadly as "soot and spit" or "colored pulp" and the gray-black soot lines and the washes and colors observed in them recur throughout his books, constructions, and collages. Close scrutiny of Castle's art, scientific analysis, and a consideration of his techniques within the context of traditional artistic practices have greatly enhanced our understanding of the artist's work. They also have helped to correct some misconceptions: perhaps most importantly, the popular notion that he completely rejected conventional art materials.

Another goal of our study was to use our analytical results and the information gathered from visual examination of Castle's supports to help determine when Castle executed his works, since he did not sign or date them and no reliable chronology exists. It was thought that the wealth of commercial product packaging he used in his art might provide clues for the dating of certain pieces. It was also anticipated that some of the constituents of Castle's drawing media—particularly modern synthetic colorants and their dates of development and manufacture—could serve as markers to indicate the earliest possible dates for some works.

Drawing on Centuries-Old Traditions: Castle's Soot and Spit

Since antiquity, artists have relied on certain essential drawing materials. Carbon black and bistre, historically two of the most frequently used drawing inks, could be acquired easily or prepared by the artist in the studio. Carbon black ink traditionally was made from soot produced by burning candle wax, oils, resins, resinous woods, or the seeds of fruits (Watrous 1967). Bistre, a brown ink exhibiting a range of hues, was prepared by extracting the colored soluble tars from wood soot by boiling a mixture of soot in water (Watrous 1967). James Castle's development of his own wonderfully personal ink drawing medium utilizing stove soot links him to these centuries-old artistic practices. Oral accounts suggest that the soot was collected from the family's wood-burning

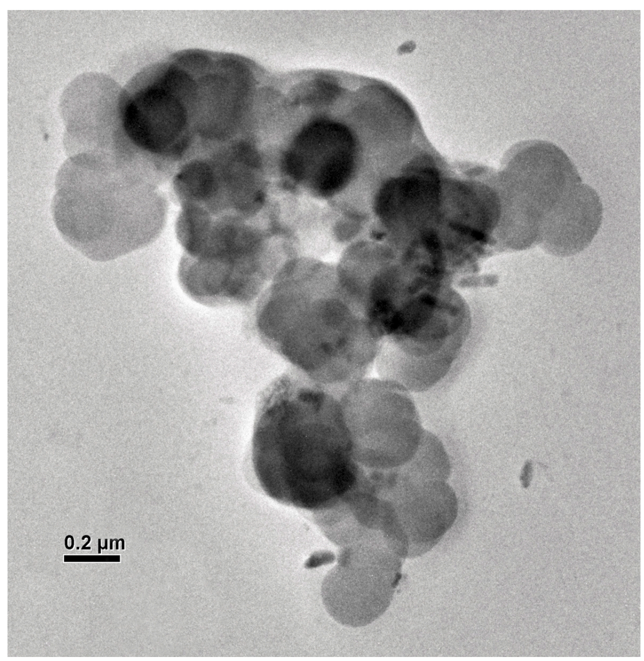

Fig. 2. Transmission electron micrograph of a black soot-and-spit ink sample showing particles with morphology characteristic of chimney soot

stove. Scientific analysis of samples of the ink from Castle's studio and individual works confirmed compositions and particle morphologies (fig. 2) consistent with soot produced by the incomplete burning of wood, rather than a commercial pigment. Furthermore, analysis determined variability in the soot composition that supports accounts that the source of the soot changed during his career when the family turned to other heating and cooking fuel sources (Harthorn 2005).[2]

While no one is sure exactly how Castle prepared his drawing ink, his niece Gerry Garrow and great-nephew Doug Wade have described how he would mix the soot with his own saliva in a jar lid and then load it onto a sharpened stick or other handmade implement for drawing.[3] To ascertain whether these accounts were accurate, tests were conducted that confirmed the presence of enzymes indicative of human saliva in Castle's drawing ink. The ink was also replicated by mixing the fine particulate soot acquired from the artist's studio with saliva. No grinding of the soot was required, but it had to be worked up well with the fingertip or similar tool, as the somewhat greasy mixture that resulted resisted easy blending with the saliva. One advantage of Castle's choice of saliva may be explained by its surfactant properties and the presence of certain constituents (mucins) that functioned as lubricants. These most likely improved the working properties—such as smoothness of the homemade ink and controllability of application—and facilitated the dispersion of the soot particles, making it a more effective vehicle than water alone (Price et al. 2008). It also is worth noting that Castle was not alone as an artist in his use of saliva as a drawing medium; the self-taught Mexican artist Martin Ramirez (1895–1963), for example, reportedly used saliva in his colored drawings.

Bringing Color into the Picture

Although Castle is best known for his soot-and-spit renderings in a subtle range of gray and black tones, color appears in a fair number of his drawings. He used it, for example, to fill in forms or to provide distinct highlights within drawings in which soot and spit predominate. The soot itself also exhibits subtle tonal variations, ranging from warm brown in some works to cooler blue lines and washes in others.[4] But it is Castle's bold full-color drawings executed on supports fashioned from wax-coated food cartons (figs. 3, 4) that are the most mystifying and challenging when it comes to discerning his sources of color and methods of application. These drawings often are referred to as "colored pulp" pieces, based on the misconception that the artist wet and pulped colored papers, and then applied and left the pulp on the drawing support (Yau 2000, 20);[5] however, no evidence of this practice was observed in our study. Intense, bold colors often dominate in these works, but the exact design materials employed, as discussed below, were difficult to determine visually.

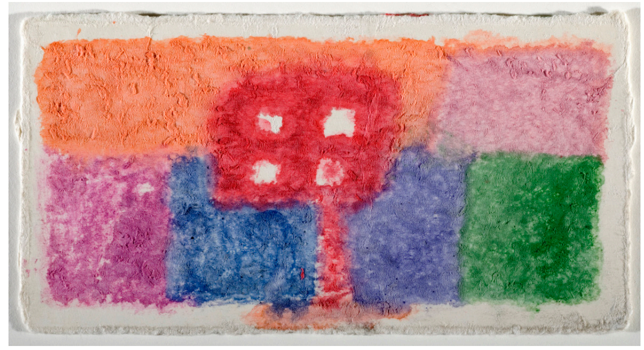

Fig. 3. *Red "dream house" in color-block landscape*, 3 1/2 x 6 3/4 in. (8.9 x 17.1 cm); Philadelphia Museum of Art, 2007-121-22; Gift of the James Castle Collection and Archive

Fig. 4. *"Dream house" with yellow sidewalk*, 5 1/2 x 7 3/4 in. (14 x 19.7 cm); James Castle Collection and Archive; Courtesy of the J Crist Gallery, Boise, Idaho

The materials retrieved from Castle's workroom offered clues to the colored works and a resource for further study. Among them were an unexpected variety of commercial art materials: jars of tempera paint, soft oil pastels (Townsend 1998),[6] harder school-type chalks, colored pencils, and wax crayons, as well as brightly colored crepe paper.[7] Equally significant was the discovery of numerous bunched and twisted wads of paper, cotton, or cotton wrapped in cloth, each wad saturated with soot or color (fig. 5).

Close observation of Castle's full-color works revealed that, rather than applying the pulp from colored tissue or crepe paper to the drawing surface and leaving it there, he used a method comparable to that employed in his soot-and-spit drawings. It appears that he either dampened and then squeezed liquid colorant from such papers into a container and then applied the color using his wads or sticks, or he rubbed the dampened colored paper directly onto the support surface. The wadded pieces of orange and red crepe papers (fig. 6a) that were found among Castle's studio

Fig. 5. Wads of paper, cotton, and cloth-wrapped cotton used by Castle to apply soot and spit or color to his drawings; James Castle Collection and Archive; Courtesy of the J Crist Gallery, Boise, Idaho

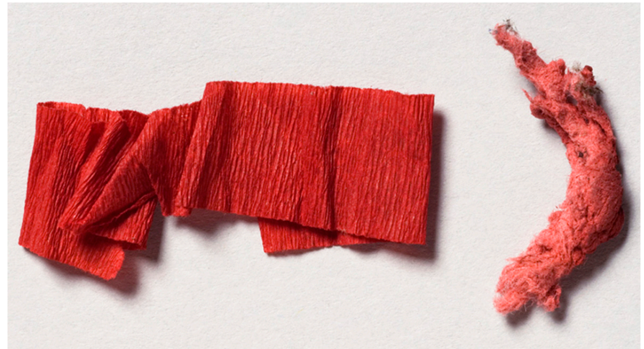

Fig. 6a. Red crepe paper and wadded red paper from Castle's studio; Philadelphia Museum of Art, James Castle Study Collection, P2007-1-43, P2007-1-44; Gift of the James Castle Collection and Archive

Fig. 6b. Red colorant extracted from wet crepe paper

materials—well worn and depleted of color—are consistent with such use. Experiments were undertaken to extract the red color from an unused sample of Castle's bright red crepe paper by wetting it with water and squeezing it by hand (fig. 6b). The resulting water-soluble dye was strikingly similar to the red color present in many of his works and could be applied with a stick in the same fashion as his soot ink. Instrumental analysis of the dyes from the wadded red crepe paper from Castle's studio and the red ink from one of his hand-sewn books using HPLC-PDA showed a close correspondence of synthetic colorants in both. Each contained a mixture of the water-soluble dyes Rhodamine 6G, Crocein Scarlet 3BS, Ponceau G, and Eosin, supporting the idea that Castle indeed extracted colorants from papers to use in his artworks (Price et al. 2008).[8]

It quickly became apparent that the range of design materials Castle employed in his full-color works was far greater than originally suspected. In a number of drawings, including *"Dream house" with yellow sidewalk* (fig. 4), pigment particles were clearly visible under high magnification, suggesting that Castle's palette may have included commercially manufactured paints in addition to his extracted colorants. This supposition was supported in part by the poster paints found in his studio (Arnold 1994),[9] and his family's recollections of his use of watercolors of the dime store variety.[10] Rather than working directly from the dry wvvatercolor cakes, however, Castle was said to have dissolved them in a water dish or jar lid, which probably allowed him to employ application techniques similar to those used in his soot drawings.[11] Analysis by EDS and XRD of a sample of a leanly-bound, powdery green paint from one of Castle's "dream house" pictures identified chromium oxide green, a pigment probably derived from watercolor or tempera paint (Price et al. 2008, 185).[12] A second such pigment, chrome yellow, was identified by LDMS on *"Dream house" with yellow sidewalk* (Kirby et al. 2009).[13]

As mentioned previously, among Castle's belongings were commercially manufactured dry media such as chalks, oil pastels, and wax crayons.[14] One set of chalks, Alphacolor from Weber Costello, showed remarkable visual similarity to the colors used in several of his full-color drawings. Evidence

Fig. 7. Detail of *Woman with wheel feet on street*, 4 1/2 x 7 in. (11.4 x 17.8 cm), showing scattered bits of waxy crayon with a distinct yellow flake evident at center; James Castle Collection and Archive; Courtesy of the J Crist Gallery, Boise, Idaho

Fig. 8. Detail of *Man in red between two giant chickens*, 5 3/8 x 9 1/2 in. (13.7 x 24.1 cm); Philadelphia Museum of Art, 2007-121-21; Gift of the James Castle Collection and Archive

of his use of wax crayons was observed, for example, in the drawing *Woman with wheel feet on street* (fig. 7), in the scattered bits of colored waxy material that likely crumbled off the crayon and adhered to the paper. Castle appears to have applied crayons to his works either dry or perhaps softened with a household solvent, and often in combination with color washes from other sources. His use of wax crayon was confirmed by GCMS analysis and comparison of the waxy particles from his constructions and drawings with the Crayola- and Little Lulu-brand wax crayons from his studio. The waxy particles from the artworks were found to contain paraffin hydrocarbons and fatty acids in a composition indicative of crayon. In addition, evidence was found for his use of both crayon brands: the compositional profile of some particles matched that of the Crayola crayons, with a mixture of paraffin and stearine (mainly stearic and palmitic acids), while other particles matched the composition of the Little Lulu crayons (produced by the Milton Bradley company), with paraffin in combination with fatty acids suggestive of hydrogenated fish oil (myristic, palmitic, stearic, arachidic, and behenic acids) (Warth 1956; Ackman 1989).[15] Interestingly, the Little Lulu crayons are labeled with a 1948 copyright by the Milton Bradley Company, indicating that Castle could not have used them on his drawings before that year.

In examining Castle's repertoire of found media, one unexpected discovery was that he used the common household product laundry bluing as a prominent colorant in his work.[16] Laundry bluing is a concentrated, intensely blue commercial product used to optically "brighten" dingy or yellowed linens or other fabrics. Visual inspection of Castle's drawings revealed the recurrence of a particularly intense blue color. In one drawing that depicts four figures standing in a row, this blue appears in both crisp stick-applied lines and passages of wash. The artist used the same blue in one of his figure constructions, *Dresser-head girl with blue plaid dress and red hat* (fig. 9)*,* to fill in broad areas of folded cardboard, creating a richly colored outer garment. Analysis of the blue from this work by MFTIR revealed the presence of Prussian blue, a common colorant used in commercial laundry bluing during the 20th century (Price et al. 2008).[17] The blue pigment in laundry bluing was formulated with a starch or gum base, and starch was detected in the blue sample from Castle's construction, further supporting the identification of laundry bluing.[18] The consistency and uniformity of the blue colorant in Castle's works also suggest a commercial source such as a bottled, pre-mixed liquid laundry bluing. Castle's use of this product was resourceful but not unique, since it has been used as a colorant in ethnographic objects and incorporated into the palettes of artists and other craftspeople worldwide (Odegaard and Crawford 1996). Moreover, laundry bluing was distributed widely during the 20th century and therefore would have been a readily available, inexpensive source of color among Castle's eclectic stock of materials.

Further visual examination of Castle's drawings and constructions revealed his occasional use of other commercially manufactured mediums, such as fiber-tipped and ballpoint pens, graphite pencils, and even green finger paint. Colored fiber-tipped pens, more commonly known by the brand name Magic Markers, often appear as discrete accents

Fig. 9. Castle figure constructions, including *Dresser-head girl with blue plaid dress and red hat* (fourth from left), 10 1/2 x 2 7/8 in. (26.7 x 7.3 cm); Philadelphia Museum of Art, 2007-121-4; Gift of the James Castle Collection and Archive. Other figures courtesy of the J Crist Gallery, Boise, Idaho

in Castle's constructions, placing the dates of such pieces at mid-20th century or later, when fiber-tipped markers gained use (Ellis and Yeh 1998).[19] In addition, scientific analysis of Castle's colored media, as discussed above, revealed 22 colorants of the monoazo, disazo, xanthene, quinacridone, triarylcarbonium, phthalocyanine, cyanide, aluminosilicate, oxide, and chromate types. While many of the colorants detected were developed in the late 19th to early 20th centuries, four pigments—phthalocyanine blue, diarylide yellow, and quinacridone red and gold—were not marketed until the 1930s–50s and thus may serve as indicators of the earliest possible dates for works containing them (Price et al. 2008, 2011).[20] For example, Castle used quinacridone red, which was first marketed in 1958, on *Red "dream house" in color-block landscape* (fig. 3), and therefore he could not have completed the landscape before that date.

DRAWING IMPLEMENTS AND TECHNIQUES

Just as Castle's drawing media often were unconventional, so too were the tools he used for their application. No brushes were found among his possessions, nor is there any mention of their use in previous writings or in recorded family recollections, yet he applied his washes with skill and nuance. While only an occasional metal pen nib was found, throughout the boxes of his materials are carved wooden sticks that Castle used to deftly render his personal vision of Idaho life (fig. 1b). Artists always have selected their pens (quills, reeds, or metal nibs) for the distinctive quality of the line they deliver. Similarly, Castle individually carved sticks to produce the surprising variety of lines he desired. Round or flat sticks, wood slats, and rough twigs were cut, carved, and whittled—some to sharp points, others to a more gradual taper, and still others to mere stubs. Nails, too, are present, the heads and points also used to deliver color to the page. The most significant difference between Castle's stick application and the use of a traditional ink pen is that the tip of the sharpened stick holds only a small amount of liquid medium, so he would have needed to continually re-dip it. Among his studio ephemera was a small scrap of paper on which he repeatedly wiped the end of his stick while in the process of drawing, perhaps to check the flow of liquid soot or to clear excess "ink" from the tip. This gives us a small but tangible glimpse into his working process.

His arresting soot-and-spit images exhibit a wide variety of marks and textures with which he skillfully rendered perspective and light and shade. A detail from the small drawing *Farmscape with totems* (fig. 10), for example, reveals how the paper surface became highly abraded with repeated passes of Castle's sharpened stick, allowing him to achieve areas of remarkably rich black. For this drawing the artist chose a heavy paper or card able to withstand his vigorous working of the surface. Viewed with raking light, the support exhibits a slight sheen, causing the velvety texture of the black trees and totems along the horizon to stand out in contrast. Castle must have appreciated the surface disruption of heavily worked areas such as this for their textural qualities. And while Castle often created rich blacks by filling in forms with this stick-applied soot technique, he also combined line drawing with soot washes to achieve dramatic tonal variation and create volume through subtle shading.[21] For the application of washes it appears that Castle preferred to use wads of cotton, paper, or cloth-wrapped cotton, as described previously, all frequently encountered among his archived ephemera. Castle could grasp these compact tools firmly between his fingers, dip into his wash or rub into a dry medium, and then apply the medium to his drawing with confident, controlled strokes.[22] An important clue to his technique are the striations that appear along the axes of the strokes, where the irregular texture of a wad of cloth (perhaps even the artist's fingernail or a stick inserted in the wadded material) displaced the medium during the application process (fig. 11). Occasionally, Castle even used his finger to wipe soot wash across the page, leaving fingerprint-like striations in the liquid medium.

Fig. 10. Detail of *Farmscape with totems*, 3 3/4 x 6 1/4 in. (9.5 x 15.9 cm): Repeated passes of Castle's sharpened stick abraded the surface, creating areas of rich, velvety black. Philadelphia Museum of Art, 2007-121-13a; Gift of the James Castle Collection and Archive

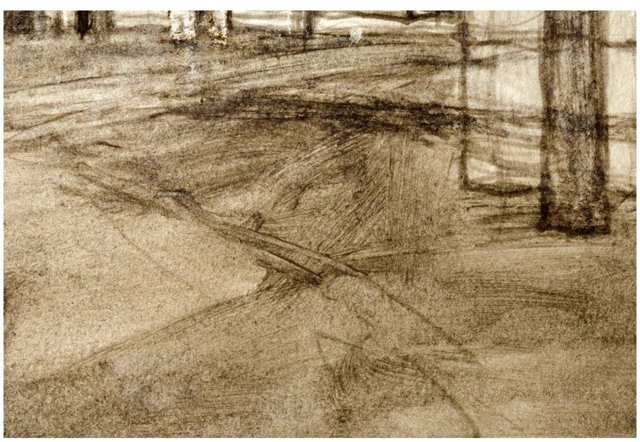

Fig. 11. Detail of *Farmscape with plank totems*, 3 3/4 x 6 1/8 in. (9.5 x 15.6 cm): Striations along the strokes of wiped soot wash were caused by the irregular texture of the wadded cotton or cloth Castle used to apply the medium. Collection of Marion Boulton Stroud, Elverson, Pennsylvania

CASTLE'S PAPERS

The lines and washes in Castle's creations owe their appearance as much to the physical characteristics of his supports as to his application techniques. Whether he consciously chose from his found papers based on specific working properties or simply reacted to the surface qualities he encountered, he clearly was able to exploit their distinctive characteristics using a range of drawing techniques. The Castle family's post office and community store brought the artist into contact with an enormous array of paper products, and he seems to have made use of practically every paper he encountered.[23] From the printing industry he employed periodicals, magazines, newspapers, catalogues, and calendars, and from the packaging industry, ice cream cartons, milk-bottle lids, food labels, cigarette packs, and matchboxes. He also drew on used envelopes, wrapping paper, and recycled notebook papers from his nieces' and nephew's homework. Elements in his constructions were fashioned from shopping bags, corrugated and other types of cardboard, and even asphalt roofing paper (also known as tar paper).

As with the work of any artist, the physical properties of Castle's chosen supports were integral to the artistic result. The purpose for which a paper or paperboard was manufactured, as well as its degree of wear, determines how it receives a design medium and significantly affects the final appearance of the work of art. The smooth, calendered, and sized finishes of writing papers, for example, promote the fluid application of ink, while the finish of paper products intended for commercial printing ensures that ink sits crisply on the surface (Schwalbe 1962).[24] When Castle drew on such supports, the fine, undulating soot lines glided easily over the surface. By comparison, lightly sized or unsized papers and boards are more absorbent, and a liquid medium sinks more quickly into the fiber matrix.[25] Castle executed dozens of remarkable drawings on unfolded and flattened cardboard from boxes of safety matches, where the slightly compressed surface imparted some resistance before the soot mixture was absorbed. It seems clear that Castle understood and even deliberately exploited the individual qualities of the supports he chose, sometimes cleverly incorporating flaws and irregularities of shape into his compositions. For example, in *View from inside shed through shed doors* (fig. 12), executed on a split and flattened envelope with the flap torn off, the curving roof line takes advantage of the concave, angled top edge of the paper, enhancing the sense of perspective.

Another preferred Castle support was wax-coated paperboard from frozen-food cartons (Worthington 1950; Austin 1950),[26] which he used primarily for the bold, full-color works described previously. One common characteristic that defines these pieces is Castle's practice of selectively scraping away and disrupting the waxy surface with an implement such as a stick or razor blade, vigorously abrading the paper

Fig. 12. *Farmscape, view from inside shed through shed doors*, 8 x 9 1/2 in. (20.3 x 23.5 cm); Philadelphia Museum of Art, 2007-121-7; Gift of the James Castle Collection and Archive

Fig. 13a. Verso of *Red "dream house" in color-block landscape*, 3 1/2 x 6 3/4 in. (8.9 x 17.1 cm); Philadelphia Museum of Art, 2007-121-22; Gift of the James Castle Collection and Archive

Fig. 13b. Detail of recto of *Red "dream house" in color-block landscape*, 3 1/2 x 6 3/4 in. (8.9 x 17.1 cm); Philadelphia Museum of Art, 2007-121-22; Gift of the James Castle Collection and Archive

fibers before and during color application. This allowed for the penetration and saturation of his liquid colorants into the paper fiber matrix, which was made more receptive to moisture through the removal of much of the wax coating. Visually, the pronounced texture of the roughened surface is evident in raised fiber clumps, perhaps contributing to the earlier designation of these works as "colored pulp" drawings. By contrast, where the waxy surface was not scraped away, the liquid medium beaded up and dried on the surface, forming fine tide lines of concentrated color observed in a number of Castle's works. The striking result of Castle's technique, in the true tradition of watercolor painting as described by Cohn, is that the white of the support is exploited in many works to create highlights. In *Red "dream house" in color-block landscape* (figs. 13a, 13b), for example, four small white windows punctuate the image, and the white support reflects up through the translucent media elsewhere, enhancing the brilliance of the colors. The brightness of wax-coated food cartons and their ability to resist distortion from contact with liquid surely must have attracted Castle to them as supports for his full-color works (Cohn 1977).[27] The works made on this type of waxed food carton, which was not commonplace until the 1950s, can therefore be dated broadly to Castle's later career (Worthington 1950).[28]

Castle's constructions and books utilize perhaps the widest range of commercial papers and paperboards. These myriad commercial paper scraps and fragments often are coated, commercially printed, or incorporate colored or foil-laminated facing papers, through which "surface"—color, texture, printed design—becomes a primary element in his expressive vocabulary. One particularly interesting example is a construction of a long-legged black bird for which he tore, wrapped, and layered numerous scraps of asphalt roofing paper around a corrugated cardboard core.[29] The rich, dense blackness of the bird's body echoes the literal weight of the unconventional material. The long, gray cardboard legs are punctuated at the foot by small patches of bright yellow printing, a part of the commercial packaging from which the legs were cut and torn. This is a wonderful example of Castle's clever use of the inherent qualities of his found materials. Other constructions whimsically incorporate found commercially printed patterns, which Castle fashioned into colorful garments that he wrapped around various figures. Such playful details give glimpses of Castle's visual acuity and highlight his attention to the tactile qualities of his found materials.

FINAL THOUGHTS

Technical study of Castle's art—drawings, constructions and, in particular, his color works—has proved essential to deciphering the artist's unusual and often complex mixtures of media and colorants and his idiosyncratic methods. It also confirmed the value of applying traditional techniques of examination and analysis to the work of an artist outside the mainstream. Detailed visual examination helped to dispel misconceptions about certain techniques—the application of "colored pulp," for instance—and allowed us to develop and refine meaningful descriptions for others—"stick-applied soot lines and wiped soot wash," for example.

During our study, soot and saliva were confirmed for the first time as Castle's principle drawing medium, and 22 colorants were identified in the form of water-soluble dyes, paints, chalks, pastels, and wax crayons. The confirmed use of many of these media demonstrates that Castle did, in fact, have access to conventional artists' materials during his career. However, his creative extraction of water-soluble dyes from papers, his use of laundry bluing as a colorant, and his adaptation of soot and saliva as an ink show that he also was actively engaged in developing his own materials. The variety of colorants detected underscores the complexity and scope of Castle's palette, which complements the remarkable creativity with which he used these materials. Furthermore, the development dates of certain colorants, and of the waxed food cartons and other packaging materials that he used for supports, provide a basis for scholars to establish a chronology for some of his works. Ultimately, a technical study such as this deepens our understanding of an artist's body of work and opens avenues for future exploration. Castle's are fascinating works—whimsical, often profoundly moving and surprisingly sophisticated, and full of experimentation and diverse materials—with the remarkable power to captivate us so completely.

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NOTES

1. Jeffrey Wolf documented numerous accounts of Castle working in taped interviews for his 2008 documentary film *James Castle: Portrait of an Artist* (New York: FFSTAA/Breakaway Films). See also a letter from Robert L. Beach to A. Kenneth York, October 26, 1960 (location of the original letter is unknown; a transcript of the letter exists in the archives of the J Christ Gallery in Boise, Idaho).

2. According to Harthorn (2005), "Charcoal soot was collected from the wood-burning stove (coal-burning stove in later years). . . . Many years later when the stove was replaced by an electric oven, Castle's sister Emma and her husband Joseph Beach acquired wood soot for Castle to use from the Veterans Hospital in Boise" (13). For this information the author relies on the 1960 letter from Robert L. Beach to A. Kenneth York (see note 1). For details of scientific analysis of the soot, see Price 2008, 175–177.

3. Castle's great-nephew Doug Wade recalled, "The only time I . . . saw him really draw was when I snuck up on him and he would generate a lot of spit and . . . his lower lip would be welled up with spit and he'd just dip the stick in there and then put it in the soot and he'd draw with that" (interview by Jeffrey Wolf, 2005 transcript of tape recording 8:7 [08:18:13]).

4. These variations in soot tone may have resulted from Castle changing his soot sources (from wood to coal, for example) or, in cases where the soot exhibits a markedly blue or brown tone, from the addition of a pigment or water-soluble dye.

5. Earlier essays on Castle suggest a variation on the perceived technique used in his full-color drawings. As Yau (2000) describes it, "Castle . . . carefully mixed together found colored paper and water. He used his fingers to turn this mixture into pulp, which he manually applied to other surfaces" (20). The source of this notion is not known; perhaps it derived from a family member's interpretation of Castle's technique or from the pulpy appearance of his roughened supports.

6. Townsend (1998) discusses the materials that have been incorporated into pastel since it became commercially available in the later 19th century, noting that manufacturers select the binding medium for each pigment mixture to produce pastel sticks with uniform handling properties. According to Townsend, "a considerable range of materials can be used to bind the coloured and white pigments and extenders which constitute the bulk of a pastel stick: drying oils, natural resins, waxes, plant gums, proteins such as glue, casein and conceivably egg may have been used in the past" (21–28).

7. Among the materials preserved in Castle's workroom were dried-up poster paints in glass jars (Carter's Tempera Color and Derayco Poster Color), colored pencils (several Sabra Jerusalem pencils, one Eagle brand Alpha pencil no. 9245, two boxes of school "crayon pencils" from the Sunset Crayons Co.), chalks and pastels (in an "Alphacolor chalk pastels" cardboard box from Weber Costello Co., including one oil-pastel stick with a wrapper reading "Sketcho/Blue" from Prang Co.), and hard school chalk (in a "Colored Chalk Crayon" cardboard box by Binney & Smith Co. [now Crayola LLC]).

8. The water-soluble dyes detected were developed in the late 19th century and were used widely in printing and colored-paper production. The HPLC analysis was conducted by Maarten van Bommel, Instituut Collectie Nederland, Amsterdam.

9. The term "poster paint" generally denotes an opaque water-based paint of bulky, creamy consistency sold in jars or tubes. Poster paint is designed for less permanent applications, such as children's artwork or craft projects. Poster paints differ from artists' watercolors in that they are bulky and contain lesser-quality ingredients. Poster paint produces a dense film that prevents light from being reflected

from the underlying paper, clearly setting it apart from watercolor. A major group of coloring components found in these paints are synthetic organic colorants.

10. Guy Wade Jr., Castle's nephew, remembered that Castle "always had colors available to him. Anytime he wanted to why he could use the watercolors us kids had . . . those little watercolors that come in a metal . . . bracket" (interview by Jeffrey Wolf, 2005 transcript of tape recording 8:10 [08:22:44]).

11. According to Gerry Garrow, "He would . . . take the little water pods out and soak them in water and then put his cloth in it if he wanted to do a wash" (interview by Jeffrey Wolf, 2005 transcript of tape recording 24:6 [05:24:09]).

12. The chromium in the green pigment was detected by EDS. XRD analysis revealed 10 intense lines at 2.66, 2.48, 1.67, 3.63, 1.43, 1.82, 2.18, 1.46, 1.29, and 1.09Å that matched with JCPDS reference pattern #38-1479 for chromium oxide (Cr_2O_3, eskolaite). The XRD analysis was undertaken by Andrew Lins at the PMA.

13. The chrome yellow (lead chromate, $PbCrO_4$) was indicated by ions for chromate in the LDMS spectra at m/z 100.1^-, 184.0^-, and 200.0^-; and for lead, clusters at m/z 207.9^+, 251.0^+, 262.9^+, and 430.0^+.

14. Wax crayons for drawing purposes were first introduced by Binney and Smith in 1903 (Ellis and Yeh 1998, 51).

15. The paraffin wax detected in the studio crayons and wax samples from drawings consisted primarily of straight-chain saturated hydrocarbons in the C20–C35 range, in agreement with Warth 1956, 404–405. According to Warth, hydrogenated fish oils contain 4–8% myristic, 29–32% palmitic, 18–22% stearic, 23–36% arachidic, and 13–17% behenic fatty acids (548). Samples of crayon particles from some of Castle's works and from Little Lulu crayons were similar in composition to Warth's description, and closely matched the composition of reference samples of hydrogenated fish oils obtained from ChemService, West Chester, PA, and Werner G. Smith, Inc., Cleveland, OH. For hydrogenated fish oil in crayon manufacture, see Ackman 1989, 421.

16. The notion that Castle may have used laundry bluing was suggested by his niece Gerry Garrow in an interview with Ann Percy, April 26, 2006.

17. The Prussian blue (iron hexacyanoferrate, $Fe_4[Fe(CN)_6]_3$) was indicated by a C-N stretching band at 2090 cm^{-1}in the sample's FTIR spectrum and by iron detected by EDS. One brand of laundry bluing, Mrs. Stewart's Bluing, contains Prussian blue and still is manufactured by Mrs. Stewart's Bluing Corp., Bloomington, Minnesota, http://www.mrsstewart.com/index.htm (accessed 08/07).

18. The starch identification was made by FTIR; characteristic spectral bands for polysaccharide were very strong O-H and C-O stretching bands at 3350 and 1150-1020 cm^{-1}, respectively. For details see Price et al. 2008, pages 179, 241.

19. The first version of the fiber-tipped pen, the European Kaweco Signier of 1911, was short lived. After its second commercial introduction in 1946, the fiber-tipped pen was accepted rapidly. The brand name Magic Marker was introduced in 1952 (Ellis and Yeh 1998).

20. For the complete list of colorants identified and their development dates, as well as the sampling and instrumental details, see Price et al. 2008, 2011.

21. According to Guy Wade Jr., "He used that lid and then somehow or another, if he didn't have the right texture, why he'd go around to another part of it and work his way around inside that jar lid because some places he wanted dark and sometimes he didn't but he'd take one of those sticks and sharpen it up, sucker stick, and he'd take this . . . and draw his pictures, and blend it" (interview with Jeffrey Wolf, 2005 transcript of interview tape 8:8 [08:18:44]).

22. A possible source for these application materials was found among his possessions: a circular disk consisting of many layers of white open-weave cloth (perhaps a coffee filter), from which he may have peeled away layers for enfolding the cotton wads prior to use.

23. Guy Wade Jr. recollected that "[James] and Mom played a game. They had the trashcan sitting out the door while she put a whole bunch of stuff in there. But she saved the paper and everything and she put them up on top for him, so when he came to take the trash out, well, he'd always take the lid off and he got in and got them and he'd run to his office with them and then he'd come back and take the trash out, but he'd get those papers out of there first" (interview with Jeffrey Wolf, 2005 transcript of interview tape 8:3 [08:05:44]).

24. In discussing Castle's found papers, it is useful to recognize the characteristics of the surface-treated papers and boards, which he employed from a wide variety of commercial packaging, publication and advertising sources (for example, can labels, cracker boxes, calendars) and which include both pigment binders and wax coatings. "Surface treatment" is a general term used by the paper and paperboard industry to describe the application of adhesives, pigment-adhesive coatings and other functional products to the already formed fibrous web. Surface treatments are distinct from internal treatments such as the incorporation of sizes, fillers, and other loading agents into the fibrous web during formation.

25. In this essay, the paper products described as thin cardboard also may be described as folding paperboard or boxboard, a broad category of commercial paperboard suitable for making folding cartons. Its qualities permit scoring and folding, and, depending on the printing requirements, variable surface properties. See the American Forest and Paper Association's Web site, http://www.afandpa.org (accessed 11/06/07).

26. GCMS analysis of one such support for Castle's *Red "dream house" in color-block landscape*, executed on a Holland-brand ice cream carton panel, showed that the panel was coated with paraffin wax, consisting primarily of straight-chain saturated hydrocarbons in the C20-C35 range. For GCMS sampling and instrumental details, see Price et al. 2008, 240, note 25. Wax-coated and impregnated papers and boards were developed for the frozen-food-packaging industry during the 1940s and 1950s. Fully refined paraffin or paraffin with microcrystalline wax was used to impregnate and coat the carton stock to improve its physical properties.

27. Cohn's 1977 discussion of traditional watercolor techniques includes much that relates to Castle's inventive approach. For example, she explains that "If unabsorbtive paper is without tooth, washes do not tend to run smoothly, finding little friction in the surface to overcome a liquid's natural tendency to coalesce into droplets" (17). She also refers to "wet abrasion" (45), an artist's deliberate damaging

of a sheet's surface sizing so that washes flow more easily—akin to Castle's selective roughening process. Cohn also comments that traditional artists choose papers for their resistance to cockling, a function of thickness and sizing, and that artists exploit the white of the paper so that "the light will reflect through the layers of color and provide the highlights of the design where color is absent" (16), two concepts readily exploited by Castle in his waxed food-carton works.

28. The frozen-food industry emerged after World War II and grew rapidly during the 1950s and 1960s. The folding half-gallon ice cream carton was introduced in 1948, according to the ice cream producer Stewart's Shops (see http://www.stewartsshops.com/ContentManager/index.cfm?Step=Display&ContentID=3, accessed 10/07). Additional research into the product and company histories of the identifiable food-carton supports on Castle's works may aid in assigning a *terminus post quem* for individual works. For discussions of specialty paper products produced for the frozen food industry, see Worthington 1950 and Austin 1950.

29. Castle sometimes tore away the brown facing paper from corrugated cardboard and used either this facing paper or the exposed corrugated or fluted core component independently. These appear fairly frequently in his constructions and books, but he occasionally executed drawings on pieces of brown corrugated cardboard as well.

REFERENCES

Ackman, R. G. 1989. *Marine biogenic lipids, fats, and oils*. Boca Raton: CRC Press.

Arnold, S. 1994. The technology of poster paint. In *Modern works, modern problems*? ed. A. Richmond. Conference Papers, Institute of Paper Conservation, Tate Gallery, London, Mar. 3–5, London: Institute of Paper Conservation. 148–149.

Ash, N., and S. Homolka. 2008. A creative obsession: Observations on James Castle's materials and techniques. In *James Castle: A retrospective*. Philadelphia: Philadelphia Museum of Art. 156–173.

Austin, J. J. 1950. Food packaging. In *Specialty papers: Their properties and applications*, ed. R. H. Mosher. Brooklyn: Remsen Press. 75–100.

Cohn, M. B. 1977. *Wash and gouache: A study of the development of the materials of watercolor*. Cambridge: The Center for Conservation and Technical Studies, Fogg Art Museum, Harvard University.

Ellis, M. H., and M. B. Yeh. 1998. The history, use and characteristics of wax-based drawing media. *The Paper Conservator* 22: 48–55.

Harthorn, S. 2005. *James Castle: Drawings, constructions, and books: collection of the Boise Art Museum.* Boise: Boise Art Museum.

Kirby, D., N. Khandekar, K. Sutherland, and B. Price. 2009. Applications of laser desorption mass spectrometry for the study of synthetic organic pigments in works of art. *International Journal of Mass Spectrometry* 284: 121.

Odegaard, N., and M. F. Crawford. 1996. Laundry bluing as a colorant in ethnographic objects. *ICOM Committee for Conservation proceedings.* 11th Triennial Meeting, Edinburgh. London: James and James. 634–637.

Price, B. A., K. Sutherland, D. Kirby, and M. van Bommel. 2008. Handmade: A scientific study of James Castle's art. In *James Castle: A retrospective*. Philadelphia: Philadelphia Museum of Art. 174–187.

——. 2011. Scientific insights into the art of James Castle. *Proceedings of Art '11: 10th International Conference on Non-Destructive Investigations and Microanalysis for the Diagnostics and Conservation of Cultural and Environmental Heritage*. Florence: Italian Society for Non-Destructive Testing Monitoring Diagnostics. 8 pp.

Schwalbe, H. C. 1962. Surface treatment of paper and board. In *Pulp and paper science and technology*, vol. 2., ed. E. Libby. New York: McGraw-Hill. 273–319.

Townsend, J. 1998. Analysis of pastels and chalk materials. *The Paper Conservator* 22: 2–28.

Warth, A. H. 1956. *The chemistry and technology of waxes*, 2nd ed. New York: Reinhold.

Watrous, J. 1967. *The craft of old-master drawings*. Madison: University of Wisconsin Press.

Wolf, J. 2005. Interview transcripts for the documentary film *James Castle: Portrait of an artist*. New York: FFSTAA/Breakaway Films.

Worthington, A. M. 1950. Waxed papers. In *Specialty papers: Their properties and applications*, ed. R. H. Mosher. Brooklyn: Remsen Press. 273–303.

Yau J. 2000. Invention and discovery: the art of James Castle. In *James Castle: The common place*. New York: Knoedler & Company. 11–24.

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Ozalids in the Music Library: Life Before Xerox

ABSTRACT

This study investigates the manufacture, history, and conservation treatment options for early photoreproductions found in music libraries, which are colloquially called "Ozalids." As architectural drawing reproductions are called "blueprints" but are not necessarily made by the blueprint process, not all of these "Ozalids" were actually produced by the trademarked Ozalid diazotype process. Based on surveys carried out in the Northwestern University Library and other Chicago-area music collections, "Ozalids"—or, more correctly, non-Xerox photoreproductions—are a diverse group encompassing a range of photoreproductive technologies, including Photostats, mimeographs, diazotypes of several varieties, and possibly other still-unidentified processes. Overall, the diazotype was the best-represented technology and therefore the focus of this research. Despite the former popularity of this copying technique, very little useful information about it is widely available.

Diazotype technology, invented in the 1920s, was the predominant small-run copying method before electrostatic (Xerox) photoreproduction was perfected and popularized in the 1970s. As music scores of this era were often handwritten, there was great demand for a copying method that could exactly reproduce unique manuscripts. The technique was popular not only for music reproduction; numerous diazotypes may also be found in collections of architectural drawings or maps, and in archives that hold office photocopies.

During the collection surveys, preliminary identification was carried out by visual assessment, and Fourier transform infrared spectroscopy was used to characterize materials and to identify and quantify degradation. Diazotypes have a characteristic appearance and aging pattern, including discoloration of the support, fading of the media, and a strong chemical odor. Deterioration is presumed to be caused by outside forces as well as inherent vice due to residual chemicals.

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As the original music manuscripts were often written on delicate onionskin paper for use in the reproduction process, many libraries are now left with only the unstable "Ozalids" as unique objects in their collections. As these copies were not produced in large numbers, many "Ozalids" can be presumed to be unique to the collection in which they are found. For this reason, as well as their value as exemplars of a once-prevalent copying technology, they are worth preserving.

Although resources exist for visual identification and basic preservation of this type of object, literature related to treatment is difficult to find. Based on the surveys carried out for this research, typical treatments that may benefit these items include surface cleaning, humidification, tape removal using solvents, aqueous and non-aqueous deacidification, and mending. Protocols were developed to carry out experimental treatments on expendable samples of various types of photoreproduction. The results revealed numerous, easily avoidable pitfalls to common treatments, including bleeding of media during solvent treatment and dramatic sinking of media due to over-humidification.

INTRODUCTION

The impetus for this project was a treatment request for several unidentified paper objects submitted to the Northwestern University Library conservation laboratory. These materials belonged to one of Northwestern Music Library's treasures: a collection of materials related to the avant-garde composer John Cage. The objects appeared to be photoreproductions, but their format was unfamiliar to the conservators, and the treatment possibilities were thus unknown. Given their intrinsic value and delicacy, the objects were not subjected to potentially harmful treatments or testing. They were housed, but it was obvious that more research was needed to identify them.

The input and expertise of the Northwestern music librarians was sought, and the unfamiliar objects were broadly identified as "Ozalids." Like the term "blueprint," which is a blanket term for any architectural plan or reproduction, "Ozalid" is used within the music library and publishing community to mean any music manuscript photoreproduction. These objects are common and seem to be found in nearly every music collection. Though many conservators are familiar with architectural photoreproductions, finding information on the history and manufacture of music score photoreproductions, their preservation needs, and their conservation options proved more difficult. This was clearly an area that merited more research.

SURVEY

In order to find and identify these materials, a survey was carried out at Northwestern Music Library to identify, characterize, and assess the condition of the photoreproductions in the collection. Similar surveys were conducted in other Chicago-area collections, including the Chicago Symphony Orchestra's Rosenthal Archives, the University of Chicago Library, and the Newberry Library. Comparing the Northwestern Music Library collection to others was important in order to determine whether Northwestern's collection was representative, and to demonstrate that the research would be relevant to the broader conservation and library community.

The survey was carried out by individually assessing the photoreproductions, excluding apparent Xerox-type reproductions. In some cases a photoreproduction appears to be a handwritten manuscript at first glance, particularly in cases where hand notations have also been applied, so care had to be taken in identifying the objects. The non-Xerox photoreproductions were examined for identifying characteristics including origin, identifying marks, appearance of media and ground, condition, and binding style.

The focus of the survey was the section of the Northwestern Music Library containing theses and dissertations in composition, a section that was known by the librarians to contain a significant number of non-Xerox photoreproductions. This section contained 818 items. Non-Xerox photoreproductions, the majority of which were dated from the 1930s to the 1980s, comprised 37% of this collection. In the local collections surveyed, non-Xerox photoreproductions presented similar appearances, degradation patterns, and identifying marks. Additionally, many of the scores from different collections featured marks from the same Chicago music-binding company, indicating that the scores were bound and probably copied by the same institution.

Existing literature on photoreproductions—books and articles on music librarianship, as well as the literature on identification of architectural photoreproductions—was consulted in order to draw preliminary conclusions. Additionally, identifying marks were analyzed for information on the stages of production, with a focus on the companies that seemed to be responsible for reproduction services. Tracking down information about these companies and their practices was one of the most challenging parts of the research, as most of the companies no longer exist and information about their practices is unavailable.

The available information about photoreproductions was synthesized to make preliminary conclusions about the identity of the "Ozalids." The most potentially misleading finding was that "Ozalid" is the patented name of a diazotype process, as well as the name commonly used by music librarians and cataloguers for all music manuscript reproductions. Many of the surveyed music manuscript photoreproductions did appear to be diazotypes, based on the visual identification described in *Architectural Photoreproductions: A Manual for Identification and Care* (Kissell and Vigneau 1999). Others appeared to be blueprints, Photostats, mimeographs, or unidentified processes.

DIAZOTYPES

Given the results of the surveys, the diazotype process was given further study. This category of photoreproductions is still broad, as items characterized as diazotypes vary widely in date of production, appearance, and condition.

Diazotypes are printed using a non-silver photographic process, utilizing a paper or cloth support that has been sensitized with light-sensitive and alkaline-sensitive chemicals. The support may be sensitized on one or both sides. The treated support is exposed to ultraviolet radiation through a transparent or translucent original object (e.g., a handwritten music score on onionskin paper). A colorless substance is formed in exposed areas. The print is then exposed to ammonia to form an azo dye in image areas, resulting in a positive image in relation to the original. The prints may be processed wet, semi-wet, or dry, using ammonia fumes. The resulting image is embedded in the paper fibers. The sensitizing chemicals and any stabilizers or other additional chemicals remain in the paper, as there is no rinsing step in the copying process (Dinaburg 1964). Diazotypes come in numerous colors including blue, maroon, brown, and black.

The legend behind the invention of the diazotype says it was developed by a German monk who was tired of having to copy everything by hand. He decided to ease his plight by inventing a chemical copying process. The monk approached the nearby chemical supplier, Kalle, for help with supplies, and they provided him with lab space and materials in exchange for patent rights to any of his inventions. The monk developed the diazotype process, which was patented by Kalle as the Ozalid process in 1923 (Sturge 1977). The diazotype, an inexpensive process, quickly became the prevalent small-run copying method of the mid-20th century. Sheet music, architectural drawings, maps, and documents were reproduced using the diazotype process, which remained popular until electrostatic copying superseded it in the 1970s–80s.

Diazotypes have a characteristic appearance and degradation pattern. This includes a strong chemical odor, which is a reminder of the processing chemicals, and a discolored support, especially around the edges. In a single-sided copy, the printed side is usually darkened in comparison to the unprinted verso. In some cases this difference is dramatic. A combination of fading image lines and darkening of the support leads to an eventual reduction in image contrast. If allowed to continue, this loss in contrast could lead to illegibility and difficulty in reformatting.

The causes of this characteristic degradation are not fully understood. Likely possibilities include inherent vice due to poor paper quality and the presence of residual chemicals from the copying process, which may continue to react with or otherwise affect the paper support. For example, the photosensitive processing chemicals can cause edge and fold discoloration (Hawken 1966), and thiourea, used as a stabilizing agent, off-gases sulfur (Price 2010). The residual phenols from diazotype processing also oxidize, causing overall discoloration of the paper support (Price 2010).

Causes of degradation unrelated to the copying process include binding or mounting methods and environmental conditions. Examples of the former include two single-sided reproductions glued together, resulting in adhesive staining, and a reproduction glued to an inappropriate secondary support, causing adhesive and acid-related staining. In addition, many of these items are bound with a comb spiral, leading to tearing at the spine, or in pairs guarded with linen tape, leading to adhesive failure at the gutter. These issues may contribute to or exacerbate the deterioration caused by the chemical makeup of the photoreproduction, or may create unrelated deterioration patterns.

PRESERVATION CONCERNS

Given the condition of many music library photoreproductions, it is imperative for collection caretakers to decide whether they are a preservation concern, and to address deterioration problems accordingly. These objects are reproductions, and are not typically high in monetary value. Many collections have chosen to copy and discard, or simply to discard, their deteriorating photoreproductions. Additionally, many collection caretakers are completely unfamiliar with the ongoing deterioration of these objects, which will quietly disintegrate until they can no longer be preserved in original or reformatted form.

There are several arguments in favor of preserving these objects. First, deterioration proceeds within decades. Based on the surveys carried out in music collections, a photoreproduction from the 1940s is almost guaranteed to be in significantly worse shape than a similar item from the 1980s.

Additionally, although they are copies, many of these photoreproductions are copied from delicate originals on transparent paper. The majority of these originals are lost or separated from the reproduction, making the reproduction the effective original. Among the surveyed collections, only the Chicago Symphony Orchestra had retained the onionskin originals, and the thin, transparent paper was tattered and delicate.

Because these scores were usually not published or mass-produced, music library photoreproductions represent rare or unique materials. Many contain hand notations, making them completely unique. Hand-inscribed photoreproductions sent from composers to professors as gifts were found in the University of Chicago Library. In the Rosenthal Archives of the Chicago Symphony Orchestra, conductors and musicians had made numerous hand annotations to the photoreproduction scores. In these cases, original material would be lost if the photoreproductions were lost.

Reformatting may be seen as an acceptable preservation measure in cases where hand annotations are not present or considered unimportant. However, even reformatting can eventually become difficult, as these photoreproductions experience loss in contrast as they deteriorate. These objects are also exemplars of once-prevalent and little-understood copying techniques that are worth preserving in their original formats.

INSTRUMENTAL ANALYSIS

Given the variability and many preservation concerns within the group of music library photoreproductions that appeared to be diazotypes, it was decided to investigate them using instrumental analysis, including light microscopy and FTIR.

Microscopy facilitated comparison of items that were grouped together based on visual inspection. Using a compound microscope, characteristics such as surface texture, line quality, and ground were closely analyzed. It was found that, while some items were similar, others were unexpectedly different, and it was not always possible to predict which items would be similar based on observation with the naked eye alone.

Microscopy also allowed for discovery and exploration of mysterious elements of the photoreproductions, such as the crystalline particles found only in the deteriorated areas of one score. These mysteries should be explored further, and they may provide clues to the deterioration patterns of these objects.

Microscopy provided one of the first clues that there was information in the photoreproductions that wasn't easily organized or interpreted based on the available literature on "Ozalids," diazotypes, and the identification of photoreproductions.

The next step was analysis using FTIR, for which Northwestern University Library conservators relied on the equipment and expertise of Northwestern University faculty, with whom they have a partnership. The result of nondestructive FTIR analysis is a spectrum that can be interpreted to tell what types of molecular bonds are present in the analyzed

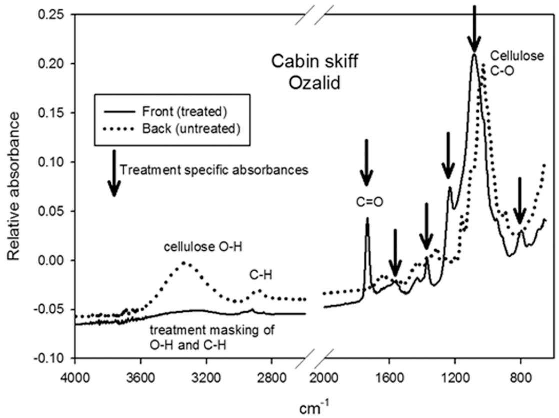

Fig. 1. FTIR spectra of the treated front and untreated back of a diazotype. Image and analysis by Dr. Neal Blair

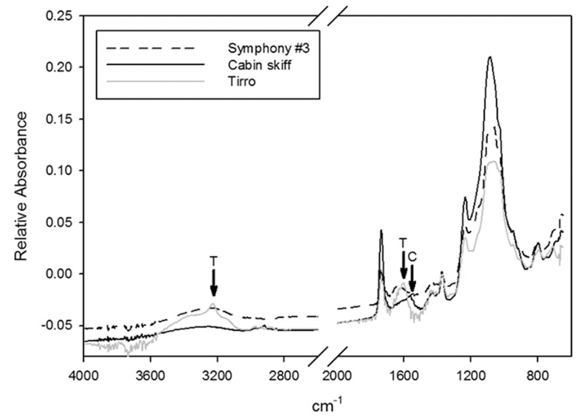

Fig. 2. FTIR spectra of a known diazotype and two music manuscript photoreproductions. Image and analysis by Dr. Neal Blair

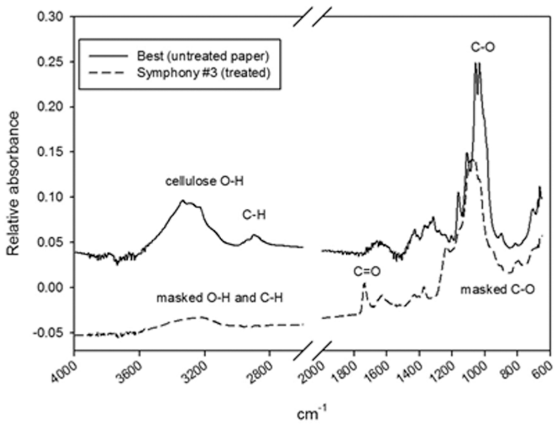

Fig. 3. FTIR spectra of the ground of two music manuscript photoreproductions, showing the difference in the masking of the cellulose spectrum. Image and analysis by Dr. Neal Blair

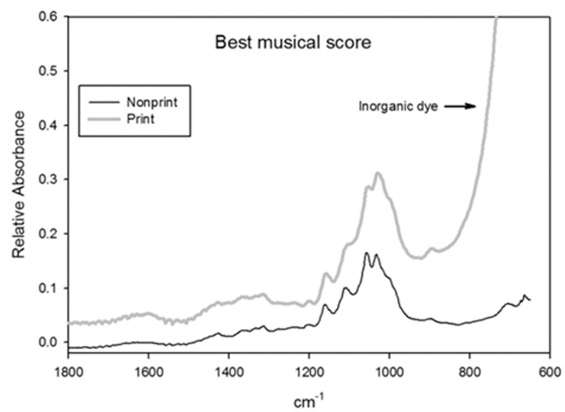

Fig. 4. FTIR spectrum of the image area of a music manuscript photoreproduction, showing the apparent presence of an inorganic material. Image and analysis by Dr. Neal Blair

area of the object. This data can then be correlated to specific substances. The goal of this analysis was to find a signature peak or fingerprint spectrum for the types of diazotypes found in the music collection, or for families of photoreproductions. Objects chosen for analysis included Ozalid-brand diazotype paper, design plans that were known to be diazotypes based on correspondence with the company that printed them, and music manuscript photoreproductions that had been identified as diazotypes based on visual analysis.

Figure 1 shows the spectra from the front and back of a one-sided diazotype; the image and related discoloration were only observed on the front of this object. Interesting elements of these spectra include masking of the cellulose signal on the front, and several signature absorbance peaks. One notable peak is a carbonyl absorbance at 1740 cm^{-1}, which was also observed in several of the music manuscript photoreproductions analyzed. This carbonyl group may belong to an ester, which is found in substances such as cellulose acetate; it may therefore relate to paper treatment.

The results were more complicated than anticipated, as soon became apparent with the comparison of the spectra from known diazotypes with those from music manuscript photoreproductions that had been identified as diazotypes. Objects that had initially been grouped together produced varying spectra, with more dissimilarities between similar objects than expected. Figure 2 shows the spectra from a known diazotype and two scores that had been identified as diazotypes. The spectra have elements in common, but they are far from identical. For example, they share a carbonyl peak at 1740 cm^{-1}, but the cellulose signal is masked to varying degrees in each, and each has significant peaks that are not shared with the others. These results indicate that the objects may not have been created using the same process, or that they may be representative of significant variations within the process.

There were other unexpected findings as well. Figures 3 and 4 show the spectra of one score identified as a diazotype. The spectra indicate lack of surface treatment and presence of an inorganic dye, elements that are incompatible with the diazotype process. In Figure 3, the ground of this score is compared to the ground of another score identified as a diazotype, showing the first score's more apparent cellulose peaks, which indicate a lack of surface treatment. In Figure 4, the printed area of the score appears to feature an inorganic dye or pigment, which is inconsistent with organic azo dye. Notably, none of the items analyzed—neither known diazotypes nor those printed on Ozalid-brand paper—showed a peak corresponding to an azo bond, which would be expected in an azo dye.

This analysis raised questions about whether any of these objects are diazotypes, and how to characterize and group this family of photoreprographics. Though instrumental analysis was conducted in order to get to know these photoreproductions better, it made the conservators and scientists realize that they might not understand the objects as well as they thought. The FTIR method seems to be promising for fingerprinting photoreproductions, but more work is needed to link copying processes and chemistry to spectra. This is an area of research that could take years to untangle, and would require extensive analysis of many more objects.

CONSERVATION TREATMENT TESTING: METHODOLOGY

The next phase of research was to explore conservation options and develop treatment protocols. If these photoreproductions could not be fully understood, at least their treatment options might be defined more completely. The most typical kind of music manuscript photoreproduction, which had been identified as a diazotype based on visual analysis, was chosen as the focus for testing.

Expendable samples representative of known types were gathered, including architectural diazotypes, Ozalid-brand diazotype paper, blueprints, electrostatic prints, and Photostats. In addition, several music scores that appeared to be diazotypes were procured. Gathering the samples was one of the most difficult parts of the project. Testing would be destructive, so collection materials could not be used. Music score photoreproductions are usually owned by institutions such as libraries, so very few were being offered on sites such as eBay. Furthermore, most people cannot identify this type of photoreproduction and do not know what types they have in their collections, even if they are willing to offer any old music scores that are up for deaccession. Luckily, a music publisher and an archivist came forward, both of whom were familiar with the types of photoreproductions found in music libraries and were willing to donate deaccessioned scores.

Repeatable tests were developed to replicate useful common treatments, including surface cleaning, tape removal using solvents in liquid and vapor form, passive humidification, aqueous and non-aqueous deacidification, and mending:

- Surface cleaning was tested using white PVC erasers and vulcanized rubber sponge erasers.
- Solvent use was tested both through direct application and through use of a vapor chamber for 30 minutes. The solvents tested included deionized water, ethanol, acetone, and toluene.
- Humidification was tested in a passive humidification chamber for periods of one hour, six hours, and 24 hours.
- Reaction to alkalinity was tested using directly applied deionized water alkalized with ammonium hydroxide to pH 9 and 11, and with deionized water alkalized with calcium hydroxide to pH 9.
- Non-aqueous deacidification was tested using a Bookkeeper spray system belonging to Northwestern University Library. Because the alkalizing agent in this product is activated with humidity or moisture, deionized water was applied to the tested portion of the sample directly following the Bookkeeper spray.
- To test for reaction to mending, the samples were torn and mended using wheat starch paste on Japanese paper, remoistenable tissue made using BookMaker's A4M methylcellulose on Japanese paper, and heat-set tissue made using Lascaux 498 on Japanese paper.

In all of the tests, the samples were examined for changes in appearance, including surface disturbance, color shift, and bleeding, feathering, fading, or sinking of media.

CONSERVATION TREATMENT TESTING: RESULTS

Testing demonstrated that vigorous surface cleaning of the music score photoreproductions could be risky. Although the surface appeared unchanged to the naked eye, a small amount of media did appear to come off on the eraser. This could be a calculated risk when treating soiled material.

Results indicated that, like known diazotypes, the music score photoreproductions were sensitive to moisture. Extended humidification times of six or 24 hours caused feathering and sinking, and direct application of water caused bleeding and tide lines.

The music score photoreproductions showed varying reactions to solvents, with one overarching theme: treatment with toluene, in liquid or vapor form, caused no feathering and only slight tide lines. Treatment with acetone or ethanol was much more dangerous, causing major tide lines in the case of liquid application, and feathering in the case of the acetone vapor chamber.

As presumed diazotypes, music score photoreproductions were expected to be sensitive to alkalinity, as diazotypes are known to discolor more quickly in an alkaline environment. The music score photoreproductions did show increased bleeding and color shift when alkaline water was applied.

It was assumed that non-aqueous spray deacidification with Bookkeeper would be disastrous for these alkaline-sensitive materials. However, the samples that were treated with Bookkeeper did not react to water any differently than the sample that was not treated with Bookkeeper, nor did they discolor overall. Given the difficulty of identifying many photoreprographic processes, it can be assumed that some music score photoreproductions or similar materials will be inadvertently treated in mass-deacification projects, and this should not be a major concern. While the long-term effects are unknown, and deacidification with Bookkeeper may seem to be excessively risky, no immediate ill effects of treatment with Bookkeeper were evident in testing.

Many basic treatments did not show any negative effects. A one-hour period of passive humidification did not cause any feathering or bleeding. Mending with paste, remoistenable tissue, and heat-set tissue was successful and resulted in no sinking or color shift.

The treatment experiments indicated that some pitfalls are easily avoided. Extended humidification of more than an hour or two can be dangerous, as can the application of liquid water, alkaline water, and water vapor. Toluene was the safest solvent to use, causing less damage than ethanol or acetone. Of course, testing is always important, but these guidelines could be a starting point for a conservator faced with the unknown.

CONCLUSIONS

As should be apparent, the conclusions for this research so far contain almost as many questions as answers. Many of the conclusions are affected by complications that arose during the project. First, the companies that produced diazotypes and other pre-Xerox photoreproduction technologies no longer exist, and there are few living experts on their production or chemistry. The known chemistry of diazotypes is variable and complex, which makes it difficult to test or easily categorize music library photoreproductions that appear to be diazotypes. Literature on the visual inspection and identification of architectural photoreproductions may not be fully applicable to music score photoreproductions, meaning that their characterization may be more complex than originally expected.

The primary conclusion is that, given the high prevalence and low recognition of this type of material in music collections, educating the conservation and library communities about these photoreproductions is the only way to preserve them. This would include steps as simple as informing collection caretakers that these items exist and have unique preservation concerns. Further steps would include developing cataloguers' knowledge and ability to correctly identify the objects so they can be readily found and recognized in the collection. Of course, conservators working with these types of materials should be able to recognize and address the needs of a deteriorating or damaged music manuscript photoreproduction.

In order to preserve this type of object, collection managers will need to be convinced of the importance of these unique musical artifacts, and collection caretakers must be trained to recognize and roughly identify photoreproductions in the music library, as well as to address their preservation and conservation needs. Most important for the conservation community, this study shows that treatment methods can be developed even without absolute identification. Most conservators are too busy to research every item that comes across their bench, and unrecognized objects may be simply returned untreated, or treated using insufficient information. Knowing which basic treatments are possible and advisable will be a very simple step to providing better care for music library photoreproductions.

NEXT STEPS

Given the still-mysterious identity of some "Ozalids," the next steps for this project could include exploration of the little-researched realm of pre-Xerox office copying. Experimentation with instrumental identification and characterization of photoreprographic materials could help increase understanding of these objects, and could lead to discovery of accurate low-tech identification techniques. Finally, preservation and conservation treatment protocols could be further developed and codified for the most common types of music library photoreproductions.

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REFERENCES

Dinaburg, M. S. 1964. *Photosensitive diazo compounds and their uses*. New York: Focal Press.

Hawken, W. R. 1966. *Copying methods manual*. Chicago: American Library Association.

Kissell, E., and E. Vigneau. 1999. *Architectural photoreproductions: A manual for identification and care*. New Castle, DE: Oak Knoll Press.

Price, L. O. 2010. *Line, shade and shadow: The fabrication and preservation of architectural drawings*. New Castle, Delaware: Oak Knoll Press.

Sturge, J. M, ed. 1977. *Neblette's handbook of photography and reprography*. New York: Van Nostrand Reinhold Company.

FURTHER READING

The Abbey Newsletter. 1982. TLA Conference: New Territory. *The Abbey Newsletter* 6(5) (Supplement, November). http://cool.conservation-us.org/byorg/abbey/an/an06/an06-5a/an06-a502.html (accessed 8/7/2012).

Borgesius, T. W. A., and Waterman, H. I. 1940. New methods for diazotype printing. *The Journal of the Society of Dyers and Colourists* 56(1): 23–26.

Brown, D. J. 1944. The basis and practice of the diazotype process. *Chemistry and Industry* (April 15): 146–148.

Cliffe, W. H. 1958. One hundred years of diazo-compounds. *Chemistry and Industry* (September 27): 1248–1255.

Conservation Distribution List. 1996. New York State Library Preservation Grants. Conservation Distribution List 09/06/96. www.cool.conservation-us.org/byform/mailing-lists/cdl/1996/0840.html (accessed 8/7/2012).

De Gorter, B. 1949. The principles and possibilities of diazo-copying processes. *The Journal of Documentation* 5(1): 1–11.

Hamill, M. E. 1993. Washingtonia II: conservation of architectural drawings at the Library of Congress. *The Book and Paper Group Annual* 12. http://cool.conservation-us.org/coolaic/sg/bpg/annual/v12/bp12-08.html (accessed 8/7/2012).

Jomain, B. 1953. Developments in the application of azoic dyes in printing. *The Journal of the Society of Dyers and Colourists* 69(13): 661–666.

Koerner, J., and K. Potje. 2003. Testing and decision-making regarding the exhibition of blueprints and diazotypes at the Canadian Centre for Architecture [abstract]. *The Book and Paper Group Annual* 22. http://cool.conservation-us.org/coolaic/sg/pmg/docs/abstracts/abstract_aic_2002_miami.pdf (accessed 8/7/2012).

Kosar, J. 1965. *Light-sensitive systems: Chemistry and application of nonsilver halide photographic processes*. New York: John Wiley & Sons.

Lavrencic, T. J. 1987. Duplicate plans, their manufacture and treatment. *Institute of Conservation of Cultural Materials Bulletin* (Australia) 13(3/4): 139–147. (n.b.: This periodical has been renamed and is now distributed as *Bulletin of AICCM*.)

Oster, G. 1961. Photoreproduction. *American Documentation* 12(4): 285–291.

Page, S. 1996. Transparent drafting films: profiles for preservation. *The Book and Paper Group Annual* 15. http://cool.conservation-us.org/coolaic/sg/bpg/annual/v15/bp15-12.html (accessed 8/7/2012).

Price, L. O. 2003. In the black: Ink-like photo-reproductions on tracing cloth [abstract]. *The Book and Paper Group Annual* 22. http://cool.conservation-us.org/coolaic/sg/pmg/docs/abstracts/abstract_aic_2002_miami.pdf (accessed 8/7/2012).

Price, L. O. 2007. The fabrication of architectural drawings to 1950. Paper presented at the Conservation Center for Art and Historic Artifacts, Philadelphia, July 16–17. www.ccaha.org/uploads/media_items/the-fabrication-of-architectural-drawings-to-1950.original.pdf (accessed 8/7/2012).

Reed, J., E. Kissell, and E. Vigneau. 1995. Photo-reproductive processes used for the duplication of architectural and engineering drawings: Creating guidelines for identification. *The Book and Paper Group Annual* 14. http://cool.conservation-us.org/coolaic/sg/bpg/annual/v14/bp14-05.html (accessed 8/7/2012).

Rhodes, B., and W. W. Streeter. 1999. *Before photocopying: the art & history of mechanical copying 1780–1938*. New Castle, Delaware: Oak Knoll Press.

Shepard, J. 2000. Preservation. *Music Library Association Notes* 56(3): 574–580.

Sugarman, J. E. 1986. Observations on the materials and techniques used in 19th century American architectural presentation drawings. *The Book and Paper Group Annual* 5. http://cool.conservation-us.org/coolaic/sg/bpg/annual/v05/bp05-05.html (accessed 8/7/2012).

Tyrrell, A. 1972. *Basics of reprography*. New York: Focal Press.

Veitch, F. P., C. F. Sammet, and E. O. Reed. 1918. Blue and brown print paper: Characteristics, tests and specifications. *The Journal of Industrial Engineering Chemistry* 10(3): 222–226.

Verry, H. R. 1958. *Document copying and reproduction processes*. London: Fountain Press.

Vogt-O'Connor, D. 1995. Caring for blueprints and cyanotypes. *Conserve O Gram* 19/9 (July). www.nps.gov/history/museum/publications/conserveogram/19-09.pdf (accessed 8/7/2012).

Ward, J. O., J. Boonin, G. J. N. Aamodt, C. Brook, and G. Ostrove. 1975. Music publishing today: A symposium. *Music Library Association Notes* 32(2): 223–258.

Ware, M. 2003. A blueprint for conserving cyanotypes [abstract]. *The Book and Paper Group Annual* 22. http://cool.conservation-us.org/coolaic/sg/pmg/docs/abstracts/abstract_aic_2002_miami.pdf (accessed 8/7/2012).

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The Populist Conservator: A Sticky Case Study

ABSTRACT

How do colleagues in related professions and the general public regard the conservator? As a scientist in a white lab coat, bent over an object with a tiny paintbrush in hand? The unseen expert referenced in family treasure shows on public television? As a pie-in-the-sky idealist whose best practices seem to belie an understanding of the limitations facing small museums and archives?

This paper is an overview of the author's research, born out of necessity, on preserving a treasured—yet not well preserved—part of American popular culture: the bumper sticker. Such objects would rarely warrant individual conservation treatment, yet are held in many permanent research collections and small cultural heritage institutions. In the midst of a traditional, materials-science-based research project on how these items were made and how they changed and deteriorated over time, the author overcame her own and others' prejudices about what constitutes an object worth preserving.

Thus the goals of the research shifted outward: to communicating the preservation message for materials that usually do not receive conservation notice—such as these challengingly sticky and ephemeral objects—and to providing economical solutions for items widely held by institutions routinely strapped for funds. Surprisingly, once the work was couched in terms of its impact on the public, the public took notice. The bumper sticker project garnered significant interest in the popular press and blogosphere, and even resulted in a video created by the author's institution. This example will contextualize a discussion of positive and accessible approaches toward publicizing the preservation of cultural heritage, in ways that make use of modern technologies.

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INTRODUCTION

Conservators routinely present oral and written case studies of treatments, normally delivered in third-person language that distances the conservator from his or her work. While this paper is a case study, it focuses instead on personal, first-person experience, and on developing collection-care best practices for an object unlikely to be treated by conservators—the bumper sticker. In the process of determining preservation strategies, I began to think more broadly about how we as a profession might do a better job of selling ourselves as experts in more public spheres.

I chose "The Populist Conservator" as my title in order to call for a more grass-roots, in-the-trenches, down-to-earth approach to what we do. We have information to share with others: How do we get the word out to the people who might benefit, establishing ourselves as knowledgeable, approachable scholars who are part of the more general conversations about objects?

When I first conceived of this project, a conservator colleague told me that I should not expect to be taken seriously when I chose to focus on bumper stickers. I respectfully disagree. Bumper stickers are a wonderful example of the types of materials that people and—perhaps more to the point—cultural heritage institutions collect. Ephemeral, 20th century materials like these—so common as to be overlooked—deserve our consideration.

Because this paper is derived from a presentation focused on the 2012 AIC Annual Meeting theme of outreach, it does not describe in great detail the research project from which it originated. For more information on the composition and preservation of the bumper sticker, see Baker (2011).

METHODOLOGY

The project on bumper stickers resulted from being aware of what was being used in the special collections and archives library at the University of Kansas. Hence, rule number one of outreach: Know your audience and the collections it uses. For a few years I spent two hours a week in the reading room, and it was a fascinating experience. I saw how patrons used materials (one hopes, gently and with respect), but I also saw *what* was being used. It is not always what the curators and conservators perceive as the most-used collections.

One day while I was at the desk, a patron returned a stack of archival folders, some containing bumper stickers. I recall staring at them, racking my brain for what I might know about them as a conservator. While it is highly unlikely that a bumper sticker would make its way into a conservation lab, the items should still be stored safely, and I did not recall anything in the conservation literature on the topic.

I conceived of a research project to determine the history of the bumper sticker, particularly from the perspective of materials evolution. I hoped to devise simple, accessible preservation recommendations for low-budget museums and archives. In addition, by studying how bumper stickers had changed materially, I could provide data to aid in dating and characterizing stickers: useful information for conservators, collection managers, and archivists.

I developed an extensive survey to document the physical attributes and condition of stickers found in research institutions, a mixture of archives, presidential museums, and other museums (see Acknowledgments). I closely examined more than 2000 stickers, largely political in nature. Political campaign stickers have the advantage of being more readily datable than other types of stickers, and since printers did not differentiate among topics, the conclusions I reached were most likely relevant to all bumper stickers.

Information was recorded about the bumper sticker message or text, manufacturer, printer (including union information), and date, when known. There were also categories for the component parts of bumper stickers: printing method, inks, adhesives, substrate material, and backing liner material. Finally, I paid particular attention to how bumper stickers were stored—and made notes about what didn't work as well as might be expected.

BRIEF HISTORY OF BUMPER STICKERS

The creation of the bumper sticker is widely credited to Forest P. Gill, a silkscreen printer from Kansas City, Kansas, in the late 1940s. Before and during World War II, Gill printed on canvas products needed for the war effort, such as tents, gun covers, and truck covers. But how could he bundle the canvas items and keep the bundles together? Gill turned to the new pressure-sensitive paper stock and highly visible daylight fluorescent inks, known by the popular trade name "Day-Glo" (Gilman 2010). Aware of his idea's potential for other applications but uncertain how to market it, Gill contacted promotional-products marketers, who embraced the new concept as a boon to the specialty advertising industry. Thus the bumper strip, as it was called in those early days, was born (Pechuls 2003).

The bumper sticker is a genuine American product, rooted in post-World War II experimentation with wartime materials—including daylight fluorescent inks, pressure-sensitive adhesives, vinyl, and silicone—and the maturation of commercial screen printing as distinct from fine art serigraphy. After World War II, more Americans purchased automobiles and had increased leisure time for travel. With the advent of a national highway system, it was easier than ever to take a cross-country trip. It didn't take long for advertisers to recognize the car's promise as a moving billboard, in particular to advertise tourist attractions. Other early bumper stickers promoted civic events, new products, and public-safety campaigns.

In the early 1950s the bumper sticker became closely associated with political campaigning. The 1952 election between Dwight D. Eisenhower and Adlai Stevenson is thought to be the first presidential race in which bumper stickers were widely used (Hanners 2000). Political campaigns, like tourist attractions before them, employed volunteers to frequent supermarkets, sporting events, shopping-center parking lots, and other public spaces to attach stickers to the bumpers of—one hopes—willing supporters' cars (*Bob Dole Campaign Guide*).

BUMPER STICKER COMPOSITION AND PRESERVATION

Almost exclusively until the 1990s, and still in large part today, bumper stickers have been screen-printed. This printing method was vital to the war effort, and was relatively easy to commercialize following World War II. The inks are durable and weather resistant, and the process is well suited to short-run orders with fast turnaround times. The popular daylight fluorescent inks, which helped the message stand out, were used extensively from the 1950s through the early 1970s and worked best with the screen-printing method (Biegeleisen 1971).

The pressure-sensitive stock of a bumper sticker is a composite "sandwich" of three basic parts: the bodystock, or main printing surface; the adhesive; and the release liner, or throwaway backing paper. The earliest bumper stickers were printed on paper. Paper predominated through the early 1970s, and it enjoyed a resurgence in the early 1980s. The early paper stickers deteriorated quickly and were difficult to remove, but they were not designed for permanence. In the early 1950s, their useful life was estimated at just two to four weeks. Despite the tendency toward quick disintegration, one optimistic advertiser—interviewed in a 1952 *New York Times* article touting the new-fangled bumper stickers and their rising popularity—suggested that "even after a strip falls, crumpled and dirty, to lie in the street of some far-off

Item level	
Most paper and vinyl stickers in good condition	Individual alkaline folder; do not fold or crease
Stickers with tacky surfaces or oozing inks and plasticizers	Separate; place within folded piece of silicone release paper inside alkaline folder; use polyester sparingly
Oversize items	Separate and store unfolded in alkaline folders in flat storage boxes
Box level	
Vinyl vs. paper	Separate paper from vinyl stickers, if possible
Ventilation	Use boxes with handle openings or keep lid slighly ajar
Offgassing control	Consider adding a buffered or zeolite paper in box, but not touching stickers

Fig. 1. Bumper sticker storage recommendations

town, it is still doing an advertising job as long as it is still face up" (Schwab 1952, X13).

As early as 1955, advertisements in printing trade journals touted the advantages of a new bodystock—vinyl—over paper because it was completely impervious to weather, flexed to fit curved surfaces, and wouldn't tear when removed (Avery Paper Company 1955). Despite the hopes of manufacturers, vinyl did not really gain popularity until the early 1960s, at least according to my survey results.

Readers of a certain age may recall using a razor blade to gingerly remove a recalcitrant sticker from a bumper. Paper stickers often left a gummy mess of paper and congealed adhesive behind on the bumper. Because of their adhesive formulation, early bumper stickers did not peel off cleanly when needed (e.g., at the end of a political campaign). Manufacturers quickly sought to develop a pressure-sensitive stock that could be removed without residue, marring, or staining. They continue to pursue removable adhesives that will keep the sticker firmly attached as long as needed, yet detach easily when desired.

The function of a bumper sticker liner, as it is called in the industry, is to protect the adhesive layer until the sticker is used. Release liners for bumper stickers are usually a paper that has been coated with silicone, normally on one side. Because the first pressure-sensitive release liner was marketed in 1954, silicone is probably present in almost all bumper stickers. In order to improve the ease with which the liner could be removed, the liner paper was slit using a machine or tool that would cut the liner without damaging the sticker.

Information printed directly on bumper sticker liners often provides a wealth of information for the collection manager, including product information such as the pressure-sensitive stock manufacturer, location of origin, patents, and, occasionally, a date. I continue to compile a master list of information found on liners to get a fuller sense of when materials and products were introduced; this information could be of great use to conservators and collection managers (Baker 2011).

Many of the materials used in bumper stickers degrade in ways that harm themselves and adjacent materials. While vinyl seems relatively sturdy, it may be damaged by bending, creasing, and scratching. In addition, degrading (poly)vinyl chloride releases acidic gases that may damage paper materials and silver-based objects or photographs typically housed nearby. Vinyl stickers should therefore be separated from vulnerable materials. Stickers may off-gas, discolor, shrink, and adhere to adjacent stickers or paper collections over time. Storage, therefore, is more challenging than for a straightforward paper item. A summary of storage recommendations for small historic museums and archives with limited resources appears in Figure 1.

OUTREACH: BUMPER STICKERS IN CYBERSPACE

Although this project was not envisioned as an outreach opportunity per sé, it took on a life of its own. The quirkiness of the topic may have influenced its popularity—after all, bumper stickers are familiar to everyone. What I found, as more and more publicity opportunities arose, is that a conservator could provide a unique voice. I could talk not just about the history of bumper stickers (which is what most reporters asked about), but steer the message to what bumper stickers are made of and why that matters for preservation. On top of that, I could make a case for why to preserve them at all.

The publicity surrounding this project caused me to reconsider the public image of conservation. If the average person on the street has heard of a conservator, which is not as likely as we would prefer, his or her information is often from the context of public television shows such as *Antiques Roadshow*, in which the conservator is mentioned but is usually absent. The message is that conservators will make objects worth more, but only if they are worth spending substantial money on in the first place.

If you look up "conservator" in Google images, you will invariably find a picture of a person in a white lab coat hunched over a microscope, using tiny tools to probe an object. While the lab coat establishes conservators as trustworthy, scientific professionals, do we look friendly? Do we appear to be able to explain concepts in language regular folks will understand? From an outreach perspective in an increasingly image-driven society, conservators could work on looking more accessible.

Outreach is much simpler than it used to be. Modern technologies provide many positive and user-friendly tools for publicizing cultural heritage. Most are inexpensive, with costs in time rather than money. Blogs, Facebook, RSS feeds, and Twitter—extensively discussed in breakout sessions at the 2012 AIC Annual Meeting in Albuquerque—provide easy ways to publicize a project, although one may have little control in determining where the message goes.

I have found that reporters are genuinely interested in new stories, and conservation or preservation projects—when sufficiently general in perspective—are welcome. Our work is conveniently visual, which is a boon for most of the modern publicity formats.

The following are suggestions that I developed in publicizing the bumper sticker project. It is entirely fitting that the bumper sticker—an informational medium that is all about the message—might serve as a method for improving our own public image.

1. Know your collections: What is the public using and why? Granted, bumper stickers are quirky, but this approach can work for other types of materials as well.
2. Identify unmet needs that a conservator could research and fill.
3. When publicizing your efforts, control the message. When reporters ask off-topic questions, steer the conversation back toward your expertise.
4. Talk and think in sound bites. What are the three main points you hope to convey? Television and radio spots are just minutes in length; Tweets are just a few words.
5. Use accessible language and avoid jargon. You do not have to dumb down the message, but make sure the vocabulary will not get in its way.
6. What is your audience? Talks aimed at fellow conservators, museum professionals, or folks at a public library event should be different, with good reason. Only one of those groups is the least bit interested in inks cured by ultraviolet radiation, no matter how fascinating they may seem to you.

Remember, we in conservation have a huge advantage from the start. Our work is fascinating, slightly mysterious, full of interesting stuff, and visual. Use these features to your advantage. Remember that although many cultural heritage objects are not deemed valuable enough to warrant conservation treatment, we as conservators should still be involved in determining storage protocols for them.

The bumper sticker research is a case study, but it represents the larger picture. Is it, in fact, important for conservators to reach out to broader audiences? How can we use available technologies to aid in the cause? Does the way in which items are selected for preservation and treatment affect our perspectives?

Let's take off the white lab coats, step outside the lab, and make ourselves more visible. In a world of countless voices and perspectives, let's move toward populism, using our scientific reasoning, aesthetic perspective, and years of training to impact the preservation of our cultural patrimony more broadly. I've found that if you can pitch it right, people are only too willing to listen.

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REFERENCES

Avery Paper Company. 1955. Neither snow . . . sleet . . . rain freezing cold nor sizzling heat harms Fasson vinyl signs. *Screen Process Magazine* (August): 95.

Baker, W. 2011. Soapbox for the automobile: Bumper sticker history, identification, and preservation. *Collections: A Journal for Museum and Archives Professionals* 7(3): 251–270.

Biegeleisen, J. I. 1971. *Screen printing: a contemporary guide to the technique of screen printing for artists, designers, and craftsmen*. New York: Watson-Guptill Publications.

Bob Dole: Republican for U.S. Senator campaign guide. n.d. Topeka, Kansas: Bob Dole for Senate.

Gilman, M. 2010. Personal communication. Gill Studios, Lenexa, Kansas. March 10.

Hanners, D. 2000. Candidates no longer favor campaign bumper stickers; contenders prefer to spend their money on other ways, seen as more effective, of getting voter support, such as radio advertising. *Contra Costa Times*, September 24. A20.

Pechuls, A. 2003. Forest P. Gill: Responsible and dependable. *Promotional Products Business* (April). http://www.ppai.org/Publications/PPB/Article.asp?NewsID=1762 (accessed September 9, 2009).

Schwab, A. Jr. 1952. Bumpers tell tourist's story. *New York Times*, June 15. X13.

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Going All the Way: Achieving the Full Potential of Collaboration between Conservators and Scientists to Produce Information, Products, and Processes of Demonstrated Use at the Bench

ABSTRACT

Heritage Science for Conservation at Johns Hopkins University was established in 2009 through a generous grant from The Andrew W. Mellon Foundation. Its purpose is to bring scientists into a closer working relationship with conservators. Bringing scientists into the conservation laboratory of an academic library fosters deep research collaborations relating to book and paper conservation. This alliance of scientist and conservator in a common laboratory also serves as a model for how the next generation of book and paper conservation science laboratories might be structured. The Heritage Science for Conservation model addresses the need for a stable locus for science and engineering dedicated to the ongoing needs of the book and paper conservator. In Heritage Science for Conservation, scientists and engineers design research projects and develop agendas in collaboration with conservators and carry out the work in the same physical space. Following this collaborative work, research is disseminated to a wide but targeted audience of conservators, engineers, scientists, librarians, curators, industrialists, students, and the general community.

During its pilot phase, 2009–2012, Heritage Science for Conservation was successful in achieving its programmatic milestones: (1) to conduct research into the fundamental causes of heritage materials degradation and the fundamental applicability of conservation technologies; (2) to expand the tools and techniques of conservation science; and (3) to produce information, products, and processes of demonstrated use at the conservator's bench. In this paper, the authors introduce the Heritage Science for Conservation model, which facilitates both ongoing research on behalf of book and paper conservation and the development of new technologies that can serve the conservation scientist and the practicing conservator. The authors present evidence of the model's success by describing three technologies developed at Heritage Science for Conservation, one for each milestone. The authors also suggest that establishing regional Heritage Science for Conservation centers at academic institutions with strong science programs and robust conservation programs will move the field toward a national conservation research agenda and strategy by capitalizing on institutional strengths and providing sustainable collaborative research, while avoiding redundant or disparate research efforts.

INTRODUCTION

Heritage Science for Conservation (HSC) is a part of the Department of Conservation and Preservation in the Sheridan Libraries and Museums of Johns Hopkins University. Sonja K. Jordan-Mowery is the Joseph Ruzicka and Marie Ruzicka Feldman Director for Conservation and Preservation, the principle investigator of HSC, and co-author of this article. The Sheridan Libraries and Museums is home to one of the oldest ongoing library conservation and preservation departments in the United States that included in its original mandate the training of book and paper conservators. Established in 1974 by John Dean and modeled on the City and Guilds of London Institute, the conservation program has, for more than three decades, served as the only apprenticeship program for book and paper conservation education in an academic library.

The other co-author of this article, John W. Baty, is Assistant Research Professor and HSC Scientist—hereafter, ARP/HSC Scientist—and is jointly appointed to the Johns Hopkins Department of Materials Science and Engineering (DMSE), Whiting School of Engineering. DMSE has a record of conservation science research on diverse cultural heritage materials, with masters and PhD graduates who are active members of the conservation science community. From the mid-1980s until the early 1990s, DMSE also had a PhD program in conservation science. As an engineering department, DMSE has a focus on products and processes not present in a core-discipline physical science department, adding an important dimension to its partnership with the

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conservation and preservation department. Johns Hopkins University has exemplified a long-standing commitment to collaborative initiatives and partnerships between the sciences and conservation efforts.

HSC is the direct result of a two-day workshop held at Johns Hopkins University on April 28–29, 2008. Funded by The Andrew W. Mellon Foundation, the workshop brought scientists, conservators, industry partners, institutional managers, and funding agencies together to discuss how to develop a national conservation science research agenda to address the pressing conservation needs for book and paper collections in our nation's cultural institutions. The workshop produced a comprehensive report that identified the research needs for book and paper collections (Jordan-Mowery and Olson 2008), including (1) the need for change in the educational model for book and paper conservators and (2) the need to foster an environment for stronger and more sustained working relationships between conservators and scientists. Conservators and scientists needed more direct access to one another and more long-lasting collaborations: a new paradigm for book and paper conservation and conservation science.

In *The Structure of Scientific Revolutions*, Kuhn (1996) defines a paradigm as a set of practices that defines a scientific discipline at any particular period of time. He notes that a paradigm provides model problems and solutions for a community of researchers. As conservators and scientists engage in research collaborations, they often observe that some of the conventional research models and questions do not satisfy the research needs of heritage materials. The close proximity of the scientist, conservator, and cultural materials yields a better understanding of the materials' complexities. This, in turn, enables the scientist to provide better technologies and methodologies for the nuances of the materials and the conditions of their storage and use.

Conservation science contributes directly to the long-term preservation of physical collections in a number of ways: (1) by enabling an ongoing dialogue between conservator and scientist in exploring the effects of current materials and treatments; (2) by developing effective materials, equipment, and techniques for conservators; and (3) by enabling quantifiable long-term research and investigation. The interpretation and dissemination of scientific findings should be at the heart of preservation activities, as a bridge of communication between disciplines. The integration of new technologies with the knowledge, skills, and expertise of conservators enables the revision of current theories. This, in turn, informs decision-making and improves treatments. In HSC, scientists and conservators work collaboratively with no distinctions in rank: all contributions are equally valued. Conservators and scientists alike learn to communicate without jargon. Working in a shared laboratory with a diversity of expertise enables scientists and conservators to develop practical treatment solutions and a common research agenda.

Because it is located in the conservation department of an academic library and its scientific faculty are also appointed to the science and engineering departments of the institution, HSC can foster deep collaborations between scientists and book and paper conservators. In order to be successful, such a laboratory must create the expectation that—whatever the current issues are, and whatever key evaluations or reevaluations need to be made—conservators have a role in guiding scientific research. The elements that keep the science and engineering practice trained on book and paper conservation are (1) the collaborative design of research agendas with conservators; (2) the execution of those agendas in the same collaborative environment; and (3) the dissemination of results to a diverse audience, including conservators, engineers, scientists, librarians, curators, industrialists, students, and the general community.

Science and Engineering Dedicated to the Needs of Book and Paper Conservators

To ensure that scientific and engineering activities meet the needs of book and paper conservation, the HSC laboratory reports to the Director of Conservation and Preservation. The ARP/HSC Scientist, in addition to supervising the postdoctoral fellows and maintaining the laboratory, maintains a research agenda that reflects the interests and expertise of staff conservators and the wider conservation community. He also draws on the resources of partnering laboratories at Johns Hopkins, as well as collaborating heritage science, industrial, and academic laboratories in the region.

The application process for the postdoctoral fellowships contains several features to ensure their relevance to book and paper conservation. The call for proposals invites applications in specific areas that reflect the facilities, expertise, and momentum of the department. The 2012–14 call encouraged proposals targeting paper strengthening and the copper-catalyzed degradation of paper. The proposals are extensive and require a timeline and budget. They also require a narrative describing how the proposed research will serve conservation needs. After the postdoctoral fellows arrive on campus, they discuss their proposals with conservators for collaborative modification. The research is then carried out in the fully equipped conservation science laboratory adjacent to the book and paper conservation laboratories in the new Brody Learning Commons of the Milton S. Eisenhower Library. This close physical proximity keeps the work of the science team focused on the needs of the conservators and promotes the transparency conservators expect in the development of conservation science technologies. Scientists are also integrated into the daily work of the conservators, thereby gaining a richer understanding of materials and treatments. The ARP/HSC Scientist and postdoctoral fellows thus develop an enhanced understanding of the motivation for their research and the limits of treatment, enabling the generation of meaningful and relevant ideas for future work.

Communication is also a central component of the HSC laboratory, and it is not limited to the dissemination of research results or the demonstration of developed technologies. Oral and written presentations begin early on in the postdoctoral fellowships, and the entire science team is dedicated to getting ever better at communicating with conservators, scientists, business people, and local communities. To date, communication vehicles have included conservation and scientific publications, conference presentations, classroom lectures, brown bag lunches, library talks, and YouTube videos. Effective communication is the bridge that connects conservators and scientists.

MILESTONES OF THE SCIENTISTS' WORK: INCREASING APPLICATION AT THE CONSERVATOR'S BENCH

The image of a bridge has been a part of HSC's visual identity since its beginning and symbolizes the solid connection between conservators and scientists. This prompts the question, how do you know the bridge has been successfully crossed? To answer the question and to make sure HSC addresses its central obligation to serve the needs of the bench conservator, HSC has identified three milestones: (1) to conduct research into the fundamental causes of heritage materials degradation and the fundamental applicability of conservation technologies; (2) to expand the tools and techniques of conservation science; and (3) to produce information, products, and processes of demonstrated use at the conservator's bench.

Successes for each of these three milestones roughly correspond to the first three years of HSC's existence (2009–12) and to presentations at the AIC Annual Meetings. At the 2010 meeting in Milwaukee, the authors presented results on the fundamental degradation chemistry of papers containing papermaker's alum (Baty et al. 2010). In two presentations in 2011 in Philadelphia—the first exploring the role of polyester film encapsulation on paper aging (Minter 2011) and the second examining the role of metal salts in sizes, pigments, and ink (Baty 2011)—the authors discussed several technologies to improve accelerated-aging studies of paper and text blocks. These included improved long-term, low-temperature aging with passive control of relative humidity and ways to control ionic strength, pH, and the rates of oxidative versus hydrolytic degradation. In 2012 in Albuquerque, HSC first presented the three technologies described below (Baty 2012). All of these technologies are designed to be useful to conservators working in their own laboratories, whether they have immediate access to physical science laboratories or not. All the technologies have been developed to the point of provisional applications for patent, but have differing needs for partnership and further work to achieve their full potential. The authors welcome comments and suggestions, as well as inquiries about partnership in the development of these technologies. The authors are pleased to partner with Johns Hopkins Technology Transfer for the intellectual protection, marketing, and distribution of these technologies.

Milestone 1: Conduct Fundamental Research on Conservation Problems and Technologies

The need for a rigorous physical-science foundation for conservation technologies is recognized throughout the field, and HSC's commitment to it is not at all unique. A powerful illustration of this need can be found in the development of nondestructive techniques for artifact analysis. Here, if a conservator is to rely on an apparatus or protocol to reveal an important criterion for treatment, the technology must be supported with rigor and transparency.

Conservators and scientists have expressed some uncertainty about the amount of materials research that has already been done and that may be transferred from other, larger fields. Scouting other disciplines for relevant data and results is a mark of any good research laboratory, but this need is especially keen in conservation science due to its comparative lack of practitioners. There are many pertinent research areas from which to draw. For example, the conversion of cellulose into biomass-based fuels and feeds shares many common features with the degradation of cellulose in paper. However, this seeming gold mine of information has its limitations, since the goal in fuel production is to degrade the cellulose quickly, using liquid water and high heat, pressure, and acidity if needed. These conditions contrast markedly with the relatively mild ambient conditions and much longer timeframes in which paper degrades in the library, museum, or archive. Hence, scientists need to study the underlying causes of materials deterioration—and the fundamental applications of conservation technologies—under conditions pertinent to heritage collections.

As the HSC laboratory has conducted fundamental research, it has received two requests from conservators, both aimed at obtaining the greatest return for the invested effort: that the research be relevant and that the precision reported be meaningful. The close collaboration between conservators and scientists in HSC's shared workspace ensures that discussions about physical science take place on a regular basis, with the goal of maximizing research benefits for conservators. As a result, HSC scientists have learned to which decimal place they need to measure, and to avoid elucidating subtle differences—such as those between reaction mechanisms—when such differences do not change treatment protocols.

As a representative technology, HSC has developed common-ion buffers to maintain paper pH during aging. The

HSC laboratory has successfully applied this technology in paper-degradation research (Baty et al. 2011) and is currently exploring its application in conservation practice.

Whereas in conservation and paper science the word "buffer" usually implies an alkaline reserve, in other fields the term implies utilizing the common-ion effect to maintain pH. In a common-ion buffer, an alkaline species and its conjugate acid are in an equilibrium that resists change in pH when either an acid or a base is added. Common-ion buffers have appeared in the conservation literature in several contexts, although not yet as a means of controlling paper pH during aging. Researchers have used the precise pH control afforded by common-ion buffers to improve enzyme treatments, as in the removal of linseed oil (Blüher et al. 1997). Also, the pH-buffering ability of gelatin sizing, which contains both acidic and basic side chains, has been demonstrated in historically relevant samples (Baty and Barrett 2007). Perhaps the most familiar use of common-ion buffers is in calibrating pH electrodes in conservation laboratories.

The types of papers in which precise control of pH is needed—both in conservation research and in practice—are papers containing metal ions such as aluminumIII, copperII, and ironII, which are present in sizes, pigments, and inks, and are known to promote paper degradation. All these metal ions exist in compounds known as coordination complexes, whether they originate from the initial manufacture of the artifact (like the copperII acetate in verdigris) or from a conservation treatment (like the ironIII phytate produced in the treatment of iron-gall ink). The compositions and orientations of these complexes—and properties such as reactivity and color—are highly pH dependent, hence the motivation for precise control of pH in conservation treatment.

The HSC laboratory has inaugurated the use of two types of common-ion buffers—the first made up of acetate/acetic acid and the second of monobasic/dibasic phosphate—and has used them to find the pH dependence of aluminumIII-catalyzed paper degradation. The results of these studies, which targeted aluminumIII in papermaker's alum, show that paper deterioration in the presence of aluminumIII is greater than what might be expected due to acidity alone, but that increasing the pH consistently slows all degradation. Therefore, an alkaline reserve is sufficient to treat papers threatened by papermaker's alum, and common-ion buffers offer no advantage. HSC continues to study degradation catalyzed by copper and iron ions, where the same conclusion may not hold. In papers containing copper and iron ions, the pH should not become too low or acid-catalyzed hydrolysis of the cellulose will result. Nor should it become too high, due to the twin threats of increased oxidative degradation and discoloration of the pigment or ink. Here, the use of a common-ion buffer in treatment may indeed prove useful in obtaining the optimum pH.

Milestone 2: Expand the Capabilities of Conservation Science

There are good reasons why core-discipline physical-science laboratories might investigate a few select conservation problems. For example, an investigator with great understanding of her specialization might disentangle the science at the heart of a vexing conservation problem. Heritage science might also seize the interest of student workers who have not yet settled on the course of their future studies. However, for both analysis and research, the conservation field needs dedicated laboratories. Such laboratories provide a critical context: Conservation science provides an expertise and a suite of tools that help answer conservators' questions. Unless it is performing analyses by rote, a conservation science laboratory will seek to expand that expertise and those tools, enabling more conservators' questions to be answered with greater certainty and greater safety of persons and artifacts. To fulfill this goal, HSC developed one technology during its pilot period that promises to be very helpful in the study of materials aging: a new aging vessel.

Among the requests the HSC laboratory has received from conservators, the primary one has been for added transparency. In order to consider information useful, procedures deployable, or products trustworthy, conservators need to hear the challenges that were overcome in their development. While discussions on the efficacy of accelerated aging are present in the literature (Porck 2000), the problems of finding a suitable accelerated-aging vessel are not. In the wake of the ASTM study on accelerated aging (Shahani et al. 2001), there appears to be a preference in the field for aging samples in sealed vessels rather than in humid ovens for a better approximation of long-term natural aging. The chemical composition of papers following sealed-vessel aging mimics that of papers in the library, museum, and archive more closely. The difficulty lies in knowing and maintaining the conditions inside the vessel throughout aging. The HSC laboratory has found that many vessels fail during exposure to accelerated-aging conditions. One vessel identified by part number in the ASTM standard (ASTM 2007) emerged from the chamber with fractures in the top of the screw cap and moisture loss from the interior. Other vessels that had lost moisture did not exhibit visual evidence of failure, and it is suspected that previous accelerated-aging studies may have been inadvertently compromised for that reason.

The HSC laboratory has looked for solutions to two other criticisms of sealed-vessel aging. The criticism leveled by scientists and technologists is that the relative humidity inside the vessel during aging at higher temperatures is not that to which the paper was equilibrated when the vessel was sealed. (This is the primary reason for aging in humid ovens.) The criticism from conservators is that the vessel's gaskets, which are lined with a fluoropolymer such as Teflon, may off-gas and affect sample aging. Even if the user is satisfied that fluoropolymer-lined gaskets are chemically inert, there may be practical reasons for avoiding them. Specifically, the HSC laboratory has observed that fluoropolymer-lined gaskets can shrink at the temperatures specified for accelerated paper aging, exposing the headspace—and, therefore, the sample—to the other side of the gasket and the screw cap itself.

A new accelerated-aging vessel designed at HSC is capable of withstanding the temperatures specified in the accelerated aging standards (ASTM 2007), and the corresponding pressures inside the vessel, without failure. It eliminates exposure to polymers through a reusable glass-on-glass seal that requires no grease. It also controls the relative humidity through the use of a saturated salt charge in each vessel that is capable of buffering the air to a known relative humidity. At this time, the HSC laboratory is actively seeking a partner with analytical-glassware-manufacturing capabilities to carry this technology forward.

Milestone 3: Produce Information, Processes, and Products of Demonstrated Use at the Bench

In order to achieve the full potential of collaboration between conservators and scientists, a laboratory must develop information, products, and processes of demonstrated use to conservators at the bench. HSC seeks to develop discrete technologies that can be produced and deployed in conservation studios that may not have adjoining technical analysis laboratories. The accomplishment of this goal is rare among conservation science laboratories today, and is possible for HSC only through the physical proximity of conservators and scientists in day-to-day work. This collaboration allows scientists to develop a vital understanding of the context of conservation, and to identify technologies—whether they are developed in the laboratory itself or are already used in the physical sciences—that may be of possible use in conservation treatment.

The technology presented here is a calibration kit consisting of a series of paper targets of historically relevant manufacture with known concentrations of specific compounds deposited on them. Conservators can use these targets to calibrate x-ray fluorescence, near-infrared, or UV-Vis spectrometers for the nondestructive analysis of atoms or compounds in heritage papers in their own laboratories. The technology that underlies the manufacture of these targets originated with the need to deposit specific compound concentrations for paper-degradation research studies. Among the technologies the HSC laboratory developed for this purpose was the use of capillary action to deposit compounds onto paper, as in paper chromatography. This technique produces great uniformity in concentration of the compound perpendicular to the direction of solvent migration (i.e., horizontally, or in the x dimension), but not vertically. Therefore, this technology consists of fabricating the paper target and taking several readings across a horizontal line, using a rigorous, destructive quantification method—such as inductively coupled plasma-optical emission spectroscopy—to calculate the uncertainty in composition. The end user is then shown the precise locations on the calibration target to read with her nondestructive technique: locations alternating with the site of previous destructive analysis. Once again, the authors welcome comments and suggestions, as well as inquiries about partnership in the development of this technology.

CONCLUSION

Heritage Science for Conservation at Johns Hopkins University was established as a model book-and-paper conservation-science laboratory. This model addresses the need for a stable locus for science and engineering dedicated to the ongoing needs of the book and paper conservator. In this model, scientists and engineers design research projects and develop agendas in collaboration with conservators and carry out the work in the same physical space. When complete, they disseminate the results to a broad but targeted audience of conservators, engineers, scientists, librarians, curators, industrialists, students, and the general community. HSC has been successful in achieving its programmatic milestones, which are (1) to conduct research into the fundamental causes of heritage materials degradation and the fundamental applicability of conservation technologies; (2) to expand the tools and techniques of conservation science; and (3) to produce information, products, and processes of demonstrated use at the conservator's bench. Perhaps the best evidence of this success is the technologies HSC has developed during its 2009–2012 pilot phase.

The Johns Hopkins HSC model has been very successful because of strong institutional traditions and resources, as well as a long-standing, ongoing commitment to innovation and cross-disciplinary collaboration. Nonetheless, the HSC model can serve as an exemplar to other academic institutions across the United States, although it will be more viable in certain institutions than in others. Requirements for success include (1) the ability to stage interdisciplinary collaboration, understood as meaningful cooperation between team members with diverse training and experience; (2) an attitude of openness and support for discovery; and (3) the opportunity for the team members to undertake a serious effort to communicate science and engineering through diverse media to diverse audiences.

Establishing regional HSC satellites would form the foundation for a national conservation research agenda and research strategy. Such a system of HSC satellites would yield enormous benefits by supporting the conservation science needed to preserve our cultural heritage collections. The establishment of these regional HSC centers would avoid costly duplication of laboratories and effort while ensuring a coordinated response to research needs.

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REFERENCES

ASTM. 2007. Standard test method for accelerated temperature aging of printing and writing paper by dry oven exposure apparatus, D6819-02. West Conshohocken, Pennsylvania: American Society for Testing and Materials International.

Baty, J. W. 2011. The use of common-ion-effect buffers and anoxic accelerated aging to determine the chemical mechanisms of paper degradation. Poster presented at the 39th AIC Annual Meeting, Philadelphia.

Baty, J. W. 2012. New book and paper conservation products and processes from the Heritage Science for Conservation Laboratory, Department of Conservation and Preservation, The Sheridan Libraries, Johns Hopkins University. Paper presented at the 40th AIC Annual Meeting, Albuquerque.

Baty, J., and T. Barrett. 2007. Gelatin size as a pH and moisture content buffer in paper. *Journal of the American Institute for Conservation* 46(2): 105–121.

Baty, J., W. Minter, and S. Y. Lee. 2010. The role of electrophilic metal ions aluminumIII and magnesiumII in paper degradation and deacidification. Paper presented at the 38th AIC Annual Meeting, Milwaukee.

Baty, J., W. Minter, and S. Y. Lee. 2011. Rethinking acidic paper degradation: Cellulose hydrolysis catalyzed by metal cations in the library, museum, and archive. Paper presented at the 2011 Spring National Meeting & Exposition of the American Chemical Society, Anaheim.

Blüher, A., A. Grube, U. Bornscheuer, and G. Banik. 1997. A reappraisal of the enzyme lipase for removing drying-oil stains on paper. *Paper Conservator* 21(1): 37–47.

Jordon-Mowery, S. K., and N. Olson. 2008. Developing a national conservation science research agenda: A workshop at Johns Hopkins University. April 28–29, Baltimore.

Kuhn, T. S. 1996. *The structure of scientific revolutions*. 3rd ed. Chicago: The University of Chicago Press.

Minter, W. 2011. Encapsulation and deacidification: Project design and preliminary results of a study of papers using long-term, low-temperature aging. Poster presented at the 39th AIC Annual Meeting, Philadelphia.

Porck, H. J. 2000. *Rate of paper degradation: The predictive value of accelerated aging tests*. Amsterdam: European Commission on Preservation and Access.

Shahani, C., S. B. Lee, F. H. Hengemihle, G. Harrison, P. Song, M. L. Sierra, C. C. Ryan, and N. Weberg. 2001. Accelerated aging of paper: I. Chemical analysis of degradation products; II. Application of Arrhenius relationship; III. Proposal for a new accelerated aging test. ASTM research program into the effect of aging on printing and writing papers. Washington, D.C.: Preservation Research and Testing Division, Library of Congress.

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The Conservation of the Jefferson Bible at the National Museum of American History

INTRODUCTION

As a student at Johns Hopkins University in 1886, Cyrus Adler discovered two cut-up copies of the New Testament in a private library in Baltimore. A catalog note glued inside the front cover of each stated that Thomas Jefferson had used these two volumes to create an original book. Nine years later, in 1895, while serving as the Smithsonian's librarian and curator of world religions, Adler located that original book with Jefferson's great-granddaughter, Carolina Randolph, and purchased it from her for $400. That year, Adler included "The Life and Morals of Jesus of Nazareth" in an exhibition the Smithsonian mounted at the 1895 Cotton States International Exhibition in Atlanta, where it was displayed under the title "Jefferson's Bible." It has been referred to as "The Jefferson Bible" ever since.

"The Life and Morals of Jesus of Nazareth" (fig. 1) is a book created by Thomas Jefferson between 1819 and 1820. For political and personal reasons, he kept it private throughout his life. It is an 86-page assemblage of cut-out New Testament passages removed from the Gospels and glued to paper. Verses are arranged in four columns across each page spread, each column showing the same verses in a different language: English and French on the right page, and Latin and Greek on the facing page. It is a chronologically arranged story of Jesus' life and teachings viewed through the eyes of the Enlightenment, without miracles, without angels and saints, and without a resurrection.

As imagined by one of the greatest thinkers of the Revolutionary Era, Jefferson's book answers the question, where there is no king sanctioned by God, what is the moral basis of the new republic? It is a statement on the separation of church from state and power from religion. It remains the single most important artifact that defines Jefferson's unique Christian faith, which he described by saying "I am of a sect by myself, as far as I know" (Jefferson 1904, 203).[1]

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Fig. 1. "The Life and Morals of Jesus of Nazareth," known familiarly as "The Jefferson Bible," before treatment

In 1902, Congressman John F. Lacy introduced a resolution in Congress to produce a facsimile of the Jefferson Bible, which the Government Printing Office printed in 1904. The 9000 copies were distributed to both the House and Senate. The House supply ran out quickly, but a facsimile was given to each newly elected senator on the day he swore the oath of office until the 1950s.

Jefferson's handwork within "The Life and Morals of Jesus of Nazareth" is comprised of 43 folios, each a single sheet of paper folded in half to produce two leaves or four pages. These 43 folios were sent to Frederick Mayo, his last bookbinder, to be bound sometime between 1819 and 1820.

Hannah French provides insight into Frederick Mayo in her 1986 book, *Bookbinding in Early America: Seven Essays on Masters and Methods.* Frederick August Mayo was born Friedrich Gotthill Meyo in Nossen, Saxony, the Dresden region southeast of Leipzig. He worked as a binder in different parts of Europe and England before a four-year impressment into the navy, where he was injured and landed by chance in the United States in 1809. He set up a stationer's shop in Staunton, Virginia, moving later to Richmond, where he became Jefferson's bookbinder in 1818. Jefferson wrote that he liked books that were "solid, as heavy as blocks of metal" (French 1986, 153)[2] and informed Mayo that he preferred London and Paris bindings to American ones, which he called "so spongy, that after a book has been once opened, it will never shut close again" (French 1986, 209).[3]

Mayo glued 62 stubs onto Jefferson's 43 folios to compensate the spine folds for the thickness of the verses that had been glued to the front and back of each page. He then added six endleaves and sewed the book three-up on four recessed cords. He sewed on silk endbands over cord cores with a double thickness of thread so that each single pass of the needle produced a double wrap. He lined the spine in heavy paper and covered in full morocco with gold-tooled designs, producing a tight-back, tightly bound, French-style book that was in keeping with Jefferson's preferences.

PRESERVATION DECISION-MAKING

The National Museum of American History and the Smithsonian strongly support the exhibition, publication, and sharing of collections via the Web. In addition to providing physical and chemical stabilization of the artifact, the conservation of the Jefferson Bible offered opportunities to fulfill these missions: Smithsonian Books published a full-color facsimile, the Smithsonian Channel created an hour-long documentary, the Smithsonian Institution hosted a dedicated website featuring high-definition digital images, and the museum opened an exhibition of the book, which later went on a national tour. When the possibility of treatment was being discussed, however, these opportunities were carefully separated from the side-by-side comparison of benefits and risks associated with the treatment of the artifact. Treatment decisions were made based upon the artifact's needs alone.

With age, Jefferson's heavily glued paper had lost its flexibility. The binding's rigid spine linings and glued-on stubs dramatically limited the extent to which the book could be safely opened. The stiff pages hinged along the stub line and cracked (fig. 2). The museum considered exhibiting the book in 2005, but after examination determined that doing so would risk further damage. Discussions to address the conservation needs began at that time in order to make the artifact accessible again. Eventually, through both institutional and private funding, a conservation plan was implemented that included an extensive survey, risk assessment, chemical analysis, treatment, and protective enclosure. A conservation team was assembled in September 2010.

The curators recognized that Jefferson's book was actually two masterpieces—Mayo's binding and Jefferson's Bible—but of the two, Jefferson's work was more important to the museum. Since the binding was clearly damaging the Jefferson document within, Mayo's work would have to be altered in order to stabilize Jefferson's work. Because Mayo's binding would cease to be an object of study once treatment began, a massive amount of pre-treatment documentation was carried out. Conservators examined other Mayo bindings at the University of Virginia Rare Book Library, and found numerous other Mayo bindings that were constructed in the same manner: sewn three-up on four recessed cords, using double-thread endbands with the same number of tie-downs. Since these other Mayo bindings could substitute as the objects of study for future scholars of colonial bookbinding, modification of the Jefferson Bible could be considered.

Fig. 2. Restricted opening of the Jefferson Bible. Note in particular the way the leaves hinge near the stubs, causing cracks and tears.

The team's first task was to create a sewing map of the book to see whether Jefferson had used a blank book and had cut out pages to create stubs. If so, modifying the book stubs would not be considered. Conservators confirmed that the Jefferson Bible was not based on a blank book. The next tasks were to complete a survey of the artifact in order to quantify its damage, to undertake materials analysis to determine its compositional elements, and to establish a base line for monitoring its aging characteristics. Jefferson's book is a complex artifact. It contains 12 different types of paper, six different printing inks, four different iron-gall inks, and two different adhesives.

The team assembled research, produced a glossary of terminology, created material standards against which the Jefferson Bible could be measured over time, and designed a custom survey database that included 200 data points for each page. To minimize damage, the survey was performed with the book open to only 30 degrees. The conservators worked in teams of two. Pages were examined in ambient, raking, transmitted, and ultraviolet illumination. A 50x microscope was used to observe iron-gall ink characteristics.

The survey results indicated that 98% of the pages had torn, with 67% torn at the head or tail of the stub line, and 56% showing cracks along the stub. An additional 69% had losses. A significant number of the 1000-plus attachments were partially delaminated. There was a clear need for physical stabilization. The iron-gall ink was in fairly good condition. Only 8% of the ink suffered from cracks, less than 7% had losses, and there were no instances of complete burn-through. There was not a clear need for chemical stabilization of the iron-gall ink. Locations for material analysis of paper fibers, adhesives, and inks were chosen with the curator from areas that did not contain "Jeffersonian" features. For example, an unintentional ink splatter was a viable sampling location whereas a period was not.

The curator did not want surface pH readings to be taken because of the risk of water staining; cold-water-extraction and degree-of-polymerization tests were also impossible due to the required sample size. The Smithsonian's Museum Conservation Institute performed micro-XRF, revealing the presence of iron, aluminum, potassium, sulfur, and copper in all papers. Near-infrared spectroscopy of 118 locations determined that the average surface gelatin content was 3.2%. FTIR indicated that the adhesive was a combination of protein and starch. Materials testing results concluded that no solvent-modified aqueous bath could benefit all the component materials. The risks of chemical treatment outweighed the benefits, so physical stabilization and long-term storage in an anoxic environment were the treatment options chosen.

After six months of study, preparation of rebinding and page-repair models, and discussions about options, risks, and historical implications, curators and conservators together established a conservation treatment plan. Authorization to proceed was received: separate the Jefferson pages from the Mayo binding, keeping the leather binding and silk endbands intact; remove the damaging stubs and preserve them separately; mend the Jefferson pages; take high-resolution digital images of the disbound pages; create new, more flexible stubs; resew the book through the original sewing holes; re-attach the silk endbands; and recase the text back into its original cover.

TREATMENT

Even though the curator and museum wanted to change everything about how Jefferson's volume functioned, they wanted to change nothing about how it looked.

Step one was removing Jefferson's four-page, handwritten index, which was sloppily glued to the Stormont-pattern marbled flyleaf. It had previously been partially pulled off and reglued, revealing numerous delaminated areas on the surface of the marbled paper. The index had also been previously repaired in situ. With the front cover supported in an open position, a microspatula and scalpel were slowly rocked against the animal glue until it released.

The text block was tightly wrapped in polyester film and plastic wrap. The book was placed in a humidity chamber for 15 minutes to minimize leather desiccation and then faced overall with Klucel G-coated kizukishi paper, which was solvent-set with acetone applied with a goat-hair brush. A single cut was made to the marbled board paper near the hinge of each board. Ethanol and methyl cellulose were applied, and the paper was slowly lifted towards the hinge to reveal the four cords, which were cut even with the board edges with a scalpel.

Using a small, rounded-edge Jeff Peachey lifting knife, the cover was separated from the text block along the spine lining. The bulk of the heavyweight lining paper was left adhered to the inside of the spine leather to support it and prevent flexing and breakage (fig. 3). Over a 5-hour period, work proceeded simultaneously on the front and back covers, proceeding towards the middle, until the leather cover was removed intact in one piece. The leather cover was immediately wrapped around a custom surrogate text-block support and placed in a storage box.

Methyl cellulose was applied to the spine of the text block to help soften and remove the remaining adhesive. Dental tools were used to gently scrape off the remnants of Mayo's lining paper. With the spine cleaned, the silk endbands were

Fig. 3. Removing the leather binding intact

separated from the text block. Each tie-down was cut near the kettle stitch, and a new linen thread was tied to the end of the silk using a weaver's knot. When each tie-down was secured, the endbands were gently lifted off the text block and placed in protective enclosures so they could be reused later (fig. 4).

The folios were opened to the center, the sewing thread was cut, and the text block was separated into the original 43 folios. Because all the folios showed significant planar distortion, the protective enclosures designed for them were sink mats, so there would be no danger of crushing them when the enclosures were stacked for storage in the vault every night. Each folio was opened and photographed before treatment in raking and ambient illumination (fig. 5).

Fig. 4. Original endbands removed, with new linen sewing thread attached to each side of the tie-down

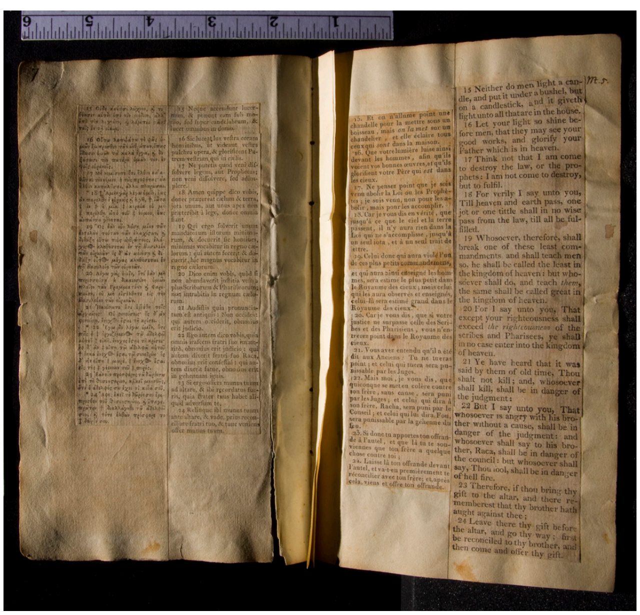

Fig. 5. Page spread of 7 verso and 8 recto in raking light during treatment. Note the adhered stub, the resulting damage, and Jefferson's dog-eared page corners.

Ethanol and methyl cellulose were applied to the glued-on stubs around each folio to soften the adhesive, and the stubs were lifted off with Teflon spatulas. The watermark "P A Mesier," which appeared on numerous stubs, was found to have been produced by a mould purchased in March 1817 for the Lydig paper mill in the Bronx, New York (Gravell and Miller 1979, plate 487, 110). After the stubs were removed, each folio was photographed again in ambient, raking, and ultraviolet light.

Copies of the photos were printed on acid-free paper. Conservators and curators examined each Jefferson page together and discussed where mends needed to be made, how the mends would be applied, and where evidence of Jefferson's hand would preclude treatment. For example, raking light photographs revealed that 60% of the pages had been dog-eared, supporting the curator's historical research indicating that Jefferson read this book nightly. The year he made the book, Jefferson wrote, "I never go to bed without an hour, or half hour's previous reading of something moral, whereon to ruminate in the intervals of sleep" (1904, 187).[4] The curators and conservators made treatment decision notes on acid-free printouts of the page photographs, and signed them as treatment authorization documents (fig. 6).

Mending kits were assembled from a variety of Japanese papers that were toned with acrylics using an airbrush. Mends were designed to stabilize pages, not to improve upon Jefferson's handwork or the appearance of this early 19th century object. Berlin tissue coated with Klucel G was solvent-set with acetone on tears near iron-gall ink. Wheat-starch paste was used for the remaining mends. Mends that extended over the edges were trimmed under the microscope, carefully following the original contour of the artifact.

Fig. 6. Senior paper conservator Janice Stagnitto Ellis consults with curator Harry Rubenstein.

Fig. 7. Resewing the text block using a sewing tray made to the exact height of the desired thickness of the text block to align and protect page edges

Digital photography using a 50-megapixel Hasselblad camera proceeded in batches as folio mending was completed. These images were carefully examined for quality control.

New stubs were made from kizukishi that was toned to match the Jefferson paper. Two new stubs were made for each folio, one for inside and one for outside the fold, thereby protecting the Jefferson folios from both the sewing thread and the spine adhesive.

A sewing tray was made to the exact height of the original text block (fig. 7). The tray provided a constant visual and tactile reminder of how much to compact the text block as the sewing progressed. The tray also provided protection for the page edges and kept them aligned as the book was sewn. The folios were sewn all-along, unsupported, with 35/3 unbleached linen thread. The sewn text block was lined with two layers of Japanese tissue and wheat-starch paste before the original silk endbands were re-sewn back into place in their original locations. The spine was lined with additional layers of Japanese paper until the book could be opened without the spine throwing upwards.

After lining, the sewn book was opened and paged through several times to observe how the pages moved and determine where additional page repairs or support were needed. The marbled pastedowns were lifted from the front and back cover boards using ethanol, methyl cellulose, and a Teflon lifter. The leather spine was supported from the inside with layers of Japanese paper, with the uppermost layer toned blue to assist future conservators. To recreate the tight-back structure, the text block was adhered to the covers using wheat-starch paste on the spine, the exposed boards, and the lining tabs, which were adhered beneath the marbled papers. About 1/8 in. of each tab was visible inside the hinges. The exposed tabs were inpainted with dots of Golden Fluid Acrylic Paints to match the Stormont marbled paper. After the treatment was complete, the Jefferson Bible maintained its original aesthetic (figs. 8–10).

Fig. 8. "The Life and Morals of Jesus of Nazareth" after treatment

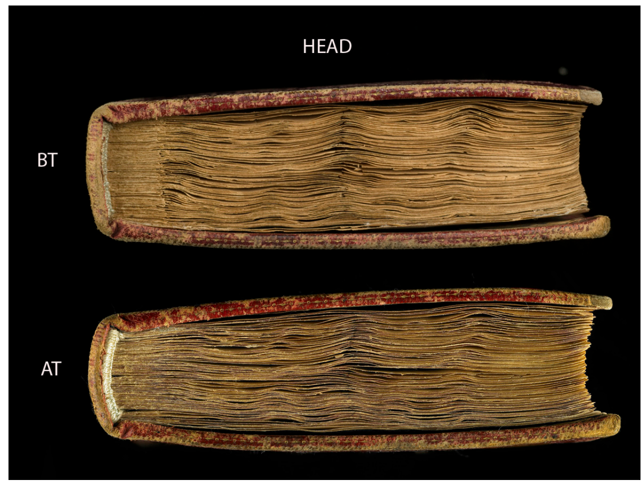

Fig. 9. The head edge of "The Life and Morals of Jesus of Nazareth" before (top) and after (bottom) treatment.

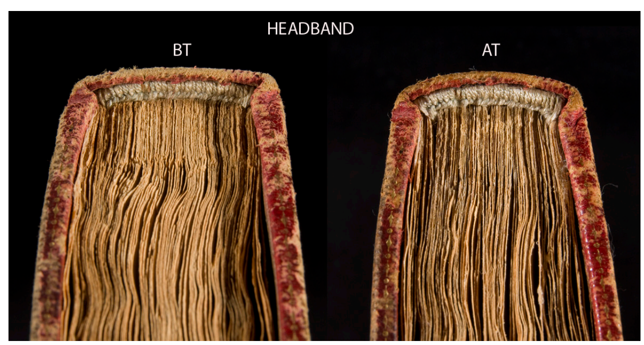

Fig. 10. Close-up of the headband of "The Life and Morals of Jesus of Nazareth" before (left) and after (right) treatment.

SOURCE BOOKS

One hundred years after Jefferson cut them apart and 25 years after Adler found them in a private collection in Baltimore, the Cohen family donated the two English New Testament source books to the Smithsonian. These books, referred to as Source Book 1 and Source Book 2, were also part of the Jefferson Bible conservation project.

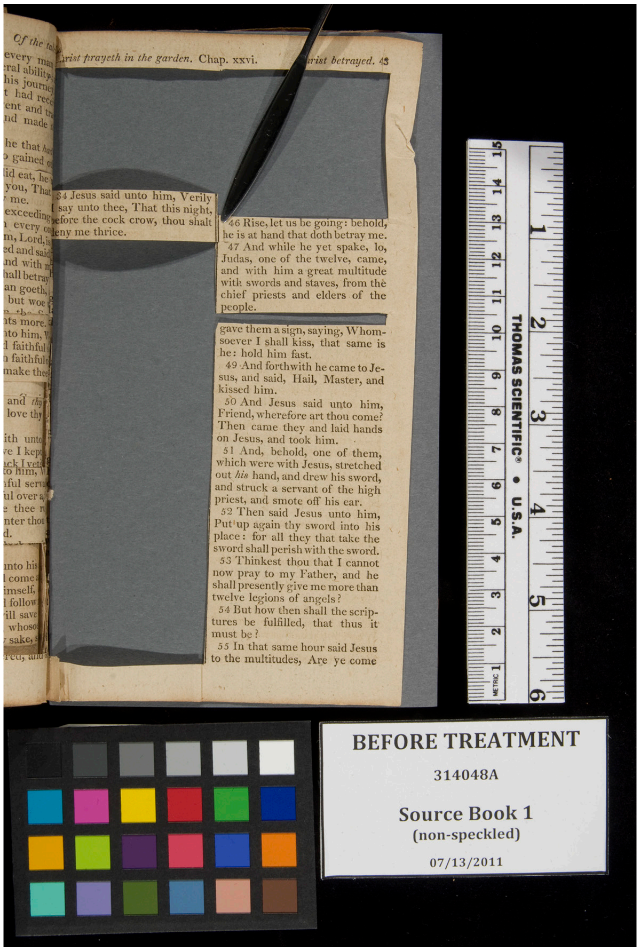

Fig. 11. Source Book 1 before treatment, with passages extracted by Jefferson

Both volumes were split through the text block, spine linings, and leather. Source Book 1 was broken twice. Source Book 2 was broken in three places. The curator suspected that these splits might have been created by Jefferson himself to aid in extracting clippings. If this was the case, or even a possibility, he did not want the breaks in the binding repaired.

Although both volumes exhibit numerous cutouts, Source Book 1 served as Jefferson's primary resource, with at least 171 individual passages extracted from the first 160 pages of the volume, which comprised the four Gospels. In Source Book 2, Jefferson removed at least 69 individual passages from the four Gospels. These passages ranged from single lines to an entire page (fig. 11). Jefferson left behind empty page borders, partial page borders, and other cut-out but unused passages, which were neatly tucked inside the extremely vulnerable books.

After several meetings with the curator, lots of brainstorming, and informal discussions with colleagues, a minimally interventional approach was deemed most suitable to stabilize the source books, and plans were made to produce digital surrogates for future scholars. As with the Jefferson Bible, the conservators and curator examined each page together and decided what to mend, what to stabilize, and what to leave alone.

In general, conservators repaired breaks in the paper that appeared to be torn from age and/or use. Areas that appeared to have been cut or sliced with a tool were not mended since these were most likely evidence of Jefferson's hand. Cuts that were vulnerable to further tearing were supported at the base while leaving the cut edges unrepaired. Of the loose fragments tucked inside the book, only those that appeared to be torn off were reattached. The remaining fragments were encapsulated in polyester film with labels for each fragment indicating its chapter and verse, its original page location in the text, and where it was found in the book. The encapsulated fragments were post-bound and were stored together with the source books. Treatment notes, including the exact locations of all mends, were written directly on the curatorial approval sheets and added to the permanent documentation. In accordance with the curator's wishes, no treatment was executed on the binding of either source book.

Even after repair, the two source books remain vulnerable to damage from handling. To preserve them, digital surrogates will be served to researchers in lieu of the original objects. Each page of the two books, from the front pastedown through the end of the Gospels, was photographed with a piece of photo-gray paper behind it. This blocked the view of the subsequent pages that showed through the cutouts, and makes the surrogates easier to read and use than the originals.

OUTREACH

The museum never missed an opportunity to showcase the project. In the eight months between the initial March 10, 2011, press release announcing the Jefferson Bible Conservation Project and the exhibit opening on November 11, 2011, the Paper Conservation Laboratory provided 47 tours during the treatment phase of the project, most lasting 45 minutes to an hour. Staff could set up the "tour table"—complete with photographs, conservation documentation, sewing models, source books, and selected Jefferson folios—in 10 minutes flat. The laboratory hosted tours for the entire museum staff, professional colleagues, donors, the museum's Board of Directors, the Secretary of the Smithsonian and his staff, the Smithsonian's Board of Regents, and members of Congress, including the Chair of the Appropriations Committee.

The project took on reality-TV status when Smithsonian Networks filmed every crucial step of the conservation treatment for a one-hour documentary called "Jefferson's Secret Bible." Whether conservators were discussing options with curators, tying threads to delicate original silk endbands, or resewing the volume, the cameras were there as witnesses (fig. 12). This process was at times inconvenient, occasionally

Fig. 12. A cameraman films as Janice Stagnitto Ellis resews the Jefferson Bible.

intrusive, definitely time consuming, and sometimes flat-out embarrassing. However, the end result is an amazing show that reaches an entirely new audience and sheds light not only on Jefferson and his little volume but on the field of conservation and the importance of preserving our cultural heritage.

The conservation treatment also provided the opportunity for Smithsonian Books to publish the first color facsimile of the object using the digital images taken during treatment. The *Jefferson Bible, Smithsonian Edition* contains a chapter discussing the conservation decision-making and treatment. The book release date coincided with the exhibition opening, and within five months the book was in its fourth printing, winning "Best in Show" in the 2012 Washington Book Publishers Book Design and Effectiveness Competition.

The Smithsonian also used the digital images to create an interactive website where visitors can view each page of the Bible and zoom in on interesting details. Between November 2011 and April 2012, the website—which contains a page showing the step-by-step conservation treatment—had more than 65,000 visitors from around the world.

The Jefferson Bible, the two source books, and a copy of the 1904 Government Printing Office facsimile were on display at the National Museum of American History for eight months (fig. 13). The exhibition gallery included three touch-screen video monitors that offered visitors the chance to view two short films provided courtesy of Smithsonian Networks, one discussing the history of the Jefferson Bible and the other featuring its conservation treatment. The third touch-screen monitor allowed visitors to interact with the high-definition digital images of the pages by zooming in on details or paging through the book. Conservation was also highlighted in one of the exhibit panels.

By April 2012, the Jefferson Bible had generated 64 online articles, including international news stories, eight printed articles, four magazine articles, five blog articles written by the conservation team for the museum's blog, two TV news clips, one radio segment, one podcast, and one full-length documentary.

Fig. 13. "The Life and Morals of Jesus of Nazareth" on display at the National Museum of American History; Courtesy of Hugh Talman

What began as a private devotional act for Thomas Jefferson has taken on different meanings as a modern nation considers afresh how religion and politics mix. This timeless message is brought to a ready audience. Through "The Life and Morals of Jesus of Nazareth," the public learns the moral philosophy of Thomas Jefferson, the principles founding our country, and the importance of preserving our cultural heritage.

ACKNOWLEDGMENTS

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NOTES

1. Jefferson to Ezra Stiles Ely, 25 June 1819.
2. Jefferson to William F. Gray, 8 November 1818, Jefferson Papers, Library of Congress. Quoted in French (1986).
3. Jefferson to Frederick Mayo, 30 November 1818, Jefferson Papers, Library of Congress. Quoted in French (1986).
4. Jefferson to Dr. Vine Utley, Monticello, 21 March 1819.

REFERENCES

French, H. 1986. *Bookbinding in early America*. Worchester: American Antiquarian Society.

Gravell, T. L., and G. Miller. 1979. *A catalogue of American watermarks, 1690–1835*. New York: Garland Publishing, Inc.

Jefferson, T. 1904. *The Writings of Thomas Jefferson Vol. XV*., ed. A. A. Lipscomb and A. E. Bergh. Washington: The Thomas Jefferson Memorial Association.

FURTHER READING

Index to the Thomas Jefferson papers. 1976. Washington: Thomas Jefferson Press U.S.

Wolfe, R. J. 1990. *Marbled paper: Its history, techniques, and patterns with special reference to the relationship of marbling to bookbinding in Europe and the western world.* Philadelphia: University of Pennsylvania Press.

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Preservation of Cultural Heritage: The Restoration of a Globe in Relief from the Department of Geography, National School of Buenos Aires

ABSTRACT

The Department of Geography of The National School of Buenos Aires (University of Buenos Aires) has varied collections that reflect the different models of teaching used during the 19th and 20th centuries and that witness and document the progress of education, the scientific discoveries, and the advances in geography, anthropology, archeology, and geology during that period. One of the most important pieces is a globe in relief dating from 1850, which suffered severe damage in an accident. It is of German origin according to the maker's mark "Schotte & Cia" (Berlin), although the topographic information is in French. In the 19th century, Germany and France were the major suppliers of teaching materials for many disciplines in Latin America, and were true purveyors of European innovations in educational systems and policies at the time.

Within the Integral Plan for Preservation of Cultural Heritage in the National School, the Conservation Group, in conjunction with the Department of Geography, presented a proposal for restoration of this cultural asset. The piece had several types of damage caused by different agents of deterioration, resulting in both physical and chemical problems. The proposal sought to reconstruct the damaged area of the globe, clean and consolidate its surface, and correct deformities in its support. The intervention also helped to recover the visual legibility of the globe, which provides varied information related to 19th century cartographic knowledge and political situations and to the scope of exploration and discovery at the time.

NATIONAL SCHOOL OF BUENOS AIRES

The National School of Buenos Aires is located in the historic center of the city. The history of the school goes back to the Jesuit Missions of the 18th century. In 1863, the school was turned into a public institution, and in 1911 it became part of the University of Buenos Aires. Presently it is one of the most prestigious high schools in the region.

The school has a diverse collection of teaching tools that reflect its long history. Frequently its teaching methodology was based on foreign models. At the end of the 19th century, Germany and France were the main providers of educational models and materials for schools in Latin America. The topographic globe is an example of the types of teaching aids imported from Europe at the time.

THE DEPARTMENT OF GEOGRAPHY OF THE NATIONAL SCHOOL OF BUENOS AIRES

The Department of Geography has a vast collection of minerals, fossils, and anthropological pieces. It also maintains a collection of geographical and historical maps, cast topographic relief maps, and various globes, including the globe in relief treated in this project. The Conservation Group, with funding from the Parents Association, has carried out several projects in the geography department. These projects have included the improvement of storage conditions, the preservation of flat maps, and the conservation of this topographic globe.

CONSERVATION OF THE GLOBE IN RELIEF

The aims of this project were to carry out scientific analysis of the globe, to create a photographic record and written documentation of the globe, and to complete conservation treatment of the piece. The intention of the treatment was to return the globe and its support stand to an approximation of their original appearance and to functional order. The globe stand required treatment because its metal components had been accidentally deformed. A secondary objective was to educate the high school community about the globe's significance and the importance of its preservation.

Presented at the Book and Paper Group Session, AIC's 40th Annual Meeting, May 8–11, 2012, Albuquerque, New Mexico.

GLOBE AND STAND IDENTIFICATION

The globe consists of three main elements: the sphere, which presents cartographic information, the metal circles or rings around the globe, and the wooden stand that supports the globe. Together, the globe and stand are 52 in. high and 34 in. wide. The stand has a three-legged wooden base topped with four curved iron rods, which support a 12-segmented iron horizon ring featuring astrological symbols. The metal axis of the globe is attached at both ends to a brass meridian ring. The wooden base has a fixed bronze support on which the meridian ring sits, allowing the globe to rotate. The sphere's diameter is 27 1/2 in. The globe was constructed of papier-mâché in two halves, with wooden plugs at the poles; the metal axis, which passes through the plugs, has bronze hour discs on its ends. The topographic relief was molded in plaster and attached to the globe's surface. The relief layer was painted with different colors corresponding to seas and continents, and some countries were outlined. The paper labels were printed in French and attached to the globe. During conservation, dated paper labels and a seal were found inside the globe, indicating that it was made between 1845 and 1847. This allowed the globe to be dated more accurately.

BEFORE TREATMENT DESCRIPTION

The main problem of the globe and stand was physical damage that occurred in 1997, when someone accidentally fell down the stairs and hit the globe (fig. 1). The impact caused breakage, loss of material, and deformation of the globe, and almost split the sphere completely (fig. 2). The metal structures were also deformed, and the globe lost its characteristic rotational movement because of the deformation of its axis.

The treatment sought to correct the damage to the globe and the metal parts of the stand, returning the globe to working condition. The globe stand, the metallic elements of the horizon ring, which is formed by iron bars and plates, the brass meridian band, and the bronze hour circles at both ends of the sphere were damaged (fig. 3).

The globe and stand had also been subjected to use and wear over the past 160 years. Prior to treatment, the globe had a layer of yellowed, brittle varnish that compromised the general view of the object. There was also an accumulation of surface dirt that made the labels difficult to read. Abrasion and the use of inappropriate cleaning products had caused additional loss of the varnish layer, weakening of the paint layer, and loss of certain labels and the information they contained. Overpaint was also noted in some areas, especially in the Argentinean region (fig. 4).

Fig. 1. The globe before treatment

Fig. 2. Detail showing breakage and structural loss

Fig. 3. Detail showing the damage suffered by the metal horizon ring

Fig. 4. Detail showing aged varnish layer

Fig. 5. Sphere separated into two halves

Fig. 6. Paper used as part of the papier-mâchè structure printed with the date 1845

SCIENTIFIC RESEARCH

Scientific analysis of the pigments, varnish, and structural materials was carried out in the National Institute of Industrial Technology in Buenos Aires. FTIR was used to identify the varnish and the binder of the paint layer. The results matched the initial hypothesis that the binding medium was oil and the varnish was a natural resin.

The solubility tests carried out in the studio determined that the adhesive used for the labels was water sensitive. Tests of the paint layer and the label text showed that they were not sensitive to water. Therefore, a 1:1 solution of water and ethanol was used with extreme caution when cleaning the labels.

TREATMENT

The treatment focused mainly on correcting the damaged support and bent metal components to allow the globe to rotate as before. Cleaning the globe's surface and correcting its deformations were also of primary importance to allow the globe to function and increase the appreciation of its original aesthetic. The treatment was completed in a period of six months.

The first step was to separate the sphere from its support and to remove the damaged metal components, or the meridian and horizon rings. The two halves of the sphere were separated in order to work on them separately (fig. 5). In the process of separation, a first consolidation step was done to avoid further loss of material. To return the globe to its original spherical shape, the broken half sphere was reconstructed and re-enforced with papier-mâché. In this process, conservators followed the original manufacturer's technique from 1845 (fig. 6), using wheat starch adhesive and thick, long-fibered paper that was strong enough to correct the deformations.

The following steps included the consolidation and relocation of original broken pieces that were detached from the globe. All treatments were carried out with reversible,

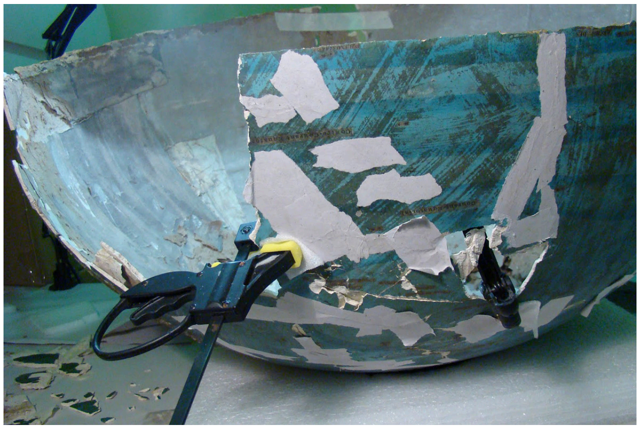

Fig. 7. Consolidation of broken pieces

Fig. 8. During the cleaning process

Fig. 9. Re-attachment of the two halves of the sphere

conservation-quality materials. For the broken pieces and consolidation of the original plaster, a neutral-pH ethylene-vinyl-acetate (EVA) adhesive was used (fig. 7), which was chosen for its strength and reversibility with water.

The surface of the globe was cleaned with a solution of distilled water and ethanol, both in liquid and gel form. The gel was formed using Klucel G (hydroxypropyl cellulose) and was applied mainly in areas where a great accumulation of varnish was found. The original labels and the overpaint were also cleaned with this solution, taking special care due to the solubility of the adhesive used on the labels (fig. 8).

In order to re-establish the original shape of the sphere, papier-mâché in the broken half of the sphere was reconstructed and re-enforced. For the other half, a system of cotton bandages was used to correct the deformations, and the interior was humidified slowly in order to achieve controlled movement and controlled tension of the material.

After cleaning, consolidation, and structural correction, the two halves needed to be re-attached. This was done using the same EVA adhesive with an inert ground of calcium carbonate. The area of attachment was re-enforced with a web of cotton wool to support the adhesive (fig. 9).

Once the two halves were united, areas of loss were filled. First, a barrier layer of shellac was put between the papier-mâché and the new material. The areas of loss were filled with a layer of plaster and then a thin layer of calcium carbonate in animal glue to imitate the original surface texture (fig. 10). The fills were retouched using watercolors. The objective was for the retouching to be recognizable from a certain distance without interrupting the general view of the object (fig. 11).

A final layer of ketone resin dissolved in white spirit was used to varnish and protect the retouched areas of the globe. Regrettably, two years after the treatment, there has been a slight darkening of these areas. This is attributed to the quality of the varnish and the ketone resin, which is softer than

Fig. 10. Detail, filling losses

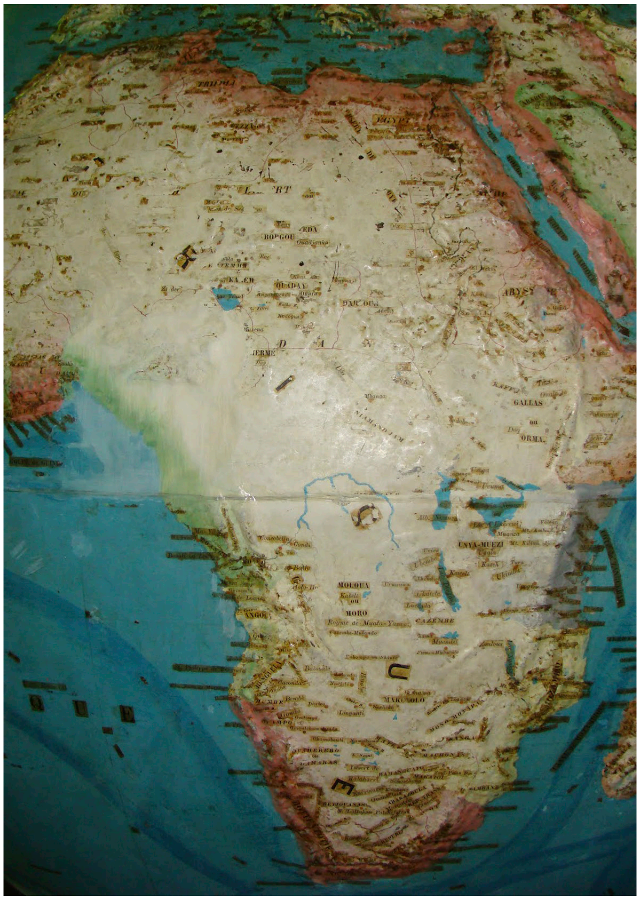

Fig. 11. Detail, retouching

acrylic resin. An acrylic resin was not chosen at the time of treatment because any solvent used to remove this type of varnish would also endanger the paint layer and the printing ink from the original labels. There is currently a project to eliminate the ketone resin from the whole surface of the globe and to apply acrylic resin (Paraloid B72 dissolved in butyl acetate) only in the retouched areas, avoiding damage to the original oil paint and the labels' ink in case of removal.

SUPPORT AND METAL TREATMENT

The treatment of the support and the metallic elements was performed by metal conservator Iván Casime. He corrected the bent, deformed metal pieces of the support, horizon ring, meridian, and bronze hour discs. The bent and deformed metal parts were treated very slowly using a system of localized pressure. The pressure used was determined by the type of metal. The goal was to bring all the elements into working order and to prevent further deformation.

Some cleaning was carried out on these metallic elements, focusing on the elimination of corrosion on the bronze elements. This cleaning was not very deep, given the instability of the painted metal. After the metal had been brought into plane and cleaned, a layer of acrylic resin varnish was applied to protect the metal and prevent corrosion. Once all the pieces were ready, the globe was re-attached and mounted to the stand (fig. 12).

Fig. 12. The globe after treatment

CONCLUSION

After a lot of hard work, it was a pleasure to see the gratitude of the community and school when the globe and stand were returned to the geography department. The same year the treatment was completed, the department organized an exhibition entitled *Didactic Material Used in Teaching Geography During the 19th and 20th Centuries*. This exhibition included a video of the treatment of the globe.

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FURTHER READING

Brañas, M., R. Ibañez, and V. de las Heras. 2003. Restauración de un globo terráqueo ingles del siglo XVIII en el Museo de América. *Anales del Museo de América*. 11: 253–258.

Forest Products Laboratory. 1953. Papier mache. In Report 1965. Madison, Wisconsin: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 5 pp.

Glazer, G. D. 1999–2012. Guide to globemakers. www.georgeglazer.com/globes/globeref/globemakers.html (accessed 08/09/11).

Glazer, G. D. 1999–2012. Glossary of globe terminology. www.georgeglazer.com/globes/globeref/glossary.html (accessed 08/09/11).

Van der Reyden, D. L. 1988. Technology and treatment of a 19th century time globe. *The Paper Conservator* 12: 21–30.

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Outreach and Collaboration across Institutional Boundaries with the Treatment of the De Brys's Collection of Voyages

ABSTRACT

The De Bry family published several travel accounts in Frankfurt in the late 16th and early 17th centuries, including a description of voyages to the New World. The De Brys's portrayals of the Native American inhabitants of Virginia and Florida in the 1580s, including the well-known and oft-consulted engraved reproductions of John White's watercolors, were intended for diverse European audiences and illustrate a people who are alternately powerfully elegant and savagely brutal. Staff at Duke University Libraries selected three of the De Brys's printed works for conservation treatment because of their poor condition and high instructional value. Conservation and curatorial staff collaboratively decided that preservation of the original texts and preparation for high instructional use should be the goals for treatment. The treatments consisted of washing and resizing two texts and rebinding all three in blind-tooled, full-calf bindings. Large tissue fills and creative guarding strategies were employed to allow oversized plates to be handled and stored in a way that minimized damage.

The conservation treatments were presented in a talk at a symposium at Duke University in the spring of 2011. The symposium was hosted by Duke's Center for Medieval and Renaissance Studies and brought together international scholars and their various interpretations of the De Brys's works. The author's involvement in the symposium offered a unique opportunity to connect these researchers to the printed originals and to hear firsthand how the repairs might impact the researchers' experiences and readings of the works. Having this type of transparent and open discourse with the scholarly community can inform future treatment decisions and, more generally, will help to raise public awareness and appreciation for special collections holdings and their preservation. The conservation of the De Brys's works and the timing of the symposium also led to other outreach opportunities on campus: the items were highlighted in an exhibit in the library and referenced in a visiting artist's installation.

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THE DE BRYS AND THEIR WORKS

The De Bry publishing house was active from the 1590s to 1630s, and consisted of Theodor de Bry, his sons Johann Theodor and Johann Israel, and various colleagues. The De Bry family trained as jewelers and goldsmiths but learned the technique of copper engraving in Antwerp in the 1570s. These skills gave them an edge in the relatively new realm of copper engraving, which was replacing the older style of woodblock printing as the leading form of book illustration. In the 1590s, the De Bry family brought this technique to the book trade in Germany, where they became established as booksellers, publishers, and illustrators in Frankfurt (Van Groesen 2012).

The De Brys are perhaps best known for publishing two series of travel accounts. Explorations in the Old World were detailed in 13 volumes of *India Orientalis*, printed between 1597 and 1628. Accounts of New World explorations were detailed in *India Occidentalis*, or the *America* series, consisting of 14 larger format volumes printed between 1590 and 1634. Nearly all of the 27 volumes in the two series were issued in German and Latin, and the first volume of the *America* series was also printed in French and English (fig. 1).

Having never visited the Americas, the De Brys based their engravings on illustrations by White and others and portrayed the native people and conquest through a European lens. As publishers, the De Brys made modifications to both the text and illustrations to enhance salability, at times tailoring the written content to the intended audience (Van Groesen 2008).

CONSERVATION OF THE DE BRY VOLUMES AT DUKE

Duke University's Rubenstein Library holds four volumes produced by the De Brys, three of which are from the *America* series. Though far from a complete and intact collection, Rubenstein's copies—particularly the Virginia volume because of its regional significance and renowned illustrations

Fig. 1. Title page of *America* part 1, 1590. Rubenstein Library C-9 fH282A c.1

of the Roanoke settlement—offer great instructional value to Duke. Neighboring Wilson Library at the University of North Carolina–Chapel Hill (UNC) owns an impressive hand-colored full set, which offers additional reference collaboration for Duke University.

Between fall 2010 and spring 2011, the Conservation Services Department of Duke University Libraries (DUL) treated the three works from the *America* series: the German-language printing of part 4 and the Latin-language printings concerning Virginia and Florida, parts 1 and 2. Printed in Frankfurt in the 1590s, these materials were selected for treatment because of their poor condition, high instructional value, limited functionality, and potential security risks. All of these items are consistently used by researchers and are pulled frequently for instructional sessions in the library.

Treatment of India Occidentalis*, Part 4*

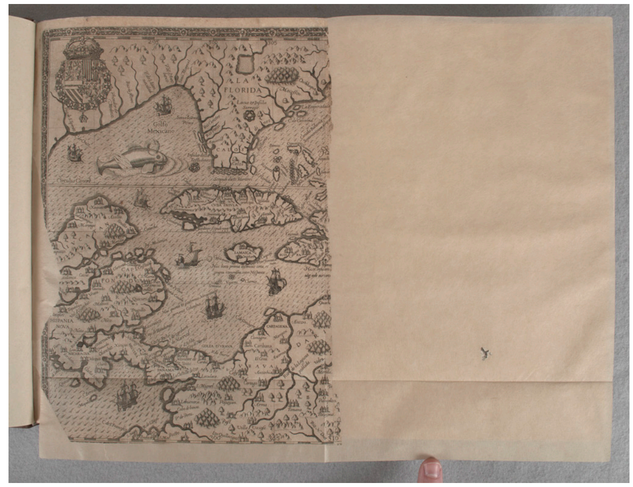
The first item to be treated was *Das vierdte Buch von der Neuwen Welt* (1594). This German-language printing of part 4 retells Girolamo Benzoni's description of Spanish settlement in Peru from *Historia del Mondo Nuovo* (Benzoni 1572). The text came to the library in what appeared to be its original paper binding. The paste paper–covered, Bradel-style binding likely once contained other parts of the series, but at some point they were removed and separated from part 4. The sewing was likely cut at that point as well, leaving a pile of loose, folded leaves inside a damaged and ill-fitting binding.

In addition, there were handling and condition issues at the front and back of the text. At the front, a map of the Gulf Coast included a large loss with a weak, torn edge, creases and misfolds, and previous repairs. The last few pages of the text were also tipped to one another along the spine edge in a way that obscured the visibility of the plates. The final plate had losses along the perimeter and appeared to have been excised from its leaf. It was then lined with one of the free flyleaves from the paper binding, a heavyweight blue paper, with what appeared to be hide glue. The remainder of the lightweight, laid text paper was in fairly good condition.

Treatment-proposal and review meetings at DUL are often a group affair involving multiple conservators and curators, and at times lengthy discussions, particularly for complicated treatments or items. The process is intentionally collaborative, with multiple viewpoints expressed and a consensus reached. Through these conversations, DUL staff decided upon treatment goals for this item: first, the leaves would be secured in a sewn binding so they could not be stolen, inadvertently misplaced, or shuffled. The text also required protection in a new hard-board binding with a flexible opening, which would be durable and well-suited to the printed work.

To meet these goals, the treatment would require selective surface cleaning of the text; separating the glued pages at the front and back; removing residual adhesive with local application of a methyl cellulose poultice; washing the damaged map and the last few leaves to remove glue and attachments, flatten misplaced folds on the map, and prepare for lining and fills; guarding, mending, and filling losses to the text; and finally, resewing the printed work and rebinding it in a full-calf binding.

The curators noted that the map of the Gulf Coast was originally a foldout plate, now missing its whole right half (fig. 2). They felt that it would be useful to indicate to researchers how much was missing by filling to the original dimensions of the plate. The possibility of filling the loss with a printed surrogate was considered but ultimately rejected out of concern for preserving the authenticity of the map. The map and last leaf were washed in deionized water baths alkalized with a saturated calcium hydroxide solution. After the attachments had been washed and separated, losses were filled with acrylic-toned Hanji 1401 tissue applied with Aytex-P wheat starch paste. Both the map and the last leaf were humidified and then lined with tengujo tissue and wheat starch paste. On both leaves, the fills and linings extended to form stubs so that the loose leaves could be sewn into the new binding.



LEFT TO RIGHT

Fig. 2. Map of Gulf Coast before treatment, *America* part 4, 1594. Rubenstein Library Arents qB915A c.1

Fig. 3. Map after washing, fills, and lining

During the process of treating the map, an interesting thing happened. A small fragment of the map that was tucked into the gutter appeared to belong along the torn edge, but on closer inspection did not line up with any part of the remaining map. Luckily, Wilson Library at UNC owns a version of the map, and a digital photograph of their complete map was produced and printed out to scale. The incomplete map from Duke's copy was superimposed over the reproduction on a light table, and it was interesting to find that the small fragment actually belonged near the center of the right-hand portion of the leaf. Conservation and curatorial staff felt it best to adhere the fragment in its rightful place, and the reproduction was used to adhere the fragment precisely where it was originally located (fig. 3).

Selected sections of the text were guarded and mended with acrylic-toned Hanji 1101 tissue. Hooked double-folio end leaves were formed from Ruscombe Rougearte 65 g/m^2 paper, and the text block was sewn on linen tapes to create a durable and flexible sewing structure that allowed for flat opening. The spine was lined with Hanji 1101 tissue and paste, and then with aerocotton and a mixture of PVAC and methyl cellulose. New endbands were hand-sewn over a hemp cord core with an aerocotton support and were adhered to the spine with the PVAC–methyl cellulose mixture. Split boards were formed from a laminate of four-ply cotton-rag mat board, and attached by adhering the overhanging cloth lining and linen tapes with PVAC. The boards were shaped and then covered with Hewitt Book calf. The leather on the spine was not adhered to the text block spine, forming a flexible, hollow-back binding.

Treatment of India Occidentalis*, Parts 1 and 2*

Because of their poor condition and unique binding features, the Florida and Virginia volumes required slightly more complex treatment decisions. As with part 4, these works are of high use and high value. The Virginia volume, *Admiranda narratio, fida tamen, de commodis et incolarvm ritibvs Virginiae ...* (1590), is particularly popular: With Theodor De Bry's engravings modeled after John White's watercolors, it is the most widely cited and reproduced work of the three DUL owns. The Florida and Virginia volumes were both formerly owned by Charles C. Jones, a Confederate colonel and historian from Savannah (1831–1893). They were apparently rebound in the 19th century in half bindings with marbled paper sides. The bindings were most likely produced while in Col. Jones's possession, as other items from his collection exhibit the same binding style.

The 19th century bindings presented challenging condition issues. The inner hinges were splitting at the front of both items, and the first few pages of the Florida volume were detached from the rest of the binding. The sewing and page attachments appeared to be intact, but the text opening was restricted, and whipstitching through the first section was visible in the joint. Additionally, it was clear that the 19th century rebindings were not executed with great care. The pages were apparently trimmed at that point, and portions of the plates were cut, including text from the second title of the Florida volume. Many leaves were tipped to one another, in some places with bands of adhesive that measured over 5/8 in. wide. The adhesive attachment restricted visibility of the contents and made the pages vulnerable to damage during handling. Further, double-folio plates in the Virginia volume were attached to the text with stiff paper guards that restricted their opening and limited legibility of the images.

Strangely, throughout both volumes, the illustrated leaves had slightly variable dimensions and the plates did not register in line with one another. Some of these pages extended beyond the text block at the fore edge from 1/8–3/4 inches. These somewhat bizarre features may indicate that these texts were made-up copies, or complete volumes formed by piecing together leaves from different editions. Acid migration from the binding materials, combined with a poor storage environment, appeared to have discolored the text edges and made them brittle. As a result, the edges of the extended plates were chipping from handling.

The two volumes exhibited the unfortunate combination of an inflexible binding structure with tipped and brittle text paper. This could be improved by washing and resewing the texts, which would require removing the 19th century bindings and sewing. The group considered: Is it more meaningful to use and handle these items in the form that Col. Jones used while doing his research? There were many compelling reasons to rebind as well: The binding materials were acidic and damaging to the text. Recasing or rebacking would likely be fairly invasive treatments of Jones's bindings, and the end results would be limited in their durability and functionality. Ultimately, DUL staff decided that it was in the best interest of the original printed works to rebind.

Many of the treatment objectives for these volumes were the same as those for the German-language volume, with the added goals of stabilizing the texts chemically and protecting the folded and extended plates from further handling damage. In addition to the treatment process used for the German printing, these two texts were also washed, deacidified, and resized. The sections were pre-humidified in a humidity chamber for an hour before immersion in deionized water baths. On average, two to three 20-minute warm-water baths were required to separate tips and reduce residual adhesive on the leaves. Each folio was then resized individually in a 1% gelatin bath and left to dry between blotters and felts.

Both conservation and curatorial staff were concerned about the folded plates and the damage that could occur from

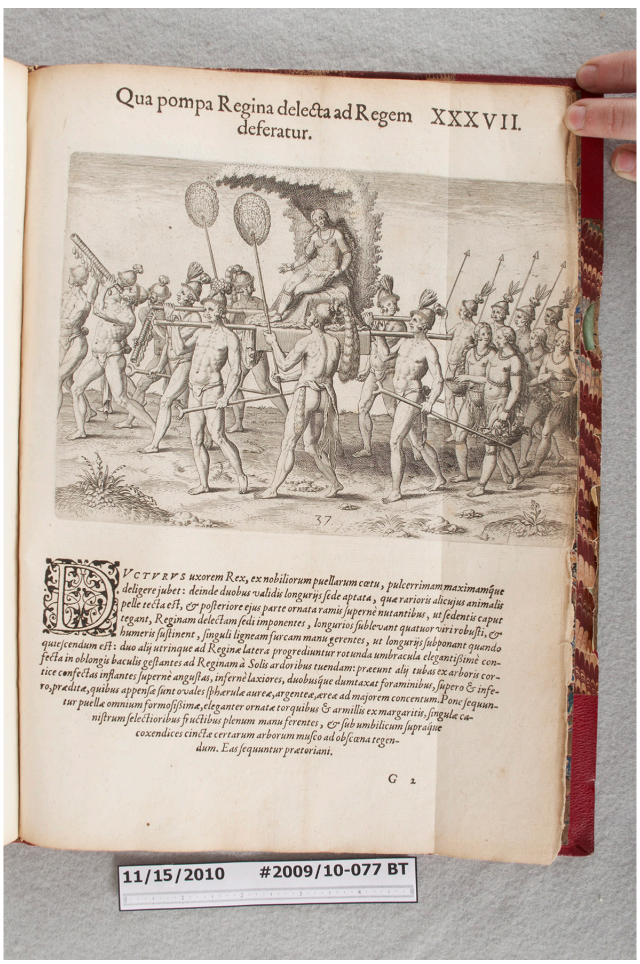


Fig. 4. Folded plate from the Florida volume before treatment, *America* part 2, 1591. Rubenstein Library C-9 fB915 v.2 c.1

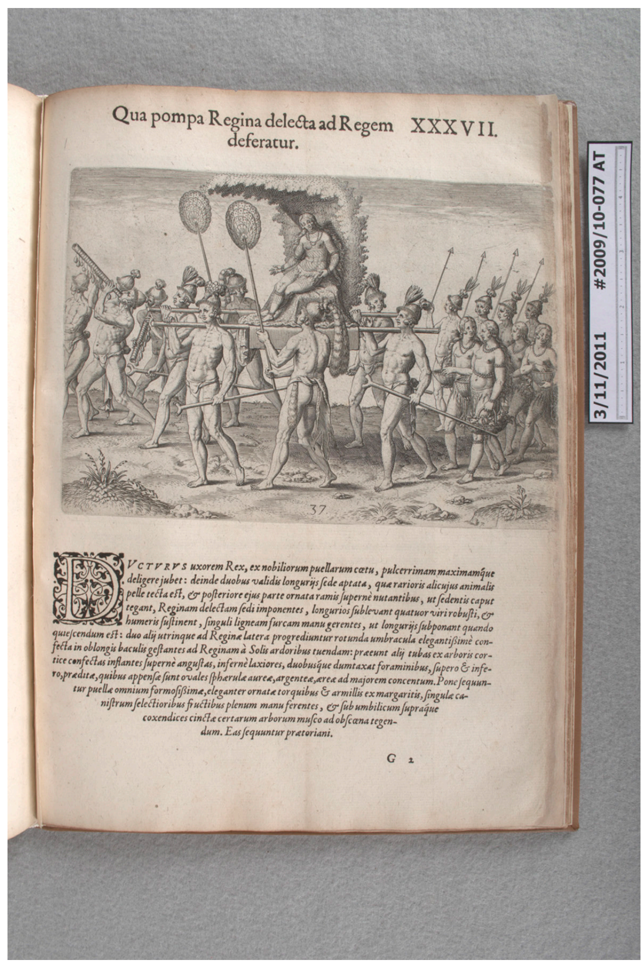


Fig. 5. Plate washed and folded so that a short stub is formed in the inner margin, eliminating the fold through the image

LEFT TO RIGHT

Fig. 6. This double-folio plate was hinged in with a stiff paper guard. *America* part 1

Fig. 7. Double-folio plate after treatment

unfolding and refolding them repeatedly during use (fig. 4). In an effort to limit damage to the plates, a guarding strategy was developed to keep the plates from extending at the fore edge. The majority of the bi-folios were split at the fold, and this made it possible to guard them so that instead of folding through the image, they folded in the margin, with a short, unobtrusive stub in the gutter that does not interfere with the plate visually (fig. 5). The movement and visibility of the double-folio plates in the Virginia volume were greatly improved through washing them, removing their stiff paper guards, and hinging them in with a more flexible Hanji 1401 paper (figs. 6–7).

These volumes were also resewn on linen tapes, bound into split-board binding structures, and covered in full calf. The simple blind-tooled design of the new bindings was based upon on a contemporary full-calf binding from the Rubenstein Library collection; its text was printed in Heidelberg in 1598. All three De Bry volumes were housed in individual cloth-covered clamshell enclosures along with their previous bindings.

During the course of treatment, these three items were digitized in their entirety. It was a project that curators had considered for some time, and because the items could be more quickly and easily scanned while disbound, the imaging was performed at that stage in the treatment.

OUTREACH

Serendipitously, during the course of treating these items, DUL exhibits coordinator and conservator Meg Brown learned about an upcoming symposium commemorating the publication of the latest issue of the *Journal of Medieval and Early Modern Studies*, which is published by Duke University Press. The issue happened to be dedicated to studies of the De Brys's works. The organizers wanted to use images from the Rubenstein Library's copies for the production of their journal, and they hoped to have the originals on display for their symposium, to be held in Rubenstein's Biddle Rare Book Room. Meg Brown saw an opportunity for outreach. She told the organizers that DUL conservators had been treating these items and suggested that the treatment process might be of interest to the symposium attendees. As a result, this author was invited to share the treatment of the De Bry volumes at the symposium.

The symposium brought together international scholars with research interests ranging from native dress and costume to depictions of cannibalism in the Americas. Although these volumes are often pulled for classes and library "show-and-tell" talks, Rubenstein staff speculated that many of the visiting researchers were likely accustomed to relying on reprints for their research. With this talk, there was an opportunity to connect the audience with the printed originals in a tangible way.

The author's presentation at the symposium minimized technical jargon and focused on the elements of the treatments likely to be most relevant to the audience at hand. An introduction to the field of conservation—including the common aims of treatment and the principles of reversibility, preservation of original material, and documentation—was presented to help orient the symposium attendees. Interactive elements—including videos of washing paper and of a lining removal from the De Bry treatments—were also added to the talk to engage the audience. The process of digitizing the works was described, and their availability online was publicized. Finally, feedback about the repairs was invited, and the audience was asked, "How might these repairs impact your research as well as your research experience?"

Following the presentation, there was a lively conversation about decision-making and the different perspectives and roles of the curators and conservators in treatment-proposal meetings. There was also a more in-depth discussion about some of the features of Rubenstein's copies. One visitor confirmed that the overhanging plates in the Florida and Virginia volumes most likely originated from other copies, and possibly later editions, which explained why the plates weren't registering with one another.

One intended goal of the talk was to demonstrate how much intellectual work and scholarship are involved in making conservation treatment decisions and how conservation work can influence and inform scholarship more broadly. It was also important to communicate that in this field, as in the DUL conservation laboratory, the aim is for conservation treatment decisions to be transparent, collaborative, and undertaken with public input.

In addition to the collaborations already mentioned between curators and conservators inside and outside the library, a couple of other events on campus took inspiration from the De Bry treatments. In fall 2010, Mary Yordy from the Conservation Services Department developed an exhibit for the DUL preservation exhibit case. The exhibit, *Mixed Blood: Conservation Work and Decision-Making in Support of the Study of Racial History*, featured digitized images from the Virginia volume. Additionally, Stephen Hoffman—a visiting artist in the Department of Art, Art History and Visual Studies—was inspired by the De Bry works when he toured the conservation laboratory in spring 2011. He decided to use some De Bry imagery in his screen-printed installation, which is still on view in the library.

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REFERENCES

Benzoni, G. 1572. *La historia del Mondo Nuovo*. Venetia: [Appresso gli heredi di G. M. Bonelli] ad instantia di P. & F. Tini.

Van Groesen, M. 2008. The De Bry Collection of Voyages (1590-1634): Early America reconsidered. *Journal of Early Modern History* 12(1): 1–24.

——. 2012. *Representations of the overseas world in the De Bry collection of voyages*. Leiden: Brill.

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Study on the Influence of Gunpowder Residues Found in Paper-Based Materials

INTRODUCTION

The use of gunpowder has become a new method of artistic expression since around the 1950s. The application of gunpowder in art began as artists explored new possibilities outside the boundaries of traditional art forms and materials. Since the aging speed and deterioration mechanisms of gunpowder are complex by nature, the safekeeping of such artworks has posed a new challenge to the field of art conservation. As there has been an increase in the number of gunpowder artworks, it is important to establish a better understanding of gunpowder and its use as an artistic medium, and to develop a proper standard for the preservation and conservation of such artworks. With this in mind, this project uses materials science to analyze gunpowder as a contemporary art medium and hopes to provide a starting point for the study of gunpowder-art conservation, which will assist museums and collectors in the better preservation of their gunpowder art collections.

The focus of this paper is on gunpowder artwork and its related derivative materials. Because of the uncontrollable nature of gunpowder, it was not possible to control the surface condition of each paper sample created. In order to compensate for this and reduce possible error in the result, 11 samples were used in each experiment group. Each sample was measured 11 times using a color spectrophotometer, and the average color difference value was calculated.

Through literature collection, sample creation, accelerated-aging experiments, analysis and diagnosis of the experiment samples, the goal of this project is to evaluate and understand the deterioration mechanisms and effects of gunpowder residue on paper, providing references for future studies.

Presented at the Book and Paper Group Session, AIC's 40th Annual Meeting, May 8–11, 2012, Albuquerque, New Mexico.

GUNPOWDER AND ART

In the past, artists used mostly paints and canvases, but contemporary art is often multimedia, and artists are expressing their ideas through many nontraditional materials. Compared to traditional art media, gunpowder is a completely new material, and gunpowder art can be both physical and conceptual. Some contemporary artists use specific sites where explosions happened or land burned to create conceptual art pieces referring to ideas such as violence, military crises, and conflicts in a metaphorical manner. However, in Asian cultures the use of firecrackers implies the dispelling of misfortune and represents people's hope for peace and unity. Conceptual works like these can use gunpowder indirectly, by recording the loud sound of an explosion on tape or capturing the moment of explosion with video or photography. Many artists also use gunpowder directly, as a physical medium, applying it onto paper and canvases to create drawings. This project focuses on the latter kind of gunpowder art, in which gunpowder is used physically in the creation of an artwork.

LEADING GUNPOWDER ARTISTS

1. *Edward Ruscha:* Ruscha is an American pop artist who began a series of new-media artworks in the 1970s, incorporated nontraditional materials such as gunpowder, blood, fruit and vegetable juices, lubricating oils, grass extracts, etc. His gunpowder mixture consisted of saltpeter, sulfur, and charcoal, and had a unique, rough texture that he used to imply ideas of violence and war. Using this gunpowder, Ruscha made elegant drawings of words, creating a powerful contrast between the physical material and the visual imagery.
2. *Matthew Stromberg*: Stromberg, a professor at Savannah College of Art and Design in Georgia, began his exploration of gunpowder in art in 2007. His work incorporates different types of gunpowder on cardboard or thick watercolor paper.

3. *Aoife van Linden Tol*: Van Linden Tol is an Irish artist who received professional training in explosives through the International School for Security and Explosives Education. In recent years, her solo exhibitions in Berlin and London explored the themes of nature, violence, and time. Her work utilizes chemical and physical reactions of powerful explosives to express the intense experiences of pain and love. Her application of explosives is not limited to paper and canvases; she has also utilized three-dimensional objects such as books, metal objects, photographs and other ready-made objects.
4. *Robert Weibel*: An American contemporary artist and printmaker, Weibel has focused on public art projects and paper-based gunpowder drawings in his recent works. Metals and plastics are sometimes used in his work to enhance the definition of drawings.
5. *Rosemarie Fiore*: A New York–based contemporary artist who has been working on a series of firework drawings since 2005, Fiore makes her work by exploding and containing different types of fireworks, including colored smoke bombs, jumping jacks, monster balls, fountains, magic whips, spinning carnations, ground blooms, rings of fire, and lasers on a large piece of white paper, creating "bursts of saturated color that are overlapped and collaged" into a final piece (Fiore 2000–2011). Due to the need for multiple explosions and collaging, her works are often heavy and thick.
6. *Cai Guo-Qiang*: Cai is a Chinese contemporary artist who became internationally known through his explosive art in the 1990s. Recently named by the *New York Times* as the world's most highly valued Asian artist (Pomfret 2008), Cai is famous for his gunpowder drawings, explosion sketches, and video recordings of his large-scale installation works. Cai uses gunpowder in two ways: gunpowder drawings and large-scale explosive installations.

Many contemporary artists make new works constantly using gunpowder as their primary medium. Gunpowder is a new type of art medium that still needs experimentation and development, and the new types of artwork it produces are posing an important test for the knowledge and techniques of contemporary archival practices. It is crucial to establish sound preservation and conservation standards based on the materials science of gunpowder. By conducting accelerated-aging experiments and analyzing the deterioration of gunpowder-based artworks, this project hopes to provide further understanding of the characteristics of gunpowder and to assist in extending the life of these kinds of artworks.

THE EFFECTS OF GUNPOWDER RESIDUES ON PAPER IN ACCELERATED-AGING TESTS: EXPERIMENTAL METHODS

The effects of gunpowder residues on paper were simulated in accelerated-aging tests. The test samples were then analyzed using automated color measurements, pH tests, and infrared spectroscopy tests. Because gunpowder is still a fairly new medium in art, there is no available reference data that can be compared with the results of this experiment.

In this experiment, gunpowder was ignited on three different types of paper materials: Toyo filter paper, handmade paper, and Canson sketch paper. The resulting paper samples were separated by their surface conditions into two different groups: those with powder residue only and those with powder residue and burn marks. These samples were then subjected to accelerated-aging tests, and the test results were compared to a control group of plain samples with no gunpowder residues.

Fig. 1. Paper sheets after the gunpowder has exploded, before cutting

Fig. 2. Cutting paper samples

Sample Creation

The gunpowder used in this experiment consisted of 75% potassium nitrate, 15% carbon (charcoal), and 10% sulfur powder (all extra-pure reagents), filtered and mixed. A fuse was placed on a large sheet of sample paper to which gunpowder was applied. A piece of wooden board was then placed on top of the paper and lightly pressed to keep the paper in place and contain the explosion while still allowing enough air to circulate. The fuse was then ignited. The paper was burned and became brittle after the explosion, with multiple holes (fig. 1).

In order to obtain samples without any holes, samples were trimmed from the sheet in the smallest possible size. Each sample needed to be bigger than the aperture of the automated spectrophotometer (1.2 cm) and to have enough space around it for safe handling (an additional 0.9 cm). For this reason, each circular sample was 3 cm in diameter (fig. 2).

Sample Quantity

Because of the uncontrollable nature of gunpowder, it was hard to manage the explosions and unify the surface condition of all paper samples created. Therefore, a large quantity of samples was created and used in the experiment in order to ensure the accuracy of the result. The experiment involved three types of paper, three different levels of damage caused by the gunpowder, and three types of accelerated-aging tests. Eleven samples were used in each of the 27 test groups, resulting in a total of 297 samples for testing and examination.

Accelerated-Aging Tests

Three different accelerated-aging tests were carried out in this experiment, each according to established Chinese National Standards (CNS). The dry-heat aging test was carried out in accordance with CNS 12886, "Test Method for Accelerated Aging of Paper and Paperboard: Dry-Heat Treatment at 105°C." For the light-and-heat aging test, a UVA 340 μm lamp was used and samples were exposed to ultraviolet light with an intensity of 0.89 W/m^2 at 60°C (fig. 3). CNS 12887-1, "Test Method for Accelerated Aging of Paper and Paperboard: Wet Heat at 60°C and 65% Relative Humidity" was used for the wet-heat aging test. While the test temperature was kept at 60°C, the relative humidity was adjusted to 80% in this experiment in order to simulate the hot and humid climate of Taiwan (fig. 4). Paper samples were aged under these conditions for 0, 36, 96, 120, 240, 480, and 600 hours.

Color Differences and Blackness

The color of each sample was measured before and after the accelerated-aging tests using the automated color spectrophotometer and CIE L*a*b* color parameters, which were developed by the Commission Internationale de l'Eclairage (CIE) in 1976. The aperture of the color spectrophotometer used was 0.375 in. Each sample was measured 11 times, and the average value was calculated. The following tables summarize the definition of L*a*b* color coordinates (table 1) and the color difference values corresponding to human perception (table 2).

The L*a*b* values were also used to calculate the blackness values of samples. The color of a black paper cannot be represented with a single L* value like the color of a white paper. Therefore, the blackness value of the paper was represented using the method suggested by Lan, Zhi, and Ming (1998), who used the formula $BL^* = L^* + |a^*| + |b^*|$ to calculate the blackness value (BL^*) of paper.

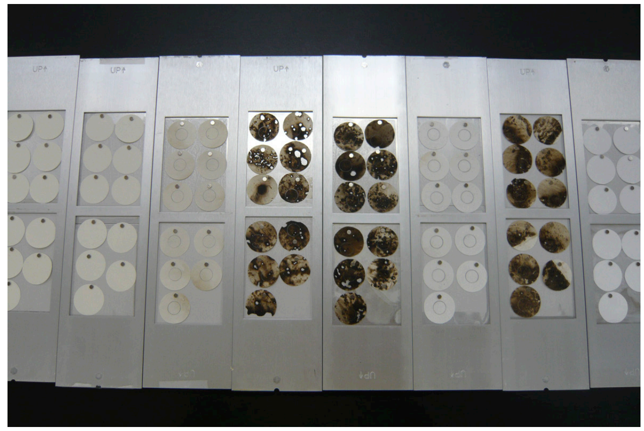

Fig. 3. Light-heat aging test

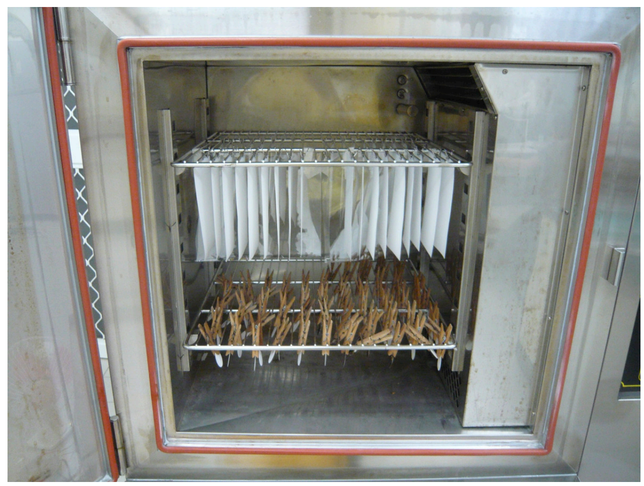

Fig. 4. Wet-heat aging test

pH

The pH value of paper indicates its acidity, but pH is determined by the concentration of hydrogen ions in a solution. Precisely speaking, pH cannot be measured for paper since it is a solid and not a liquid. Therefore, when pH values are used to indicate the acidity of papers, the pH value actually indicates the acidity of the solution in which the paper was soaked.

Coordinates	Definitions	Meaning in the Change of Values
L*	light-dark value	ΔL* = (L*′ – L*); L* = 0–100 +L = more light, –L = more dark
a*	red-green value	Δa* = (a*′ – a*); a* = –1 to +1 +a = more red, –a = more green
b*	yellow-blue value	Δb* = (b*′ – b*) b* = –1 to +1 +b = more yellow, –b = more blue
ΔE*	color difference	$\Delta E^* = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{½}$ The larger the ΔE* value, the larger the color difference.
L*, a*, b* = Values **before** the accelerated-aging test **L*′, a*′, b*′** = Values **after** the accelerated-aging test		

Table 1: L*a*b* Coordinates and Their Meanings

Color Difference Values (ΔE*)	**0–0.5**	**0.5–1.5**	**1.5-3.0**	**3.0-6.0**	**6.0-12.0**	**12.0+**
Human Perception	Very little difference	Minor difference	Visibly different	Different	Huge difference	Totally different

Table 2: Color Difference Values and Human Perception

Acidity is one of the most important factors affecting the longevity of a paper. Due to the presence of hydrogen ions, hydrolysis and oxidation reactions can occur more readily in the cellulose and hemicellulose of acidic papers, degrading the sturdiness of the paper. This kind of deterioration is more severe in acidic papers with lower pH. However, when a paper has a very high pH and is extremely basic, its longevity is not enhanced because the speed of oxidative degradation becomes faster for cellulose in a highly basic environment. Therefore, neither strong acidity nor strong basicity is desirable for the preservation of paper materials. In the case of artworks using gunpowder (a basic medium), papers should not become overly basic.

Three levels of gunpowder damage were created on three different types of papers, which were then aged in wet-heat, dry-heat, and light-and-heat conditions for 600 hours. There were also nine groups of control samples used for comparison before and after accelerated aging, resulting in 36 groups of samples for pH testing. The cold-extraction method described in TAPPI T509 om-96 was used to test the pH value of the samples (TAPPI 1996). A cold-extraction method was used because the hot-water extraction method can cause the decomposition of water molecules, which may affect the acidity of the resulting solution. Paper samples were cut into small pieces and soaked in distilled water. A HANNA Instruments HI 8424 Microcomputer pH meter was used to test the pH of the solution.

Infrared Spectroscopy

FTIR with attenuated total reflectance (ATR-FTIR) was used in this experiment for infrared spectroscopic analysis. This technique utilizes the infrared-absorbing characteristics of certain functional groups within molecules to examine chemical compounds and the construction of sample surfaces.

Paper samples from before and after the accelerated-aging tests were placed on the test platform and exposed to the infrared light. After samples had absorbed the infrared light energy, Fourier transform was used to convert the raw data into a full spectrum.

X-Ray Fluorescence Spectrometry

A Seiko Instruments Inc. SEA200 Mobile Element Monitor (Field-X) was used for the XRF analysis of the paper samples (fig. 5). XRF can be used to detect elements with

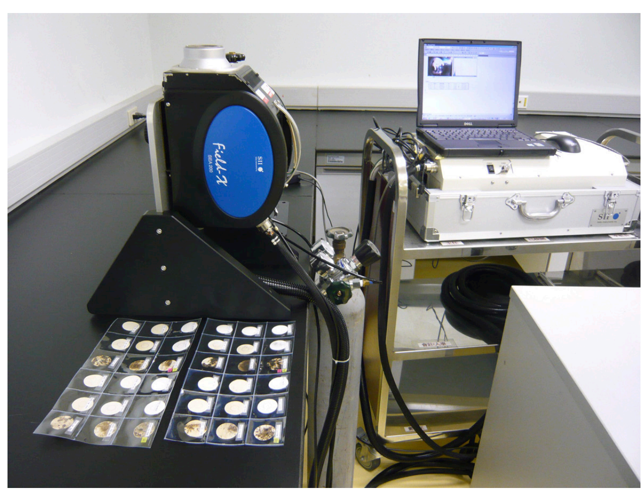

Fig. 5. Samples undergoing XRF analysis

atomic numbers larger than 12 for qualitative and quantitative analysis. Because the molecular mass of the elements detected in this experiment was expected to be small, helium gas was introduced to minimize the noise in the results.

The XRF analysis was carried out on three types of paper samples with three different levels of gunpowder residues before and after each wet-heat, dry-heat, and light-and-heat accelerated-aging test. Results were compared to the samples from the control group before and after accelerated aging.

ACCELERATED-AGING TESTS: RESULTS AND ANALYSIS

Color Difference Analysis

Based on the average color measurements taken before and after the accelerated-aging tests, the ΔE* and ΔL* values of samples from the group with more gunpowder residues and burn marks after the explosion were clearly higher than the ΔE* and ΔL* values of the other sample groups (i.e., the samples with burn marks became lighter). This result was consistent in all three types of accelerated aging tests (figs. 6–8). A possible cause might be that the gunpowder residue on the paper samples fell off during the accelerated-aging tests, resulting in increased lightness. As for the color change of the samples, the ΔE* value of the sample group with gunpowder residue was relatively close to that of the control group, even though there were still differences between different types of papers.

The three types of paper used in this experiment contained different amounts of lignin as well. According to the lignin-detection test, the filter paper was lignin free, the handmade paper contained some lignin, and the sketch paper contained the most lignin. After accelerated aging, color changes in the handmade paper and sketch paper were similar, but the sketch paper, with its higher lignin content, showed more prominent color change and therefore a higher ΔE* value in the light-and-heat aging test than in the wet-heat and dry-heat aging tests (fig. 8). The main cause of this color difference was the photo-oxidation of lignin inside the cell walls of paper fibers—a chain of radical reactions that happens when the photosensitive groups of lignin, such as its α-carbonyl group, absorb ultraviolet light and produce chromophores. Paper samples with lignin content also showed higher ΔE* values than lignin-free paper samples after accelerated aging. In terms of yellowing, the sample groups with burn marks showed higher Δb* values, and samples with higher lignin content had more severe yellowing compared to lignin-free samples.

Blackness Value Analysis

The blackness value was calculated from the L*a*b* values measured before and after the accelerated-aging tests using the color spectrophotometer. The blackness value was

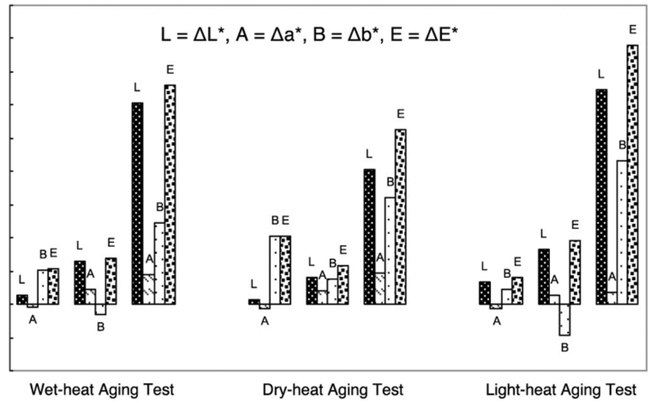

Fig. 6. Comparison of color changes in filter paper samples with gunpowder after accelerated aging (In each accelerated-aging test, levels of gunpowder damage are shown from left to right as none, powder residue, and residue with burn marks.)

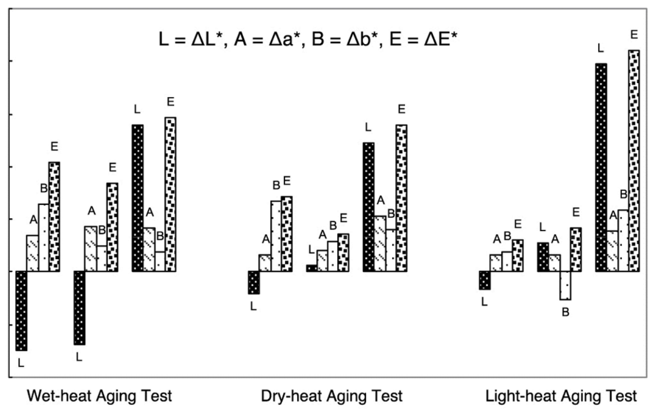

Fig. 7. Comparison of color changes in handmade paper samples with gunpowder after accelerated aging (In each accelerated-aging test, levels of gunpowder damage are shown from left to right as none, powder residue, and residue with burn marks.)

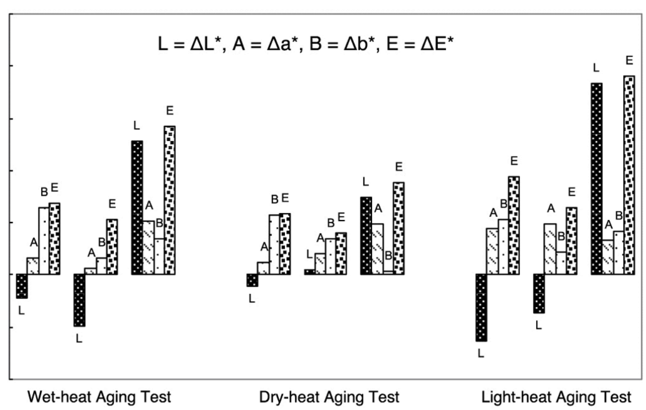

Fig. 8. Comparison of color changes in Canson sketch paper samples with gunpowder after accelerated aging (In each accelerated-aging test, levels of gunpowder damage are shown from left to right as none, powder residue, and residue with burn marks.)

calculated using the formula BL★ = L★ + |a★| + |b★|. The lower the calculated BL★ value, the darker the sample. This value was used to observe the change in the darkness of samples with burn marks. Blackness values of samples with burn marks over the 600 hours of accelerated-aging tests showed that there were no obvious differences in the blackness of Toyo filter paper samples after wet-heat, dry-heat, and light-and-heat aging. The blackness value was a little higher (i.e., the samples became lighter) only after the light-and-heat aging test. Handmade paper samples showed a more obvious increase in the blackness value after the light-and-heat aging test compared to the wet-heat and dry-heat aging tests, and the same was observed for Canson sketch paper samples.

pH Analysis

Figure 9 shows the overall decrease in the pH of the samples after 600 hours of accelerated aging. The pH values at 0 hours into the accelerated-aging tests were higher than the values at 600 hours in all three accelerated-aging tests. Although the pH values became lower after aging, the papers used in this experiment were all basic to begin with, so the pH of samples with gunpowder residues mainly fell in the range of neutral to basic after aging.

In the group of aged samples, the samples with burn marks had higher pH values compared to the others, probably due to the higher amount of gunpowder residue. From the resulting graph, it is possible to see that burnt samples have higher pH values than samples with only powder residue, which have higher pH values than samples without any gunpowder residue.

Infrared Spectrometry Analysis

Figures 10–11 display the ATR-FTIR absorption spectra for the experimental samples, and table 3 summarizes the codes used to represent the sample groups in the spectra.

Figure 10 shows that other than Canson sketch paper, which has a more prominent peak at 878 cm^{-1}, all three types of papers have relatively similar functional groups. Figure 11 contains the spectra for burnt samples of the same papers. In comparison with figure 10, additional peaks are found at 1374 cm^{-1} and 1113 cm^{-1} for A3; at 1377 cm^{-1} and 1110 cm^{-1} for A6; and at 1402 cm^{-1} and 1112 cm^{-1} for A9. These two peaks suggest the presence of potassium sulfate and potassium nitrate (figs. 12, 13).[2]

A comparison of the peaks for the control groups (figs. 14, 16, 18) shows that the peaks were all the same before and after the aging tests, and that no new functional groups appeared in the control samples. As can be seen in figures 15, 17, and 19, no significant changes were observed after aging in samples with powder residues, either. Comparing control samples and samples with gunpowder residues (figs. 14–19) also shows that their absorption peaks were the same, which means that gunpowder residue has little or no effect on the organic components of paper samples.

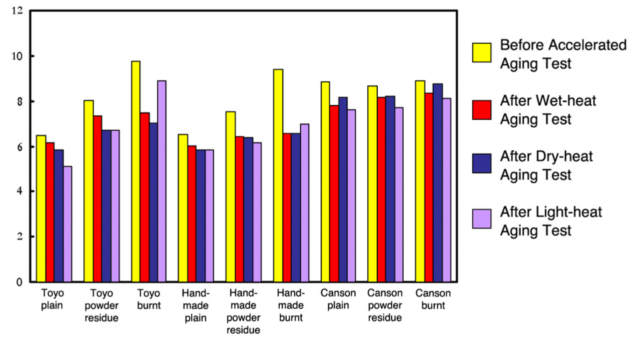

Fig. 9. Comparison of the pH value of nine sample groups

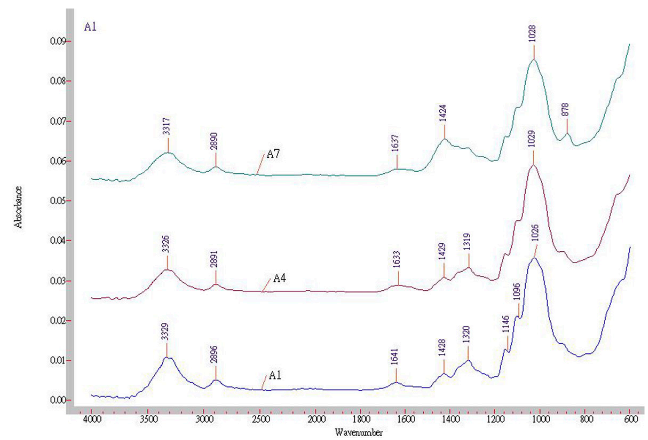

Fig. 10. Control group of filter paper (A1), handmade paper (A4), and Canson sketch paper (A7) before aging

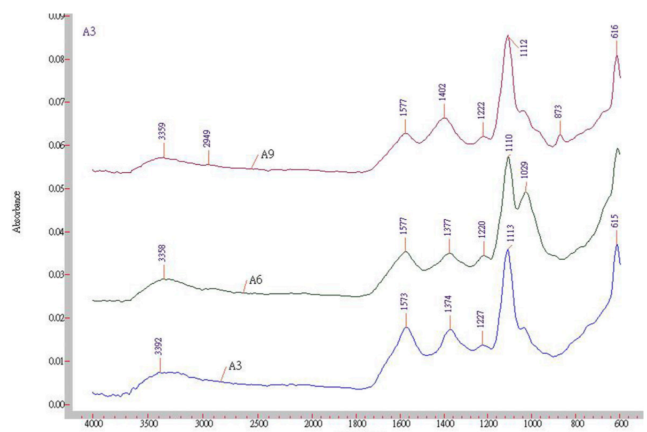

Fig. 11. Burnt group of filter paper (A3), handmade paper (A6), and Canson sketch paper (A9) before aging

Figures 20–23 show the change in absorption peaks for the three different burnt paper samples after aging. There are noticeable peaks at 1022 cm^{-1} for B1, at 1025 cm^{-1} for B6, and at 1032 cm^{-1} for B9 after wet-heat aging (fig. 21); at 1030 cm^{-1} for

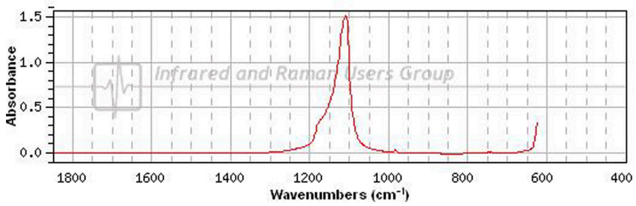

Fig. 12. IMP00167 Potassium Sulfate, Cargille, #5-A, PMA, trans. Courtesy of Infrared and Raman Users Group (IRUG), www.irug.org.

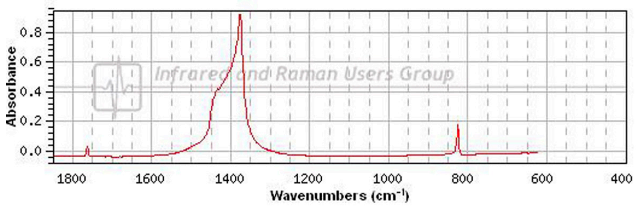

Fig. 13. IMP00168 Potassium nitrate, Cargille, #5-B, PMA, trans. Courtesy of Infrared and Raman Users Group (IRUG), www.irug.org

C6 and at 1029 cm^{-1} for C9 after dry-heat aging (fig. 22); and at 1028 cm^{-1} for D6 after light-and-heat aging (fig. 23). These absorption peaks are very similar to the absorption peaks of the control groups (figs. 14, 16, 18). A possible explanation for this is that the gunpowder residues deteriorated and disappeared after the long period of accelerated aging, causing the absorption peaks of the original base paper to appear again.

While there is a small potassium nitrate peak present in the spectrum for the Toyo filter paper (B3) after wet-heat aging (fig. 21), peaks for both potassium nitrate and potassium sulfate disappeared from other sample groups after the same aging test. After dry-heat aging, on the other hand, the spectra for all of the samples except the Toyo filter paper (C3) showed peaks for both potassium nitrate and potassium sulfate (fig. 22). Absorption peaks for potassium nitrate and potassium sulfate are present in the spectra for all sample groups after light-and-heat aging (fig. 23).

XRF Analysis

XRF results show that the signals for sulfur and potassium in counts per second (cps) were stronger in samples before accelerated aging than after aging. The burnt samples also had stronger signals compared to the control samples and samples with only powder residues, and the strength of the sulfur and potassium signals was proportional to the amount of gunpowder residue. The results after three types of accelerated-aging tests show that sulfur and potassium have stronger cps signal values in the light-and-heat aged samples than in the wet-heat and dry-heat aged samples. In other words, sulfur and potassium have lower sensitivity to light than to other aging factors in this experiment.

RESULTS AND CONCLUSIONS

Materials science has always played an essential role in the field of collections preservation and restoration because the properties of materials themselves can affect the preservation and life expectancy of artworks. Gunpowder as a creative medium is still in its experimental stages, and conservation science still has a limited understanding of its physical and chemical characteristics when used in works of art. Until now, no scholarly papers have been published on the physical and chemical properties of gunpowder in the context of its use as an art medium. This is the first research paper published, either in Taiwan or internationally, on the scientific analysis of gunpowder as an art medium and its effect on papers, in order to establish a preliminary understanding of gunpowder's impact on paper materials.

According to the test results from this experiment, the color difference values obtained from samples with large amounts of gunpowder residue were much larger compared to values obtained from samples with little or no gunpowder residue. This result was consistent in all tests, regardless of which paper type or which accelerated-aging test was used. Therefore, without analyzing what caused the color change in the sample, it is evident that the more gunpowder residue a sample has, the bigger its color difference value will be. Samples with higher color difference values also have a greater increase in their L* (light/dark) values compared to their a* and b* values. Based on preliminary deduction, the main cause for this color change in samples is probably the deterioration or detachment of gunpowder residue from the paper samples. This also means that it is important to ensure the stable adherence of gunpowder to the base material when preserving samples with large amounts of gunpowder residue.

The results of pH testing clearly show that aged samples with gunpowder residue have higher concentrations of hydroxide ions in their test solutions compared to the test solutions of aged control samples without gunpowder residue. The overall pH of samples after accelerated aging was in the range of 7–9. The main reason for this is that the main components of gunpowder are all basic. However, this does not prove that paper containing gunpowder will be preserved better, because there was still a substantial decrease in pH after accelerated aging. It is not possible to determine or hypothesize whether this decrease in pH was caused by the deterioration of the gunpowder itself, the deterioration of the paper, or the interaction between the gunpowder and the paper during accelerated aging. The cause of the pH shifts still requires further investigation.

The medium used in this experiment contains a mixture of substances. ATR-FTIR was used in order to further understand the changes in the samples' composition after accelerated aging. Since the FTIR spectra of the control groups showed no obvious changes after accelerated aging,

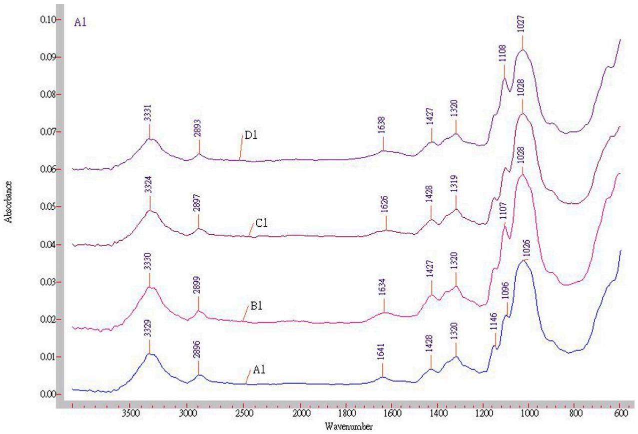

Fig. 14. Toyo filter paper control group (no residue) before and after aging

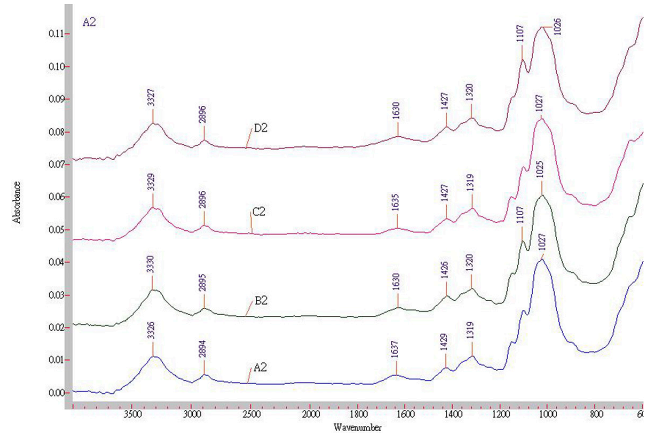

Fig. 15. Toyo filter paper with powder residue before and after aging

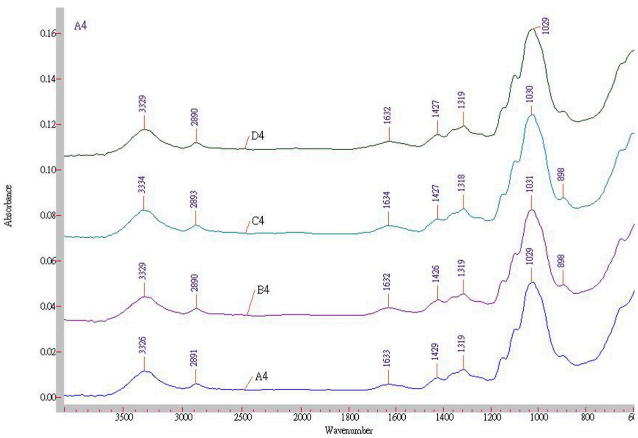

Fig. 16. Handmade paper control group (no residue) before and after aging

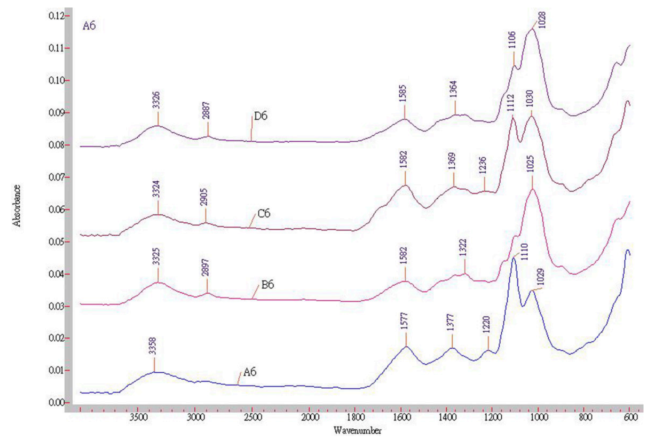

Fig. 17. Handmade paper with powder residue before and after aging

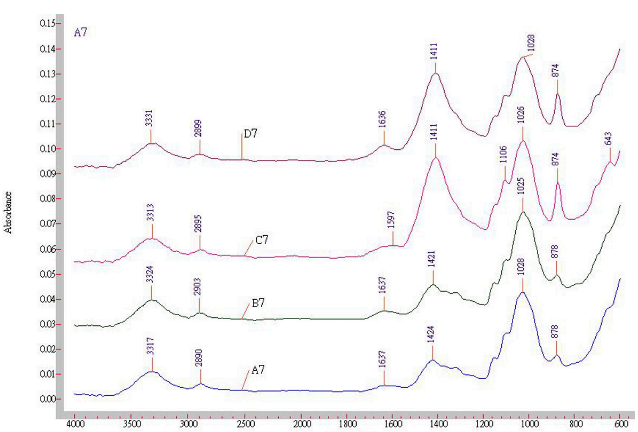

Fig. 18. Canson sketch paper control group (no residue) before and after aging

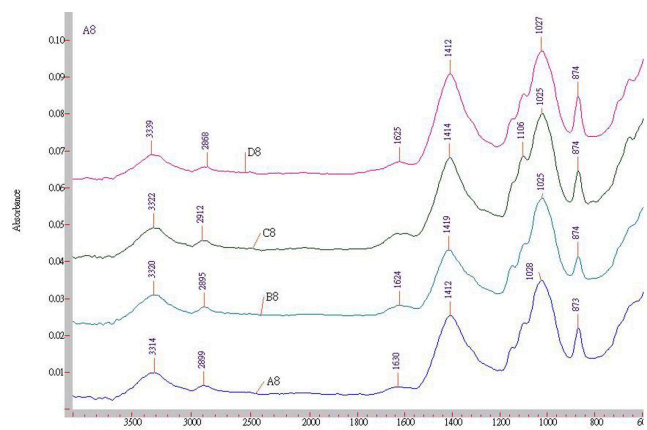

Fig. 19. Canson sketch paper with powder residue before and after aging

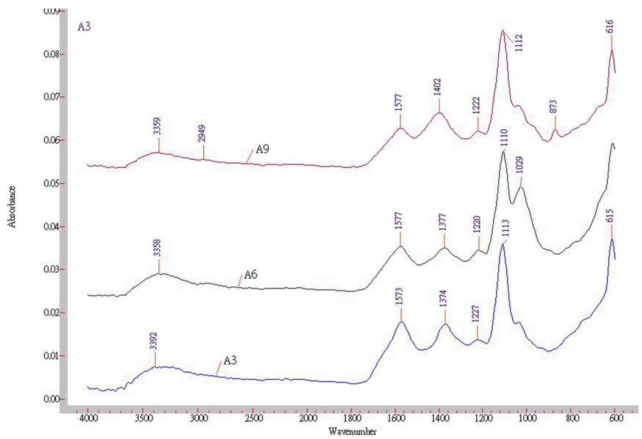

Fig. 20. Samples with burn marks before aging

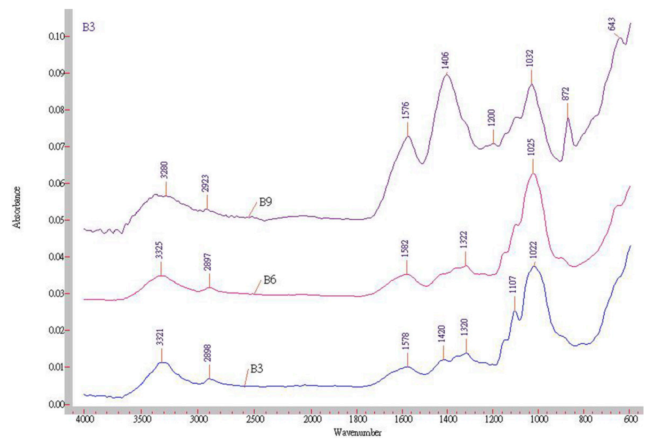

Fig. 21. Samples with burn marks after 600 hours of wet-heat aging

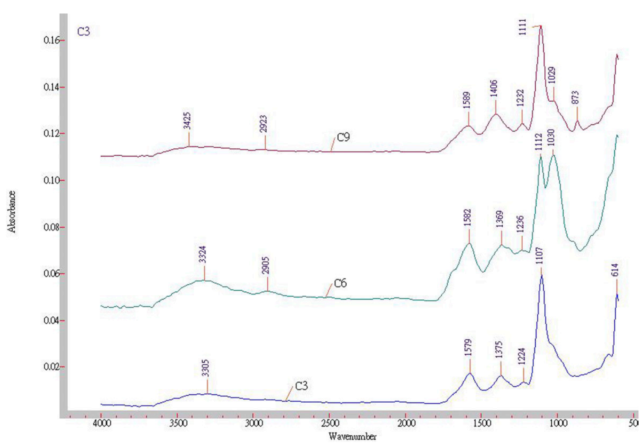

Fig. 22. Samples with burn marks after 600 hours of dry-heat aging

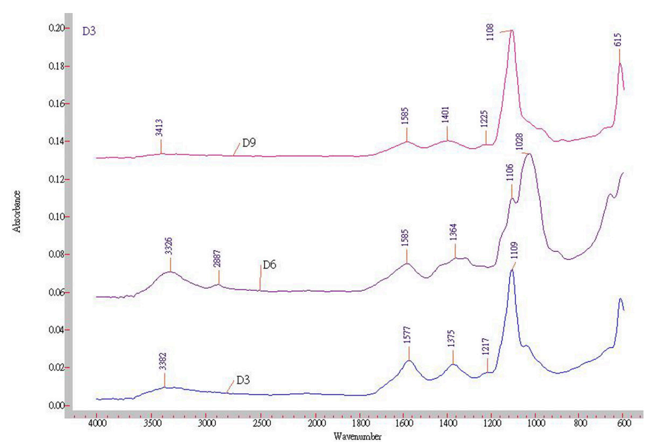

Fig. 23. Samples with burn marks after 600 hours of light-and-heat aging

Gunpowder Damage	Toyo Filter Paper	Handmade Paper	Canson Sketch Paper
A: Control Groups Before Accelerated Aging			
None	**A1**	**A4**	**A7**
Powder Residues	**A2**	**A5**	**A8**
Burnt	**A3**	**A6**	**A9**
B: Sample Groups After 600 Hours of Wet-Heat Aging			
None	**B1**	**B4**	**B7**
Powder Residues	**B2**	**B5**	**B8**
Burnt	**B3**	**B6**	**B9**
C: Sample Groups After 600 Hours of Dry-Heat Aging			
None	**C1**	**C4**	**C7**
Powder Residues	**C2**	**C5**	**C8**
Burnt	**C3**	**C6**	**C9**
D: Sample Groups After 600 Hours of Light-and-Heat Aging			
None	**D1**	**D4**	**D7**
Powder Residues	**D2**	**D5**	**D8**
Burnt	**D3**	**D6**	**D9**

Table 3: Codes Representing Sample Groups in the Infrared Spectra

the differences between the spectra for the control groups and the sample groups with large amounts of gunpowder residue after accelerated aging were probably caused by the change of functional groups in gunpowder.

There were two prominent absorption peaks that appeared in the spectra of samples with gunpowder residues. The characteristics of these two peaks show that the new substances are potassium nitrate and potassium sulfate. Their peaks disappeared or became significantly weaker after accelerated aging. Possibly these two substances degraded or fell off the samples during accelerated aging, causing their absorption peaks to become weak. The absorption peaks for functional groups characteristic of the original paper samples also became more visible in the IR spectra after accelerated aging. From this, it is concluded that there was no apparent interaction between the gunpowder and the paper during the accelerated-aging tests, and that no new substances were produced after the aging process.

Based on this analysis and the results of the aging tests performed on samples containing gunpowder, the deterioration most likely to occur in this kind of artwork is the degradation and detachment of the gunpowder residue. Therefore, finding a way to ensure the stable adherence of gunpowder to its base material is urgently required for the preservation of this kind of contemporary artwork.

Suggestions for the Current State of Gunpowder Art Collections

1. *Collect Information*: Institutions cannot avoid collecting contemporary, new-media artworks. In the case of gunpowder artworks, there are many different kinds of gunpowder used, and when different kinds of gunpowder come in contact with paper materials, the interactions that may take place are not always the same. Differences in these artworks and their characteristics must be taken into consideration when acquiring gunpowder artworks. Aside from the standard acquisition process of registration, cataloguing, and photographic documentation, it is important to keep a detailed, descriptive record of each piece. Only through a complete and coherent database on gunpowder art collections can conservators further investigate the proper ways to preserve gunpowder artworks.
2. *Exchange Information and Opinions:* A gap sometimes appears between artists and conservators in terms of their understanding and opinion of collection and preservation procedures, but this gap can be overcome by active communication. When artists are reluctant to share everything about their works, it often leads not only to improper advice, poor choices, and ineffective treatments where the preservation of artworks is concerned, but also creates waste of both human and monetary resources. Therefore, the work of conservators is not limited to the preservation of artworks anymore. In order to make artists willingly share information about their work, conservators should establish a trusting relationship with artists, which will require not only good communication skills but also sincere attitudes and a genuine interest in the public welfare, which should convince artists to trust and open up to them.
3. *Develop Technology:* The results of materials-science research can affect the significance and integrity of artworks. Many new art media still require further analysis and examination using professional scientific devices and technologies, and the success of this process relies on effective communication and cooperation between researchers and conservators.
4. *Be Aware of Possible Deterioration:* This experiment revealed that the type of deterioration most likely to occur in gunpowder artwork over the short term is the detachment of gunpowder residue from the base material. Therefore, the foremost problem to consider is how to keep the gunpowder stably affixed to the artwork. Since gunpowder and explosives alike can contain hazardous substances such as potassium sulfate and potassium nitrate, which may contaminate the storage environment, it is also important to take into consideration how these substances may interact with other artworks before stabilization. However, as mentioned before, there are many different types of gunpowder artworks, and institutions should discuss them with their researchers and conservators and come to a consensus decision regarding their storage and conservation.

Proposals For Further Research

The road to gunpowder art preservation is long and complicated. In this project, accelerated aging lasted up to 600 hours, but further research should be done using longer aging periods to examine the deterioration conditions. This research focused only on gunpowder (black powder), but there are also other types of explosives that still require research and analysis.

It was discovered through this experiment that the first step in preserving gunpowder artworks of this type is the stabilization of gunpowder, and how to stabilize the gunpowder without changing its physical texture would be another subject worth further exploration. How to physically store these types of works, especially when their sizes are big, is another subject for research. Though little research has been done on the preservation of gunpowder art to date, as the amount of this kind of work increases, it will inevitably be a valuable subject for discussion in the future.

Aside from focusing on gunpowder arts, this paper hopes to raise collecting institutions' and conservation organizations' awareness of the difficult problems associated with preserving contemporary artworks, and to prompt further research in related areas. Much hard work is still required to preserve the metamorphic and vibrant nature of contemporary artworks. For the well-being of collections in Taiwan and elsewhere, an improved understanding of the preservation needs of contemporary art cannot come too soon.

REFERENCES

Fiore, R. 2000–2011. Firework drawings. www.rosemariefiore .com/firework-drawings-archive (accessed 07/18/12).

Lan S. G., Zhi M. S., and Ming H. D. 1988. 以BL*值表示黑紙之顏色 (Representing the color of black paper using BL* values). *Forest Products Industries*.

Pomfret, J. 2008. With stocks in turmoil, Asian art draws buyers. *New York Times*, February 3. www.nytimes .com/2008/02/03 /business/worldbusiness/03iht-rtrinvest04.1.9693776.html (accessed 07/18/2012).

TAPPI. 1996. Hydrogen ion concentration (pH) of paper extracts (cold extraction method), TAPPI T509 om-96. Atlanta: Technical Association of the Pulp and Paper Industry.

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Deceptive Covers:
Armenian Bindings on 18th Century Imprints from Constantinople

ABSTRACT

Armenian medieval manuscript bindings and book structures have been well described and understood, unlike later bookmaking by the Armenian diaspora communities around the Mediterranean in the early modern period. Historians of the book or book arts have used external decorative features, such as the tooling, to locate the craftsmen creating the bindings. Thus it has been suggested that Armenian books printed in Constantinople in the 18th century may have been transported to Europe through commercial routes to be bound. However, early printed Armenian books in the Library of Congress's collection show that the underlying structure of the bindings is based on medieval Armenian manuscript book making, while decorative features have a European aesthetic, implying that they were bound locally by Armenians. Using the findings of two surveys related to bindings on early printed Armenian books from Constantinople in the Library of Congress collection in Washington, D.C., and the Mesrop Mashtots Institute in Yerevan, respectively, the authors will discuss the evolution of Armenian binding. Changes in style, structure, and craftsmanship of bindings on Armenian books printed in Constantinople in the 18th century will be located within changes in the aesthetics and identity of the local Armenian community, and their commercial relationships with other Armenian diaspora communities in Europe.

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NINA QUABECK

Change the Frame and You Change the Game? Research and Reevaluation of the Presentation Formats of the Kunstsammlung Nordrhein-Westfalen's Paul Klee Collection

INTRODUCTION

Knowledge of the presentation formats originally devised by Paul Klee is crucial to a more complete understanding of his works. The artist's very specific ideas about presentation become obvious when one studies the original frames of paintings and the secondary supports of works on paper. However, the simplicity of Klee's style in mounting and framing often led dealers or previous owners to intervene, changing the frame or even altering original mounts. The study documented in this paper was done in conjunction with the exhibition *100 x Klee,* which opened in September 2012 at the Kunstsammlung Nordrhein-Westfalen in Düsseldorf. The preparations for that exhibition, which focuses on the history of the museum's Klee collection, inspired a study of the original presentation formats of the Paul Klee works in the collection. At the Kunstsammlung, the majority of Klee's works arrived in frames representing the tastes of their previous owners rather than that of the artist. Extensive documentation was gathered by examining all of Klee's works in the Kunstsammlung's collection, which had never before been studied as a group. By comparing this information to existing original presentation formats and to archival photographic records, a better understanding of the original mounting systems of the works was gained.

BACKGROUND

To illustrate the importance of the Klee works for the Kunstsammlung, it is necessary to look back at the beginning of the museum. It was founded in Düsseldorf, Germany, in 1961, after the Federal State of Nordrhein-Westfalen, in a landmark political act, acquired a singularly large body of works by Paul Klee. This decision signaled the desire to rebuild the state's cultural identity after the Second World War. The political leaders of post-war Germany were trying to make up for the wrongs of the recent past, since Düsseldorf's art scene—like that elsewhere in Germany—had been suffocated by the cultural politics of the Nazi dictatorship.

Many of today's most esteemed artists were labeled as degenerate by the Nazis, terrorized by the authorities, and in many instances even forbidden to work. Paul Klee, who had long been connected to Düsseldorf through collectors, and especially through dealer Alfred Flechtheim, suffered directly. He was suspended from teaching at the Kunstakademie in Düsseldorf in April 1933, only two years after he'd taken up this position. Fearing for his safety and artistic freedom, Klee fled to Switzerland soon after the suspension, never to return to Germany. His business with German and European collectors began to suffer at the same time, leaving only one promising market open for Klee: the United States of America. There, the art dealers Emmy "Galka" Scheyer, Israel B. Neumann, and Karl Nierendorf had set out to introduce German artists to the American public in the 1920s. They were joined by Curt Valentin, who emigrated from Berlin in 1937. They managed to promote Klee's works successfully, so that several institutions and a number of American citizens were able to build respectable collections of Klee's works early on.

It was the bulk of one such private collection that the young state of Nordrhein-Westfalen bought in 1960 as an act of "atonement" (*Wiedergutmachung*). The private collection in question was that of G. David Thompson of Pittsburgh, Pennsylvania. The collector began buying Klee works in the 1940s, and acquired his works from both Valentin and Nierendorf in the United States, from Berggruen in Paris, and from the Scheyer Estate. Famous for being headstrong and irascible, he had bargaining techniques that frightened dealers, and he had a penchant for buying in bulk.[1] In this way, by the time he decided to part with his collection, he had managed to amass one of the world's largest Klee collections.

With the acquisition of 87 works from the Thompson Collection, the foundation for the Kunstsammlung's collection was laid. Today, the Düsseldorf Klee collection encompasses

Presented at the Book and Paper Group Session, AIC's 40th Annual Meeting, May 8–11, 2012, Albuquerque, New Mexico.

100 works: 39 black-and-white drawings, 36 colored works on paper, 23 panel paintings, and 2 paintings on glass.

CURRENT PRESENTATION FORMATS OF THE DÜSSELDORF KLEES

Most of the Kunstsammlung's Klee paintings entered the collection in typical commercial gallery frames, consisting of gilt frames with textile-covered wooden liners. Many of these frames could be traced back to exhibitions in Valentin's gallery in the late 1940s or early 1950s. It is possible that similar frames were implemented by the other American dealers, but a lack of photographic records makes this difficult to prove.[2] The majority of the Kunstsammlung's Klee paintings remain in these gilt frames to this day. Aesthetically, these frames clearly reflect the preferences of the mid-20th century, as well as the tastes of their previous owners. While this is certainly informative, the current frames do not enhance the works themselves. From today's point of view, they appear to muffle the works' striking modernity, and in many cases, the liners cover up original components, such as parts of the strainers, the margins, or even the inscriptions on the mounts.

The black-and-white drawings arrived in Düsseldorf in less elaborate frames, as a photograph from the Kunstsammlung's opening exhibition indicates (fig. 1). This specific group of works received new frames in 1999, after their presentation system was reevaluated by the new head of conservation and

Fig.1. Installation view of the 1961 inaugural exhibition held at the Kunstsammlung Nordrhein-Westfalen. To the left is the drawing *Glass Figures* (*Glasfiguren*), 1937.214, which appears to be framed in a simple wooden frame. *Lions, attention please!* (*Lowen, man beachte sie!*), 1923.155, a colored work on paper, appears in a more elaborate gilt frame. Courtesy of Rudolf Holtappel, Oberhausen, Landesarchiv Nordrhein-Westfalen, Abteilung Rheinland, RWB 0934 Nr.0002

the new director of the museum.[3] While curators and conservators at the Kunstsammlung were also suspicious about the origin of the gilt frames that the paintings and colored drawings had arrived in, the resources necessary to address the issue properly were simply not available. However, awareness of the incongruity of the dated, historicizing frames and their modernist works increased every time a work was unframed and examined. In 2010, when a major digitization project took place at the museum, all 100 Klee works were unframed within a period of one week. The chance to examine the works together spurred a reevaluation of the presentation formats of the paintings and the colored works on paper in the Klee collection. The prospect of the 2012 Klee exhibition paved the way for a research project in which the conservation department worked intimately with the curatorial department.[4]

OVERVIEW OF PAUL KLEE'S ORIGINAL PRESENTATION FORMATS

A previous study distinguished between several broad categories of original presentation formats, based upon the examination of early studio and exhibition photographs.[5] Paul Klee had studios in Munich, Weimar, Dessau, Düsseldorf, and Bern. Sadly, no photos from his working space in the Academy in Düsseldorf survive, but his studios at the Bauhaus especially were quite well documented, and the photographs are available to study at the archive of the Zentrum Paul Klee. For this research, these archival photographic records were consulted by Anette Kruszynski and the author. Fortunately, the Zentrum's files yielded a number of images in which works from the Kunstsammlung could be seen. While most images pertaining directly to works held by the Kunstsammlung were exhibition photographs from 1948 onward, a few studio photographs could also be consulted. From these, it became clear that Klee used a variety of frames over the course of his life.

Early on, he apparently often worked with used frames he picked up in antique shops. Beginning in the early 1920s, a Bauhaus-inspired frame with a heavy triangular molding appears quite frequently. One favored format of presentation that can also be found in many studio photographs from his time at the Bauhaus is a very simple strip-frame. After his emigration to Bern, he frequently employed a store-bought frame with a steep, rounded molding and a deep lip.[6] Judging from the amounts of works and easels present in some studio photographs, one cannot help but form the impression that Klee, who always used to work on several pictures at once, apparently liked having his works around him. In figure 2, an impressive number of works—started, finished, framed, and unframed—can be seen leaning on the easels and hanging on the walls, most of them in strip-frames; a work with a slanted, broad molding is visible at the upper right.

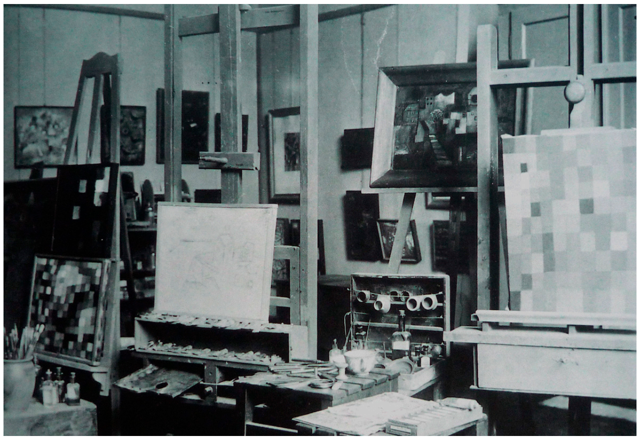


Fig. 2. Klee's studio at the Bauhaus in 1925. Photo by Paul Klee, courtesy of Archiv Zentrum Paul Klee

A number of works with their original presentation formats intact can also be studied at the Zentrum Paul Klee in Bern. There and at the Klee Estate, also in Bern, scholars have compiled a considerable amount of information concerning Klee's original frames and mounts.[7] Written proof of the artist's scrupulous attention to all aspects of the making and the presentation of his works can be found in Klee's diaries and letters and in the recollections of his contemporaries. His son Felix Klee remembered that his father "not only made paintings, he also prepared the colors himself, fabricated the frames and mounts and recorded every work, including measurements and technique, in his oeuvre catalogue."[8]

The handwritten work catalogs that Klee kept to systematically record his works also provide invaluable information on original mounting and framing. In his records, Klee assigned each work a catalogue number and noted the title. Next he checked the category—in his oeuvre, he differentiated between "single color sheets," "multicolored sheets," and "panels": an unusual use of terminology, but one that is of considerable interest in the study of Klee's works. A "single-color sheet" (*Blatt einfarbig*) indicates a drawing executed in a single medium. A "multicolored sheet" (*Blatt mehrfarbig*) can be carried out in watercolor, oil, pastel, chalk, or paste paint. "Panel" (*Tafel*) is the term reserved for works carried out on a support such as a wooden panel or a canvas on a stretcher, but also for pieces of cardboard mounted onto strainers or works on a gesso base.[9] Next, Klee added a description of the media and techniques he used. Often, for his panels, this includes a remark about framing. For the multicolored or single-color sheets, no comments about framing appear, as his mounts were the official presentation formats for works on paper.

All this information has been transcribed into the *Catalogue Raisonne Paul Klee*.[10] Checking an entry in the *Catalogue Raisonne Paul Klee* and comparing this information to the actual condition of the work will indicate whether a Klee work has an original frame or mount. A note about the "condition" (*Erhaltungszustand*) was added when it became known that a work had been altered in any way.

The Strip-Frame

One presentation format Klee favored for his panels appears to be the simple strip-frame. These strip-frames were recorded in his oeuvre catalog as "original strip-frame" (*Orig. Leisten*). One studio photograph shows a work from the Düsseldorf collection propped up on an easel in the artist's studio (fig. 3). The panel *Dangerous* (*Gefährliches*),1938.124, appears in a strip-frame with the strips of wood butt-joined rather than mitered at the corners: a typical feature for Klee. The strip-frame recorded in this image was discarded at some point in the history of the object, possibly for the gilt frame the work had when it arrived in Düsseldorf. The original strip-frames are not well represented in the Kunstsammlung's Klee collection. It seems likely that once the works left the sphere of influence of the artist, the strip-frames were no longer regarded as original artistic components of the works and were replaced by more elaborate frames.

However, one cannot help but feel the connection between a work's specific construction and Klee's choice of frame. For example, the surface appearance of the panel *Colorful Lightning* (*Bunter Blitz*), 1927.181, was achieved by a creating a structured, almost crusty ground into which the lines that form the image were incised. It has a certain mural character that is much enhanced by the stained strips of wood nailed to its sides, which are happily still in existence (fig. 4). Yet even in the instances in which the strip-frames have survived, slight modifications have often been made. In this case, the strips were taken off and re-applied so that they are

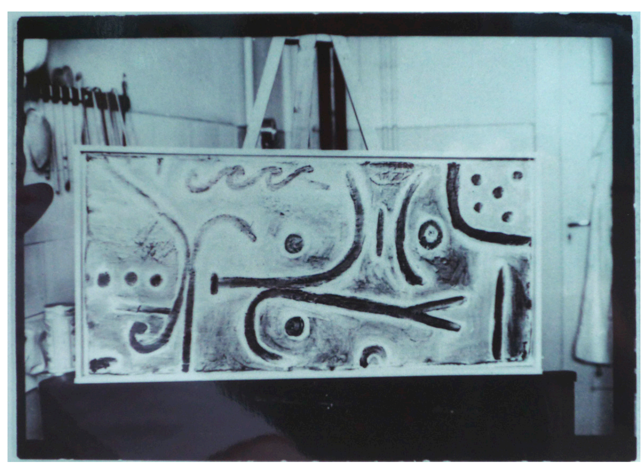


Fig. 3. Paul Klee, *Dangerous* (*Gefährliches*), 1938.124. Oil on cotton on cardboard on strainer, 27.5 x 58.5 cm. Archival photograph of the work in the studio in Bern, showing the work with an unpainted strip-frame attached to its edges. Photo by Paul Klee, courtesy of Grohmann-Archiv, Stuttgart

Fig. 4. Paul Klee, *Colorful Lightning* (*Bunter Blitz*), 1927.181. Oil on canvas on cardboard on strainer with original strip-frame, 50.3 x 34.2 cm. The strip-frame is level with the surface of the work, a tell-tale sign that the strips have been taken off and reapplied by a third party. Courtesy of the author, Kunstsammlung Nordrhein-Westfalen

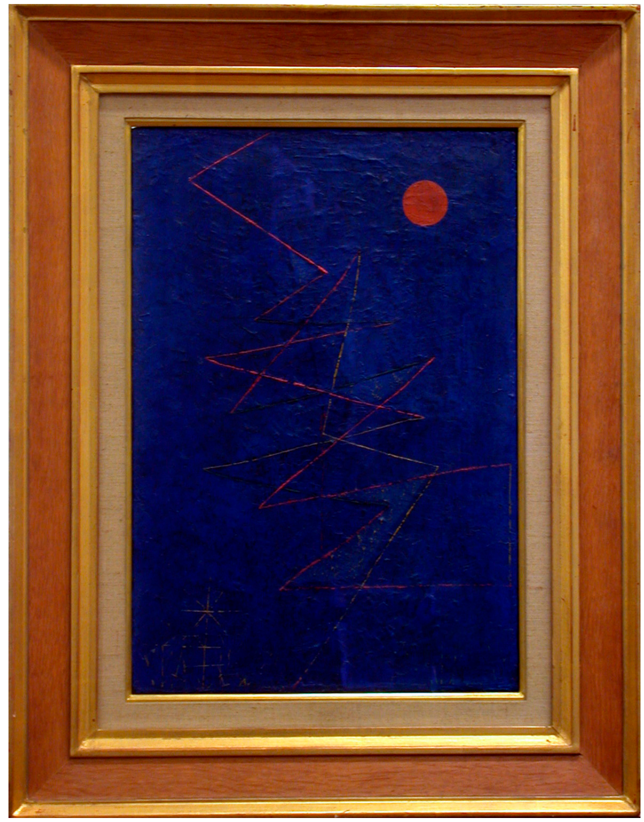


Fig. 5. *Colorful Lightning* (*Bunter Blitz*) in its ornate frame and liner, which cover up the strip-frame and hide the work's three-dimensional character. Courtesy of the author, Kunstsammlung Nordrhein-Westfalen

level with the surface of the work, probably so that the work would fit snugly into its gilt frame (fig. 5). Klee, however, always mounted the strips to his panels in such a way that they protruded 5–10 mm from the surface of the work.[11]

Today, works that have retained their strip-frames are often presented in simple box frames that allow the viewer to appreciate the three-dimensional character of these works while providing the necessary level of protection. However, it is important to be aware that strip-framed works were actually intended to go up on the wall just as they were, as can be seen in an early installation shot that shows *Colorful Lightning* in the *Surrealist Exhibition* organized by Roland Penrose at the Cambridge University Arts Society in 1937 (fig. 6). In this image, the work is mounted on the wall in its strip-frame, amidst works by other artists in ornate frames. After the artist's death, in the *Paul Klee Memorial Exhibition* at Kunsthalle Basel in 1941, works in strip-frames were also hung amidst works in other types of frames (fig. 7). This seems to indicate that in exhibitions that were prepared while Klee was alive, or that took place where his influence or that of his family prevailed, the strip-frames were regarded as complete presentation formats.

Fig. 6. *Exhibition of Surrealism*, Cambridge University Arts Society, 3–20 November 1937. *Colorful Lightning* is visible at the top right, presented just in its strip-frame. Roland Penrose, *Penrose's Scrapbook, 1936-1937*, Scottish National Gallery of Modern Art, p. 36

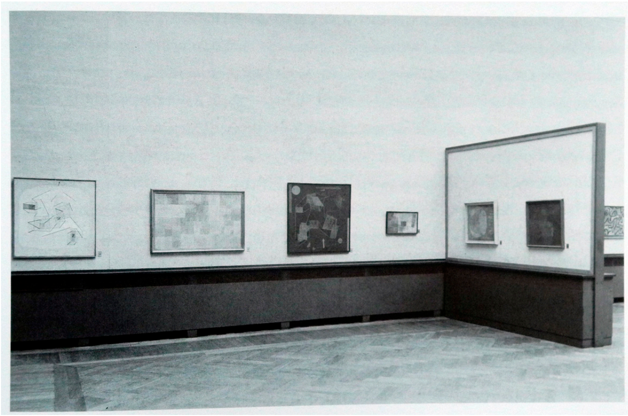


Fig. 7. *Paul Klee Memorial Exhibition* held at the Kunsthalle Basel in 1941. Works in strip-frames are shown next to works in other types of frames. Photo by Robert Spreng, courtesy Archiv Zentrum Paul Klee

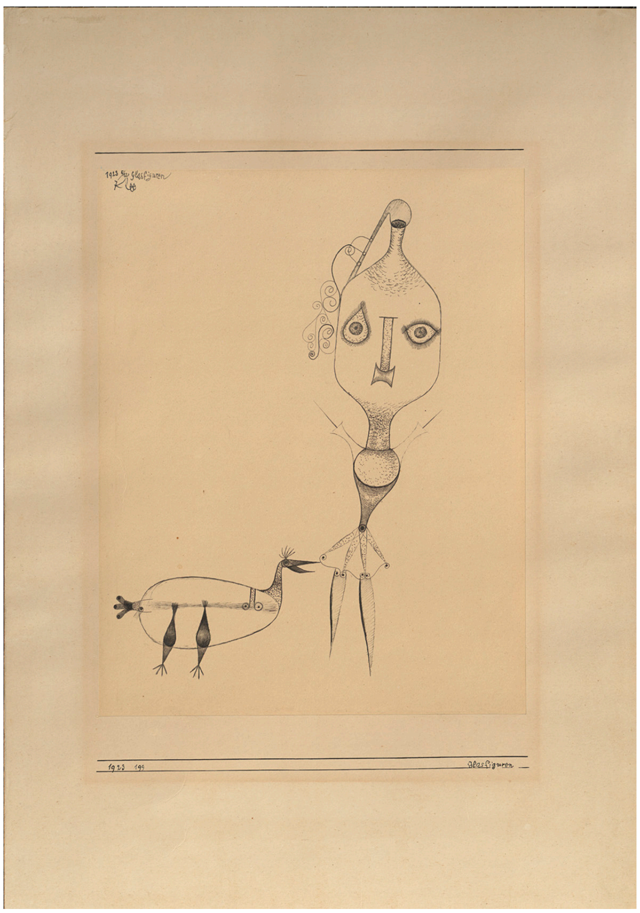


Fig. 8. Paul Klee, *Glass Figures* (*Glasfiguren*),1923.199. Pen and ink on paper, mounted on cardboard, 28.8 x 22.4 cm. The ink drawing was lined onto the mount, which developed slight horizontal buckles in the process. Courtesy of the author, Kunstsammlung Nordrhein-Westfalen

Klee's Standard Presentation Format for Works on Paper

To distinguish works on paper from panels, Klee developed a distinct presentation format for them. This involved mounting works on paper onto secondary supports. Paper conservators in the United States have raised awareness of the special needs of Klee's works on paper, describing them as compound "art objects, that is to say, two sheets of paper aesthetically related as well as physically adhered to one another."[12] The material of the mounts in the Kunstsammlung's collection is typically a thin, compound board made of two calendered endpapers of reasonable quality covering a slightly thicker core of woodpulp stock.

Mounting Methods for Works on Paper

In the early years of his career, Klee lined his works to mounts; later, he mounted his works with dabs of adhesive, the amounts of which would vary from just a few spare dots to many of them all along the margins. Even though it is apparent from the lack of air bubbles between the layers and the absence of spilled adhesive on the fronts of the mounts that Klee worked meticulously when lining his works, the secondary supports sometimes do exhibit horizontal undulations. These seem to appear mainly in those cases where Klee used machine-made paper, referred to as "writing paper" (*Schreibpapier*) in the *Catalogue Raisonne Paul Klee*. This short-fibered paper stretches considerably when moistened in the lining process and then contracts upon drying, creating the undulations that can be seen, for example, in the drawing *Glass Figures* (*Glasfiguren*), 1923.199 (fig. 8).

In the instances where Klee chose to spot-adhere a work to the mount, there is often the phenomenon of the primary support buckling around the adhesive dabs. The dabs themselves seem to acquire an embossed appearance, as can be seen in the drawing *Venus Leaves and Withdraws* (*Venus geht und tritt zurück*), 1939.679 (fig. 9). While the localized tension that this method of adhesion created can be problematic—some works have been known to develop tears around the adhesive dabs—they should also be regarded as part of the artist's composition, because the buckling must have occurred in the process of mounting of the works rather than upon aging.[13] Judging from how much he favored this method of mounting in later years, it seems likely that Klee not only accepted but actually intended the change of appearance the papers underwent when he spot-adhered them to his secondary supports.

Dimensions and Design of the Mounts

Apart from using the method of mounting each work as an artistic device, it can be assumed that Klee also chose the format of each mount deliberately to complement the dimensions of the work. Studying the group of black-and-white drawings held by the Kunstsammlung,

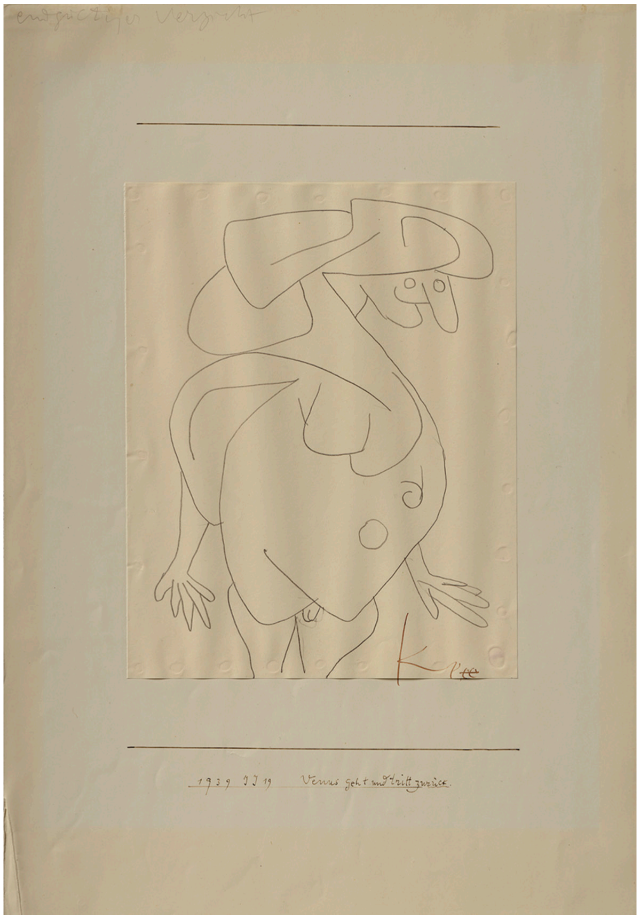


Fig. 9. Paul Klee, *Venus Leaves and Withdraws* (*Venus geht und tritt zurück*), 1939.679. Pencil on paper, mounted on cardboard, 50 x 35 cm. The work was adhered to the mount with dabs of adhesive placed in fairly regular intervals along the edges of the primary support. Courtesy of the author, Kunstsammlung Nordrhein-Westfalen

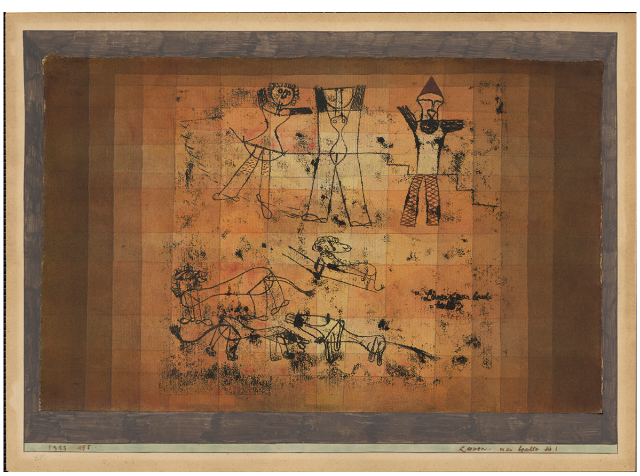


Fig. 10. Paul Klee, *Lions, attention please!* (*Loewen, man beachte sie!*), 1923.155. Oil transfer drawing, pencil, and watercolor on paper, bordered with watercolor and ink, mounted on cardboard, 30.5 x 48.5 cm. Klee decorated the mount with bands of watercolor, noting the title and date in the pale blue band below the image. Courtesy of the author, Kunstsammlung Nordrhein-Westfalen

it seems obvious that the format of the primary support, rather than being forced to conform to a standardized format, appears to have been chosen so that the margins are in proportion to the dimensions of the work. Klee also often decorated the margins around a work. In these instances, the mount serves as an integral part of the design, as in the work *Lions, attention please!* (*Loewen, man beachte sie!)*, 1923.155, which he chose to border with bands of watercolor (fig. 10).

The Mount as Record-Keeping Device

Klee routinely entered inscriptions—comprising the date, catalog number, and title—on the mounts of his works, and frequently added marginal lines above and below the primary supports. About the secondary supports' record-keeping role, it has been observed that "in a broader sense, this scrupulous procedure of mounting and recording his works implies that Klee did not consider [his works on paper] officially finished until he had done so."[14]

PROBLEMS WITH CONSERVATION TREATMENTS

The following tale from the Kunstsammlung's own history is related to draw attention to the fact that Klee's eclectic use of mounting methods can easily lead to misinterpretation on the part of people entrusted with the care of these objects. A treatment report in the museum's files, dated 1991, describes the separation of the primary support and mount of *The Boulevard of the Abnormal Ones (Der Boulevard der Abnormen)*, 1938.46, a painting on newsprint mounted on cardstock that shows a parade of figures marching across a landscape (fig. 11). The report contains photographs showing that the painted newsprint was almost three-dimensional in appearance (fig. 12). At the time, it was felt that the work exhibited an unacceptable amount of buckling of the primary and secondary supports.[15] The report states that it was feared the buckling would cause the underbound paint layer to flake off. As a precautionary measure, it was decided that the primary support would be taken off the mount, relaxed, and then lined rather than spot-adhered to the mount, which itself would be lined onto a new auxiliary board. Today, *The Boulevard of the Abnormal Ones* lies perfectly flat, and is thus a world away from the topographical landscape Klee created by spot-adhering the piece of newsprint to the mount. Such interventions have sparked critical debate among Klee scholars: "How do Klee's works look when they have been treated by traditional conservation techniques? Is it still possible to appreciate and understand the substance of the work, or does only a relic remain of the original?"[16] These questions are uncomfortable ones, and ones that our profession will have to grapple with.

A conservation problem that looms large for the Kunstsammlung's Klee collection was created by

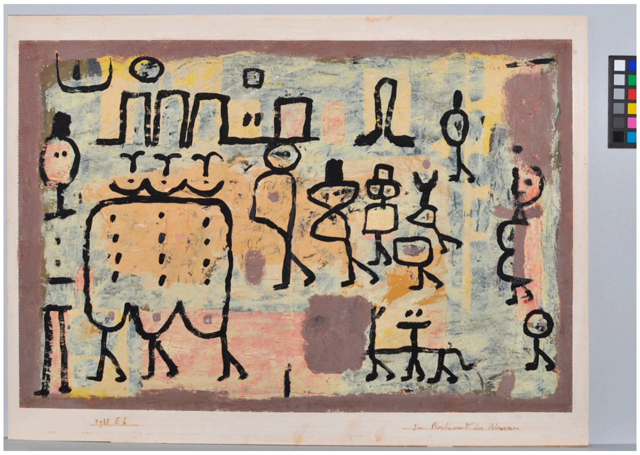
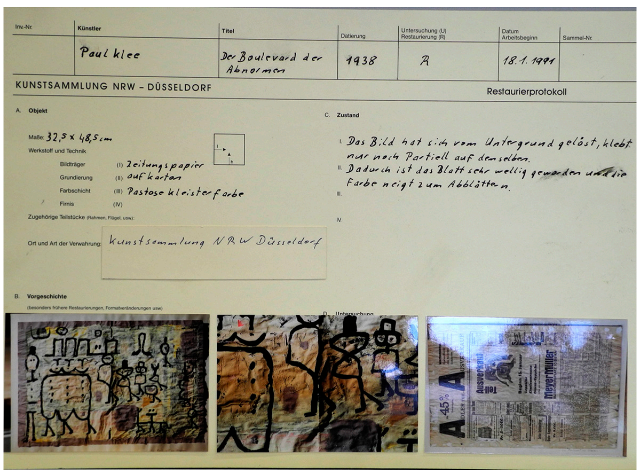


Fig. 11. Paul Klee, *The Boulevard of the Abnormal Ones* (*Der Boulevard der Abnormen*), 1938.46. Colored paste on newspaper, mounted on cardboard, 33.2 x 49 cm. Courtesy of the author, Kunstsammlung Nordrhein-Westfalen



Inv.-Nr.	Künstler	Titel	Datierung	Untersuchung (U) Restaurierung (R)	Datum Arbeitsbeginn	Sammel-Nr.
	Paul klee	Der Boulevard der Abnormen	1938	R	18.1.1991	

KUNSTSAMMLUNG NRW – DÜSSELDORF

Restaurierprotokoll

A. Objekt

Maße: 32,5 x 48,5 cm

Werkstoff und Technik

Bildträger (I) Zeitungspapier

Grundierung (II) auf karton

Farbschicht (III) Pastose kleisterfarbe

Firnis (IV)

Zugehörige Teilstücke (Rahmen, Flügel, usw):

Ort und Art der Verwahrung: kunstsammlung NRW Düsseldorf

C. Zustand

I. Das Bild hat sich vom Untergrund gelöst, klebt nur noch Partiell auf demselben.

II. Dadurch ist das Blatt sehr wellig geworden und die Farbe neigt zum Abblättern.

III.

IV.

B. Vorgeschichte

(besonders frühere Restaurierungen, Formatveränderungen usw)

Fig. 12. Treatment report from 1992 describing what was felt to be damage to *The Boulevard of the Abnormal Ones* (*Der Boulevard der Abnormen*). Courtesy of the author, Kunstsammlung Nordrhein-Westfalen

near-permanent periods of exhibition in the early days of the museum. The decision to allow permanent access to this body of works went in conjunction with the act of atonement (*Wiedergutmachung*) that was so vitally important for the founding of the museum. It was the wish of the politicians to show Klee's masterpieces permanently and prominently in the museum, for all the world to see. Hence, many of the works on paper have suffered severe light damage. The accumulation of hours of light exposure has led to fading of a few of the ink drawings in the collection. The mounts have also been affected. Often, a work's margins (where the secondary support was protected by a window mount) are lighter than the exposed image area. Discoloration has also appeared on mounts that were covered by acidic mats, which were removed in 1999. As it is unlikely that these disfigurements can be reduced, the works will be displayed with mats covering the discolored margins in order to minimize distraction for the viewer.

ALTERATIONS TO KLEE'S ORIGINAL PRESENTATION FORMATS

While Klee's cardstock mounts are intimately related to their artworks, they have also been especially prone to alterations by third parties. It seems that once the works left Klee's studio, his official presentation formats for the pieces—their mounts—ceased to be viewed as integral parts of the artworks.

The most common alteration found in the Kunstsammlung's Klee collection is the cropping of the original mounts to new proportions, probably to allow the works to be placed in smaller frame formats. Trimming the mount to the edges of the primary support is less common in the Kunstsammlung's collection. Since Klee sent his works on paper to his dealers unframed, it seems likely that trimming was carried out when works were framed for exhibition in commercial galleries. Framers were also prone to leaving marks such as notations, tapes, or even glue on the original mounts. In some instances, margins around the primary support were toned with a wash of watercolor. This seems to be especially common in works that passed through the hands of Galka Scheyer and Karl Nierendorf.[17] Cropping and toning may have been attempts to remove damaged edges or hide stains or discoloration. Another theory is that paint was added "in an attempt to visually suppress the appearance of a work as a work on paper by toning back the lightness of the mount and concealing the marginal lines that are typical for works on paper."[18]

Another modification by third parties consisted of taking works off their original mounts in order to reapply them to new backings. This is referred to as the "alteration of presentation format" (*Typveränderung*) by the Klee Estate, and is considered a most substantial form of damage.[19] It can be surprisingly hard to identify, as the works that suffered this abuse were often, but not always, paintings on scraps of textile, which were then carefully adhered to a new secondary support and, in some instances, even embedded in chalk grounds. Only through close visual examination and comparison to the entries in the *Catalogue Raisonne Paul Klee* are these interventions able to be uncovered.

Interim around Easter (*Zwischenzeit gegen Ostern*), 1938.342, a watercolor on a chalk ground on jute, is one example. Today, the work is lined with a secondary canvas and mounted on a stretcher (fig. 13). However, a fragment of the original mount bearing the title and date of the work has been adhered to the back of the stretcher. This evidence indicates that the work was originally mounted on cardstock (fig. 14). When the *Catalogue Raisonne* was consulted, these suspicions were confirmed:

Fig. 13. Paul Klee, *Interval around Easter* (*Zwischenzeit gegen Ostern*), 1938.342. Watercolor on chalk and paste ground on jute, mounted on canvas on stretcher (not by the artist), 29.7/32.5 x 66.5 cm. Courtesy of the author, Kunstsammlung Nordrhein-Westfalen

Fig. 14. Verso of *Interval around Easter* (*Zwischenzeit gegen Ostern*) with a fragment of the original mount bearing the title and the date attached to the lower bar of the stretcher. Courtesy of the author, Kunstsammlung Nordrhein-Westfalen

Fig. 15. Archival photograph of *Interval around Easter* (*Zwischenzeit gegen Ostern*) before it was altered. Courtesy of Archiv Zentrum Paul Klee

Fig. 16. Paul Klee, *Thoughts in the Snow* (*Gedanken bei Schnee*), 1933.32. Watercolor on plaster ground on tulle on cardboard, mounted on plaster-coated Masonite (not by the artist), 45.5 x 46.5 cm. The work appears in its current presentation format, mounted onto a plaster-coated sheet of Masonite. Courtesy of the author, Kunstsammlung Nordrhein-Westfalen

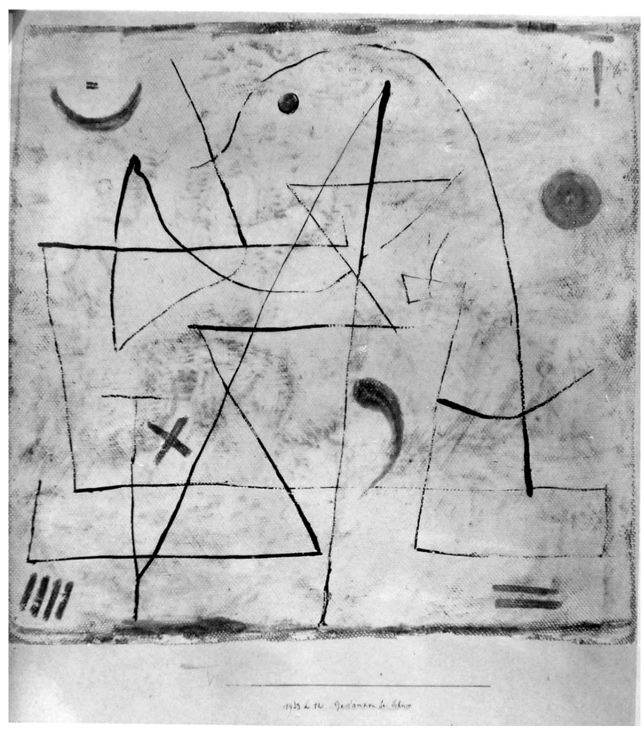


Fig. 17. This archival photograph shows *Thoughts in the Snow* (*Gedanken bei Schnee*) before it was altered. Photo by Cauvin, courtesy of Archiv Zentrum Paul Klee

Fig. 18. Detail of *Thoughts in the Snow* (*Gedanken bei Schnee*) showing the original compound support embedded in the toned plaster substrate. Courtesy of the author, Kunstsammlung Nordrhein-Westfalen

the work had been classified in Klee's oeuvre catalogue as a "multicolored sheet," indicating a work on paper. Finally, the archival photograph of the work showed the primary support mounted on cardstock, with the typical inscriptions along the bottom (fig. 15). Originally, the work must have been spot-adhered rather than lined to the cardstock mount, judging by the shadows that its edges are casting.

Another striking example of complete alteration can be studied when one compares the current condition of the work *Thoughts in the Snow* (*Gedanken bei Schnee*), 1933.22, (fig. 16) with its original condition as revealed in an archival photograph (fig. 17). Here, the support, a delicate compound of plaster and tulle lined with cardstock, was cropped to the edges of the image area, mounted onto Masonite, and embedded in a layer of plaster. The plaster margins and the edges of the primary support alongside them were toned a light grey (fig. 18). Again, attached to the reverse of the Masonite panel is a fragment of the original mount bearing the artist's inscription.

These type-altering modifications appear extremely baffling from today's point of view. In one case at least, it is documented that a transfer onto a different kind of secondary support was carried out as a conservation treatment by Petra Petitpierre, a former student of Paul Klee, on behalf of Lily Klee.[20] Since the Kunstsammlung's altered works did not pass through Petitpierre's hands, it is possible that the original mounts were removed and the works transferred to canvas or Masonite for financial reasons, to upgrade them from "work on paper" to "painting" status.

In order to shed more light on this issue, research involving the Klee Estate, the Klee scholars at the Zentrum, and conservators and curators at United States institutions with Klee holdings would certainly be worthwhile. As the Düsseldorf Klee works have passed through the hands of various American owners, it seems likely that similar alterations have been made to works that are still held in the United States. So far, only a few American collections have been approached with questions about alterations to Klee's original presentation formats. Collections that acquired Klee's works early on, such as the Museum of Modern Art, appear to have works that remain largely untouched. By contrast, collections that contain works that changed ownership several times before acquisition are likely to have works whose mounts were altered. A number of works that were part of Galka Scheyer's collection and are now held by the Norton Simon Museum have been taken off their mounts, while pieces of the cardstock bearing the title were retained. In one case, however, the files contained information that the primary support of *Plants in the Courtyard* (*Pflanzen im Hof*), 1932.25, was taken off its cardstock mount and pasted onto a piece of cardboard covered with Japanese or Chinese grass paper, and the fragment of cardstock with the artist's inscriptions was adhered to the back of this cardboard.[21]

Conservators at the Solomon R. Guggenheim Museum in New York are researching whether two works from the Karl Nierendorf estate may also have been removed from their original mounts prior to entering the museum's collection in 1948. Klee classified both these works as "multicolored sheets" (*Blatt mehrfarbig*), but one is now on plaster-coated Masonite and the other on painted and textured cardboard. In both cases, there is no evidence of original cardstock fragments or inscriptions.[22] Although the *Catalogue Raisonne* states that they were both removed from their original mounts, further research is needed to determine their current status.

Although both works were part of Nierendorf's estate, the five works in the Kunstsammlung's collection with similar alterations did not pass through Nierendorf's hands. In fact, they have only one common factor in their provenance: the Thompson collection. Judging from the similarity of the alterations, it appears that the same person may have been working for certain dealers and collectors of Klee's works.

FINDING A NEW PRESENTATION FORMAT FOR KLEE'S WORKS ON PAPER

Early photographs showing framed works on paper remain few and far between. Some do exist, though, such as the one showing Klee in his Bauhaus studio in Dessau in 1926, with a group of small works hung on the wall (fig. 19). Though the photograph is blurry, it seems that what is displayed on his studio walls are works on paper, apparently in very simple frames.

In order to come up with an alternative solution to the gilt frames in which the colored works on paper have been presented so far, Kunstsammlung curators and conservators

Fig. 19. Paul Klee in his Bauhaus studio in Dessau, 1927. The framed small-scale works on the studio walls are thought to be works on paper. Photo by Lucia Moholy, courtesy of Bauhaus Archiv, Berlin, and VG Bild-Kunst, Bonn, 2012

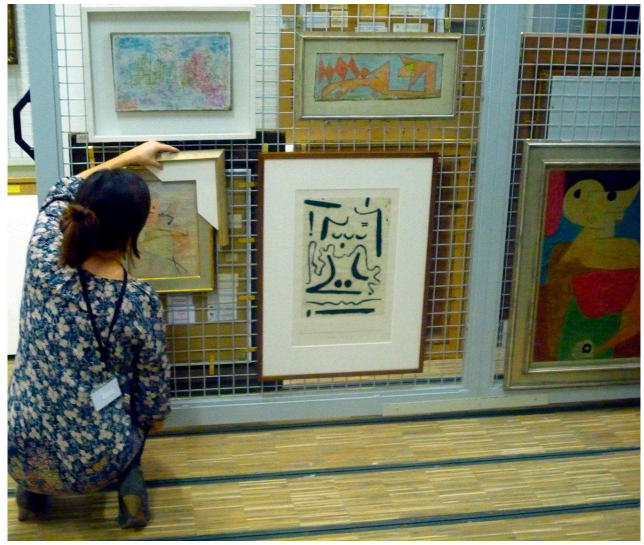


Fig. 20. Experimenting with the custom-made Bauhaus frame sample. Compared to the simple frame visible on the black-and-white drawing on the right, the frame sample seemed too interpretative. Courtesy of Mina Rikitake, Kunstsammlung Nordrhein-Westfalen

Fig. 21. Paul Klee, *The Important Package* (*Das Wert-Paket)*, 1939.858. Ink, pencil, and colored paste on paste ground on paper, mounted on cardboard (cardboard toned later, not by the artist), 45.5 x 32.7 cm. This 2011 mockup shows the work floated in the type of frame it will receive in 2012. Courtesy of the author, Kunstsammlung Nordrhein-Westfalen

spent considerable time poring over various archival photographs and frame samples. The task of finding a single, appropriate frame style that would help balance Klee's highly individualized imagery and surfaces within a grouping—a task that was previously made more difficult by varying frame types—proved fairly grueling, as all frame samples supplied by Düsseldorf's major frame manufacturer felt simply wrong. Hence, experiments with a custom-made frame commenced. Modeled on a very simple Bauhaus-era frame with a triangular profile, the custom frame was aesthetically pleasing, but its gilt finish was off-putting. This too felt "historicizing," and even with a simple brown stain, the frame seemed too interpretive. In the end, it seemed that the more simple and less elaborate the frame, the better it allowed the subtleties of Klee's works on paper to speak for themselves (fig. 20). The museum settled on the frame that was already being used for the black-and-white drawings: a band-frame made from North American walnut (fig. 21). Its simple profile also seemed to mirror the unadorned wooden frames found in early photographs, which helped the decision along considerably.

While Klee's works hang on the white walls of today's galleries, a simple wooden frame seems to offer maximum serenity and simplicity for the appreciation of the art. Yet the Kunstsammlung's decision—to present its visitors with a more "authentic" display by liberating the works on paper from their ornate gilt frames—is itself a product of the sentiments of the present time and may be regarded as such by future generations.

REVISED PRESENTATION FORMATS FOR PANELS

The Kunstsammlung's Klee panels will not receive a single frame style. In acknowledgement of Klee's eclectic frame choices, an individual solution will be found for each piece. A recent trend for his panels seems to be the reconstruction of frames and strip-frames with the aid of archival photographs. The Zentrum Paul Klee is very much ahead of the curve in this, as are some American institutions, and it is hoped that the Kunstsammlung may be able to follow their lead.[23] For the Klee exhibition in 2012, a number of works are presented unframed in showcases that allow the viewer to appreciate the works front and back, in order to do Klee's compound works of art justice.

CONCLUSION

Artworks in fine-art institutions have whole histories that may never be known, ranging from changes in presentation format to changes in ownership. It is fascinating to trace the alterations that Klee's works have undergone; the process helps to explain how, with changes in ownership, some elements of artistic intent were subordinated to individual aesthetics. This project offered rare glimpses of how Klee's scrupulous attention to detail extended to all aspects of the presentation of his works. As guardians of the world's art collections, curators and conservators should remember to consider aspects such as the artist's original vision of display. Even more importantly, they can seek to preserve evidence of the artwork's display history through diligent documentation, preservation of historic records, and sensitivity not only to the artwork but also to its accompanying materials and structures.

ACKNOWLEDGMENTS

The presentation of this study was supported by the Christa Gaehde Award from the Foundation of the American Institute for Conservation of Historic and Artistic Works. This research would not have been possible without the help of a number of people. The author is deeply indebted to Stefan Frey (Estate Paul Klee, Bern) for answering many questions and for reading the text and making valuable comments. Thanks also go to Marion Ackermann, Anette Kruszynski, Anne Skaliks, and Mina Rikitake (Kunstsammlung Nordrhein-Westfalen); Myriam Weber, Patrizia Zeppetella, and Eva Wiederkehr (Zentrum Paul Klee, Bern); Werner Müller (Kunstmuseum, Basel); Jessica Lunk, Diana Blumenroth, and Gunnar Heydenreich (University of Applied Sciences, Cologne); Jens Baudisch (Staatliche Kunsthalle Karlsruhe); Jeffrey Warda and Gillian McMillan (Guggenheim Museum, New York); Scott Gerson (MoMA, New York); Leah Lehmbeck (Norton Simon Museum); Suzanne Penn (Philadelphia Museum of Art); and Amanda Hunter Johnson (SFMoMA), who have all helped greatly with this project. Special thanks to Victoria Binder for her comments and, of course, to Debra Evans (Fine Arts Museums of San Francisco) for her interest in the project and her continuous support and encouragement. Heartfelt thanks to both Debbie and Renée Wolcott for their thorough editing of this text (all remaining mistakes are the author's own, as a few passages had to be squeezed in at the last minute). This paper is dedicated to the author's husband, Cornelius—also a painter—who good-naturedly deigns to discuss his framing choices with his interfering wife!

NOTES

1. In his 2006 article "G. David Thompson: An Art Collector Snubbed by Pittsburgh's Social Elite" (*Pittsburgh Quarterly* Spring/Summer), Graham Shearing writes: "His collecting practice was in direct opposition to that of the connoisseur. He liked to buy in bulk: 'What isn't selling, late Klee maybe? OK, I'll take the lot.'" www.pittsburghquarterly.com/index.php/Art-columns/missing-links.html (accessed 08/20/2012).
2. It is known that Karl Nierendorf implemented new frames for Klee works that passed through his hands. However, the records of Nierendorf's gallery are thought to be lost, so photographic evidence is unavailable.
3. Internal memos between Werner Müller, the former head of conservation, and Armin Zweite, the former director, relate that the old frames, the acrylic glazing, and the acidic mats were replaced with sturdier frames, acid-free mats, and Mirogard Protect Magic glazing.
4. This project was carried out in close collaboration with Anette Kruszynski, head of collections, and Marion Ackermann, artistic director of the Kunstsammlung.
5. For a detailed account of Klee's framing of paintings, see Bradford Epley and Christa Haiml (2006), "Paul Klee's Frames: Documenting Choices and Changes," in *Klee and America*, Houston: Menil Collection, pp. 253–263.
6. Stefan Frey pointed out that Klee repeatedly bought the latter type of frame at Farbwaren Schneider, Bern. Original frames and stretchers sometimes show a company stamp on the reverse.
7. Stefan Frey at the Estate Paul Klee and Patrizia Zeppetella, Myriam Weber, and Eva Wiederkehr at the Zentrum Paul Klee were very generous with their time and their resources, both during visits to Bern and when receiving calls or e-mails with questions.
8. In his book *Paul Klee* (1960, Zürich: Diogenes Verlag), Felix Klee compiled documents and recollections about his father. See p. 70 for his comment on Paul Klee's detail-orientated approach to working. The translation of this passage is the author's.
9. It is of interest for paper conservators that, for his paintings, Klee often used cardboard as the primary support, which he nailed onto wooden strainers to achieve extra thickness. As Klee referred to his paintings as panels (*Tafelbilder*), this is the term that will be used for paintings in this paper.
10. The Paul Klee Foundation, 1998–2004, *Catalogue Raisonne Paul Klee*, vols. 1–9.
11. Thanks to Patrizia Zeppetella for bringing this detail to light.
12. The landmark paper on the subject of treating Klee's compound works on paper was published by Margaret Holben-Ellis, Antoinette

King, and Elisabeth Kaiser Schulte in 1986: "An Approach to the Treatment of Paul Klee Drawings," *Book and Paper Group Annual* 5, pp. 19–32. This quotation appears on page 19.

13. Myriam Weber, 2006, "Materialität und Fragilität der Papierarbeiten von Paul Klee" in *Ad Parnassum: Auf dem Prüfstand*, Bern, pp. 99–116.

14. See note 11, p. 20.

15. Anette Kruszynski interviewed both the former head of collections and the Kunstsammlung's first conservator about the treatment of *Boulevard of the Abnormal Ones*. In the interviews, the revelation of the possibility that the buckling might have been inherent to the design was received as rather shocking news.

16. See Wolfgang Kersten and Anne Trembley (1990), "Malerei als Provokation der Materie," in *Paul Klee: Das Schaffen im Todesjahr*, ed. Josef Helfenstein and Stefan Frey, Stuttgart: G. Hatje, pp. 79–80. The translation of this paragraph is the author's.

17. This notion came to the author's attention via the Klee Estate, and is confirmed by a letter from the custodians of the Kunstmuseum Bern to Rolf Bürgi, listing 28 works that had decreased in value due to alterations that had occurred while the works were in Nierendorf's possession. At the Norton Simon Museum, when one consults editor Fronia W. Simpson's 2002 catalogue *The Blue Four Collection*—which includes technical notes for many works—one repeatedly finds the following remark: "The original mount was trimmed and the remaining margins toned, apparently by Scheyer" (see for example *The Tree of Houses,* p. 268).

18. See note 5, p. 263.

19. Personal communication with Stefan Frey, Klee Estate.

20. Petra Petitpierre carried out a number of treatments after the death of the artist. The Klee Estate files contain a list entitled "Restoration of Damaged Paintings (*Restaurierung defekter Bilder*)" compiled by Petitpierre. A few works she treated are described by Nathalie Bäschlin, Beatrice Ilg, and Patrizia Zeppetella (2000) in the essay "Beiträge zur Maltechnik von Paul Klee" in *Paul Klee: Kunst und Karriere*, Bern: Stämpfli, p. 199.

21. In this particular case, the work underwent treatment in the 1960s, when the grass paper–covered mount was removed and exchanged with Masonite. All this was unveiled by Leah Lehmbeck at the Norton Simon Museum, who went sleuthing in the accession files and looked at a number of objects.

22. The author would like to thank Jeffrey Warda and Gillian McMillan for their time and enthusiasm when, at rather short notice, a visit to New York City became possible. They kindly unframed, examined, and confirmed the similar constructions of *Severing the Snake*, 1938.262, and *Rolling Landscape*, 1938.409.

23. The Zentrum Paul Klee has successfully implemented reconstructions for lost frames that were documented in its files. Currently, a project concerning the collection of reverse glass paintings is under way. At the Philadelphia Museum of Art, a new strip-frame based on archival photographs was constructed for the painting *Fish Magic* (*Fischzauber*), 1925.85, in 2006. This information was kindly supplied by Suzanne Penn, Philadelphia Museum of Art.

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Confronting Stenciled Posters: The Discovery, Conservation, and Display of Soviet TASS World War II Posters

ABSTRACT

Summer 2011 brought to fruition a 10-year collaborative project in which museum professionals from all corners of The Art Institute of Chicago conserved, researched, and displayed hundreds of oversized World War II TASS posters alongside commercially printed war posters and artists' renditions of war.

The TASS posters were modeled after stenciled posters made by the Russian Telegraph Agency, ROSTA, during the Russian Civil War (1917–23). The initial goal of the TASS Studio was to produce one poster for each day of World War II. Over the course of 1,418 days of war, the studio collaboration brought together more than 92 of the most noted artists, poets, writers, stencil cutters, and painters of the day, resulting in 1,240 designs and a total of 690,000–700,000 individually stenciled posters. Although the posters were produced rapidly, with poor quality paints and papers—the shortage of artists' materials plagued the studio throughout the war—they were made to the highest aesthetic standards. The TASS posters were distributed each day and hung in shop windows throughout Moscow and abroad, fulfilling the TASS Studio artists' goal of disseminating agitational propaganda.

In 1997, staff in the Department of Prints and Drawings at the Art Institute made a startling discovery during preparation for a major renovation. At this time, art from all corners of the department was inventoried and temporarily relocated. While emptying out a closet, Art Institute staff discovered a narrow, trough-like shelf high above rack storage; it contained two thick rolls of paper and 26 folded-paper parcels. Enclosed within these parcels were 157 long-forgotten TASS posters that were mailed to the Art Institute in 1942. The USSR Society for Cultural Relations with Foreign Countries (VOKS) was responsible for the international distribution of TASS posters, and it began mailing posters to the United States as early as the summer of 1941. Current knowledge indicates that this remarkable collection was never exhibited during the war.

This talk described the discovery and study of the Art Institute's collection of TASS stenciled posters. Trends in materials usage were outlined, and the stencil process used in the TASS Studio was elucidated. Conservation was discussed in two phases: Phase I, which addressed the Art Institute's long-forgotten TASS posters, was carried out in 1997; Phase II, which treated the Ne Boltai private collection of posters, was conducted during 2010–11. Innovative and unconventional conservation treatment techniques were necessitated by the oversized format and poor-quality materials of the TASS posters. Unorthodox display methods—developed to bring the posters back into the public eye in the exhibition *Windows on the War: Soviet TASS Posters at Home and Abroad, 1941–1945*—were described.

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True Love Forever: Preserving the Legacy of Norman "Sailor Jerry" Collins

ABSTRACT

Norman Keith Collins, known as Sailor Jerry, has helped to elevate the status of tattoos to fine art. A renaissance man of his time, Jerry was interested in art, electronics, politics, and business. Early in his career, he traveled the globe with the U.S. Navy, eventually landing in Honolulu to set up a tattoo shop on historic Hotel Street in Chinatown. He built a reputation for quality work, which attracted customers in spite of the cost. Sailor Jerry is credited with the invention of the magnum tattoo needle, used to apply broad strokes of color to the skin, as well as an improved tattoo-machine construction, whose smooth operation resulted in greater detail and less pain for the sitter. He was the first tattoo artist to find and use a purple ink that was not fugitive or toxic. During a time when trade secrets were guarded, he befriended the most talented tattoo artists in the world, corresponding only with those whom he tested and deemed worthy of his attention. His studies culminated in a style that combined the bold colors and designs seen in Japanese tattoos with iconic Americana imagery. Sailor Jerry, who longed for the day when tattooing would be seen as fine art, would be pleased to learn that his flash, stencils, rubbings, and sketches underwent full conservation treatment at the Conservation Center for Art and Historic Artifacts.

Twenty-six sheets of Sailor Jerry's original flash, 148 acetate stencils, and 19 original drawings were examined, treated, housed, and framed to the highest standards for long-term preservation and exhibition. The colorants used to create the bold flash art found on the walls of Sailor Jerry's shop remain brilliant, mainly due to the conscious decision of the artist to invest in quality materials. The acetate stencils, slightly yellowed and brittle, are artifacts of a tattoo craft made obsolete by today's digital means. The sketches illustrate Jerry's confidence and his control over his hand and tools. This collection reveals the progression of the artist's idea as seen in sketch form, its realization in full-color flash, the translation onto the acetate stencil, and the rubbings taken from the stencils. Treatment included selective surface cleaning, tape removal, mending, and flattening of a variety of supports, including watercolor paper, transparent paper, and acetate pieces. The tools and materials used by Sailor Jerry were diverse and demanded creative problem-solving in terms of their conservation treatment, display, documentation, and transport. Communication and collaboration with the owner was vital, and the cultivated relationship has spurred research, exhibition, and outreach opportunities. One of the most rewarding aspects of the project has been the opportunity to present conservation and preservation issues to new audiences, including tattoo enthusiasts, in the form of lectures, newspaper articles, blog posts, and video documentaries.

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Examination and Analysis of a Mesoamerican Deerskin Map

ABSTRACT

Princeton University Library's very rare mid-16th century Aztec deerskin map is a distinct and dramatic reflection of the Early Colonial Period of Mesoamerica, when the Spanish conquest of the region forever altered the culture. Aztec and Spanish influences compose the map's imagery with glyphs and glosses, and depict a traumatic change in an indigenous way of life.

A thorough examination and analysis of the ca. 1550 map was conducted to help ascertain its authenticity. Pigments, dyes, and the deerskin support were analyzed through various microscopic, spectrographic, and observational means, such as Fourier-transform infrared spectroscopy, ultraviolet-visible spectroscopy, light microscopy, and ultraviolet-induced visible fluorescence to help determine the authenticity of the map and its constituents.

The analysis strongly suggested that the support was indeed deerskin by microscopically comparing its surface characteristics with those of a known deerskin sample. Spectroscopy and microscopy results indicated the presence of dyes and pigments including cochineal, bone black, and Maya blue, a dye–pigment complex of indigo and palygorskite that has a well-documented association with Aztec culture. Two substances were found that had very scant documentation associating them with the Aztec culture. These were gamboge, a dark mustard-yellow resin usually associated with Southeast Asia, and Maya Green, which appeared spectroscopically to be a version of Maya Blue. The object appeared to be authentic after extensive research and evaluation of the analysis.

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Treatment Considerations for the Haggadah Prayer Book: Evaluation of Two Antioxidants for Treatment of Copper-Containing Inks and Colorants

ABSTRACT

The Altona Haggadah, ca. 1763, is an illuminated manuscript containing iron-gall ink and numerous drawings with pigments such as atacamite, or basic copper chloride. It was deacidified with Wei T'o in 1987. Additional treatment is necessary to delay further damage to the paper caused by copper-catalyzed oxidation. The water sensitivity of the manuscript required that only non-aqueous treatments be considered. Two antioxidants, tetrabutylammonium bromide (TBAB) and 1-ethyl-3-methylimidazolium bromide (EMIMBr) were chosen for testing. Wei T'o and Bookkeeper were used for deacidification.

Iron-gall ink, iron-copper ink, atacamite, and verdigris were applied on unsized Whatman #1 paper and pre-aged. Six combinations of antioxidant and deacidification treatments were used on pre-aged samples. The treated pigment and ink samples were aged at 80°C and 65% RH. Both aged and unaged samples were evaluated using color measurement, zero-span tensile tests, and pH measurement. Inductively coupled plasma atomic emission spectrometry (ICP-AES) was also carried out by an external laboratory to determine the concentrations of magnesium, iron, and copper in the samples. The tensile strength results showed that deacidification alone benefitted the two sets of acidic ink samples; treatment with the two antioxidants did not provide additional protection. The benefits of antioxidants with deacidification were clearly shown with atacamite samples; the results with verdigris samples were inconclusive.

INTRODUCTION

The treatment of the Altona Haggadah, an illuminated manuscript containing iron-gall ink and numerous drawings with copper-containing pigments, prompted research into non-aqueous treatments to delay further damage to the paper caused by hydrolysis and copper-catalyzed oxidation.

Presented at the Book and Paper Group Session, AIC's 40th Annual Meeting, May 8–11, 2012, Albuquerque, New Mexico.

Condition of the Haggadah

"Haggadah" means "telling" in Hebrew. A Haggadah consists of scriptural passages, prayers, hymns, and rabbinic literature meant to be read during the Jewish Passover Seder meal. This 1763 Altona Haggadah is an illuminated manuscript, part of the Jacob M. Lowy Judaica Collection belonging to Library and Archives Canada (fig. 1). The format of the text and illustrations closely follows that of the 1695 Amsterdam Haggadah, one of the earliest printed versions of Haggadot.

This Haggadah was written and illustrated in color in Altona, Germany, a major center of Jewish life and scholarship at the time. It is particularly important since it does not represent high book art but rather gives testimony to the way a middle-class Ashkenazi Jewish family of the 18th century would have celebrated the Passover holiday.

The text block consists of 24 leaves (12 folios) gathered into 6 sections of 2 folios each. The paper is a medium-weight handmade paper with a *fleur-de-lys* watermark visible on the last page. The text is written in iron-gall ink. Green, red, and blue pigments were used in the illustrations. Pigment analysis carried out at the Canadian Conservation Institute (CCI) identified the red pigment as vermilion, the blue pigment as Prussian blue, and the green pigment as atacamite (copper chloride hydroxide) (Helwig and Corbeil 2008).

Prior Treatments

Cracks and losses in the paper caused by corrosion from the ink and green atacamite pigment can be found throughout the manuscript (fig. 2). Prior to 1987, many of these weak areas were repaired with thin Japanese paper, which was pasted directly over the illustrations in some cases. Examination in 1987 revealed that several new areas of the paper had deteriorated and were in need of support, especially in areas of more densely applied ink.

Conservation treatment in 1987 included removing the manuscript from its covers and dismantling the pages.

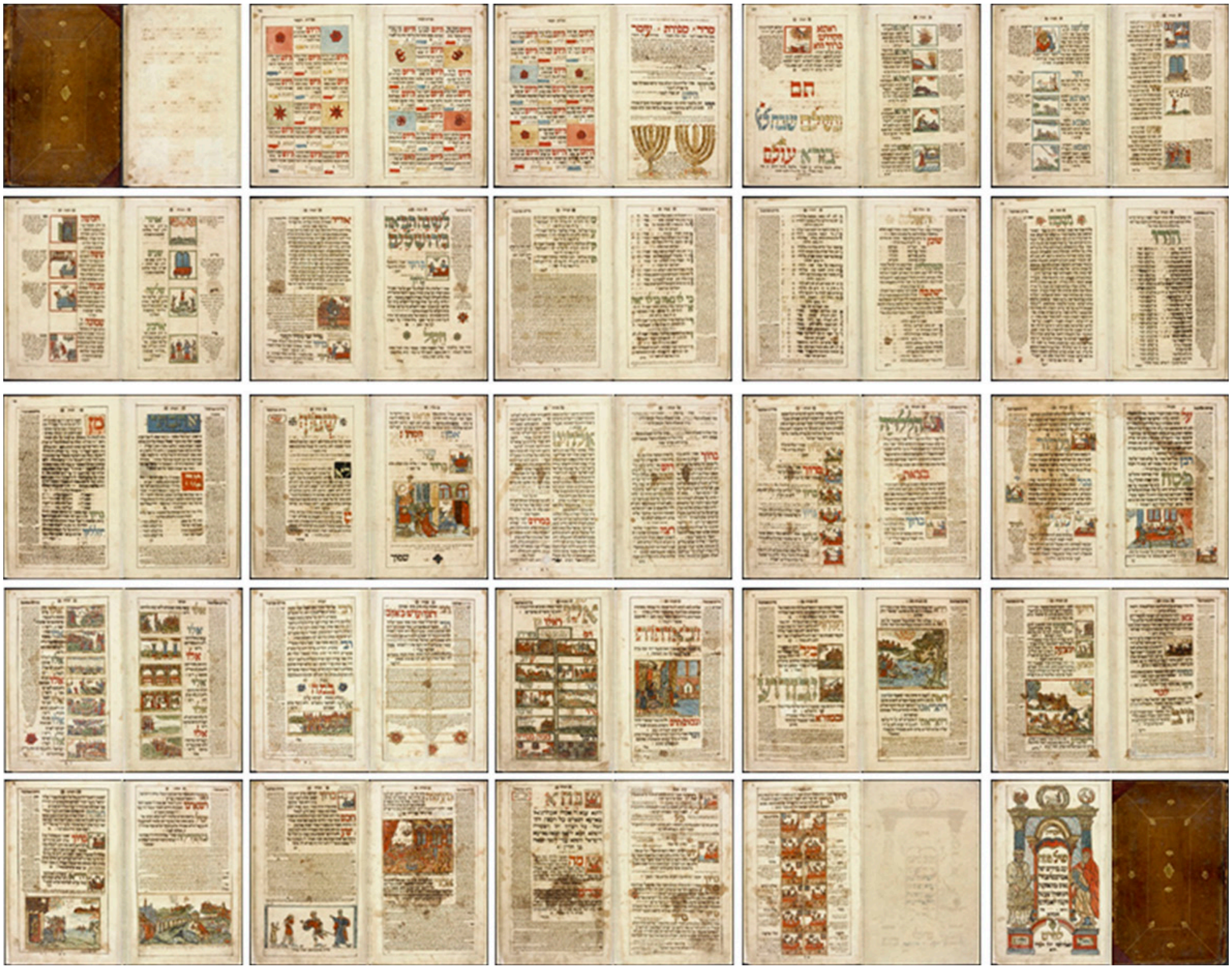

Fig. 1. 1763 Altona Haggadah, Jacob M. Lowy Judaica collection, Library and Archives Canada, accession # LOWY MS A229 (Courtesy of Library and Archives Canada)

Fig. 2. Inks and pigments on the Haggadah (Courtesy of Library and Archives Canada)

Damaged and weak areas of the paper were repaired with thin Japanese paper and carboxymethyl cellulose (CMC) adhesive. Deacidification began using an aqueous solution of magnesium bicarbonate applied with an ultrasonic mister. This was quickly discontinued, as feathering became evident in some of the inked areas. Instead, the pages were deacidified by spraying with Wei T'o #2 solution (methyl/ethyl magnesium carbonates in 1,1 dichloro-1-fluoroethane [HCFC-141B] and methanol).

CURRENT TREATMENT NEEDS

In 2007, reexamination of the Haggadah showed that the deacidification treatment carried out in 1987 was unable to completely protect the paper from continued deterioration caused by the ink and pigments. Many new cracks and losses were found in the inked lines and areas with green atacamite.

Fig. 3. 1987 repair using Japanese tissue (top) and most recent repairs using the gelatin-coated Berlin tissue (bottom) (Courtesy of Library and Archives Canada)

Fig. 4. Before and after images of the digital stain reduction (Courtesy of Library and Archives Canada)

On eight of the pages, ink had penetrated to the verso of the page, making the text difficult or almost impossible to read. On the remaining pages, the burn-through effect was visible, but had not yet obscured the text.

The deteriorated condition of the Haggadah prompted discussions about the need for further treatment to effectively delay damage caused by oxidation catalyzed by copper and iron in the ink and pigment. Due to the water sensitivity of many elements in the manuscript, only non-aqueous methods could be considered for future treatment. In 2007, solvent-based treatments were only in experimental stages and required further research before they could be applied to originals.

Since then, the corroded pages have been mechanically stabilized using gelatin-coated Berlin tissue—one of the lightest tissues presently available (Fig. 3). Research indicates that type-B gelatin with a high or medium Bloom degree has a considerable capacity to protect paper by preventing migration of free ironII ions (Kolbe 2004). The gelatin-coated tissue (0.4% Type-B gelatin, 275 Bloom) was reactivated *in situ*, using a 3:1 ethanol–water solution (Pataki 2009; Titus et al. 2009). Figure 3 shows the difference between repairs done in 1987 and recent repairs.

For the purpose of publication, wine stains obscuring several pages of the Haggadah were also reduced digitally using Adobe Photoshop software (fig. 4).

Following the mechanical stabilization of the manuscript, a joint research project was developed between Library and Archives Canada and CCI to investigate possible solvent-based treatment options for the Haggadah.

ANTIOXIDANTS FOR TREATMENT OF PAPER WITH COPPER-CONTAINING INKS AND PIGMENTS

The two main mechanisms of paper deterioration are hydrolysis, catalyzed by acid (Nevell 1985; Zou et al. 1994), and oxidation, a complex process catalyzed by transition metal ions, among other factors (Strlič et al. 2004; Šelih et al. 2007). The predominant degradation pathway is pH dependent. As the pH of paper increases, the relative importance of acid hydrolysis decreases (Strlič et al. 2004).

Deterioration of paper caused by copper has been studied in detail (Williams et al. 1977; Mairinger et al. 1980; Banik and Ponahlo 1982; Shahani 1986; Banik 1989; Daniels 1987, 2002; Kolar et al. 2003; Henniges et al. 2006a, 2006b). The result is browning and, eventually, weakening of the paper directly in contact with the copper pigment and the paper in close proximity to the pigment. The European Union-funded InkCor project identified a number of antioxidants that can be used in non-aqueous solutions (Kolar et al. 2008). Halides were among the most effective for treatment of both iron- and copper-based inks and pigments (Malešič et al. 2005 and 2006; Kolar et al. 2008).

Two possible antioxidants were selected for further testing: tetrabutylammonium bromide (TBAB) and 1-ethyl-3-methylimidazolium bromide (EMIMBr). Both function as peroxide decomposers (Kolar et al. 2008), and both are soluble in ethanol. EMIMBr is reported to be more effective than TBAB and even more effective than aqueous calcium and magnesium phytates (Kolar et al. 2008). For deacidification, Wei T'o was chosen for testing because the Haggadah was previously treated with Wei T'o. Bookkeeper spray was also chosen, because it is the non-aqueous deacidification agent that is used at Library and Archives Canada.

Whatman #1 paper was selected for preparing the samples because it is a well-characterized paper, has been used in many recent studies, and has properties that resemble those of the paper of the Haggadah. The selection of the pigments, inks, and experimental conditions was based on a review of recent literature (Malešič et al. 2005; Maitland 2007; Kolar et al. 2008). TBAB has been tested on verdigris and azurite on paper (Maitland 2007), and EMIMBr has been tested on iron-tannate-dyed cotton and silk textiles (Wilson et al. 2011).

Two iron-gall inks—with and without copper—were included because the Haggadah text is written in iron-gall ink, and historically many iron-gall inks also contained copper contaminants. Atacamite was included because it was found on the Haggadah, and verdigris was included because it is well known to cause discoloration in paper (Banik 1989) and was included in previous studies (Maitland 2007; Kolar et al. 2008).

This joint project sought to confirm the efficacies of these two halides on paper inscribed with iron-gall inks (with and without copper), verdigris, and atacamite, and to add to existing data.

EXPERIMENTAL METHODS

Preparation of inks and pigments

Iron-gall ink with a 5.5:1 iron–tannin ratio was prepared by dissolving gum arabic (15.7 g) in deionized water (500 ml). Iron sulphate ($FeSO_4.7H_2O$; 21 g) and tannic acid (24.6 g) were then added sequentially. Iron-gall ink with copper was prepared using a 5.5:1 ratio of iron and copper to tannin and a 0.7:1 ratio of copper to iron. Gum arabic (15.7 g) was dissolved in deionized water (500 ml) as before. Iron sulphate ($FeSO_4.7H_2O$; 12.23 g) and copper sulphate ($CuSO_4.5H_2O$; 7.73 g) were then added to the gum arabic solution, followed by tannic acid (24.6 g) (Kolar et al. 2003; Malešič et al. 2005). Both inks were filtered prior to use.

Verdigris (copperII acetate, $Cu(OH)_2{\cdot}(CH_3COO)_2{\cdot}5H_2O$; Kremer 44450; 30 g) and atacamite (copperII chloride hydroxide, $Cu_2Cl(OH)_3$; Kremer 103901 and synthesized at CCI; 27 g) were each weighed out on glass plates. Acetone was then added until each pigment was thoroughly wetted. Next, sufficient water was added to each pigment until smooth slurries were formed. Liquid gum arabic was added (Winsor & Newton; 25 g for verdigris and 22.5 g for atacamite), and each slurry mixture was ground on a glass plate with an etched glass muller until the pigment particles were fine. The mixtures were placed into petri dishes and air dried. Once dried, each pigment was further ground without additional moisture to achieve a fine powder, resulting in 30.5 g of verdigris and 31 g of atacamite, both containing gum arabic.

Application of inks and pigments to paper and pre-aging

A total of 35 samples were prepared for each of the ink, pigment, and paper control groups. Whatman #1 paper was used as substrate for both the ink and pigment samples. To ensure even distribution of the ink, single sheets of Whatman #1 paper, 10 x 20 cm, were immersed in an ink bath for 30 seconds, removed, and hung diagonally to dry. Any excess ink that pooled at the bottom corner was removed by blotting to create a more even sample.

Pigment mixtures were prepared by adding 1.5 g of pigment to 5 ml of water. To ensure an even distribution of the pigment, 2 ml of the pigment solution was airbrushed onto Whatman #1 paper. A Mylar mask was used to provide a consistent sample area of 5 x 19 cm. This resulted in an estimated pigment concentration of approximately 0.0034 g/cm^2. Figure 5 is a representation of the ink and pigment samples.

Pre-aging was carried out in a Votsch climatic chamber, type VC 0020, using a cycle of 55°C at 80% RH for 6 hours followed by 55°C at 35% RH for 18 hours. The inks were aged for 1 day (24 hours), while the pigment and paper control samples were aged for 72 hours. Different aging periods for inks and pigments were chosen based on the results of a preliminary aging test, which indicated that a longer period of aging would cause ink samples to become too brittle for treatment and further heat aging. The Whatman paper controls and the pigment samples, however, could be safely aged for 72 hours. Each group of samples was aged separately to avoid contamination.

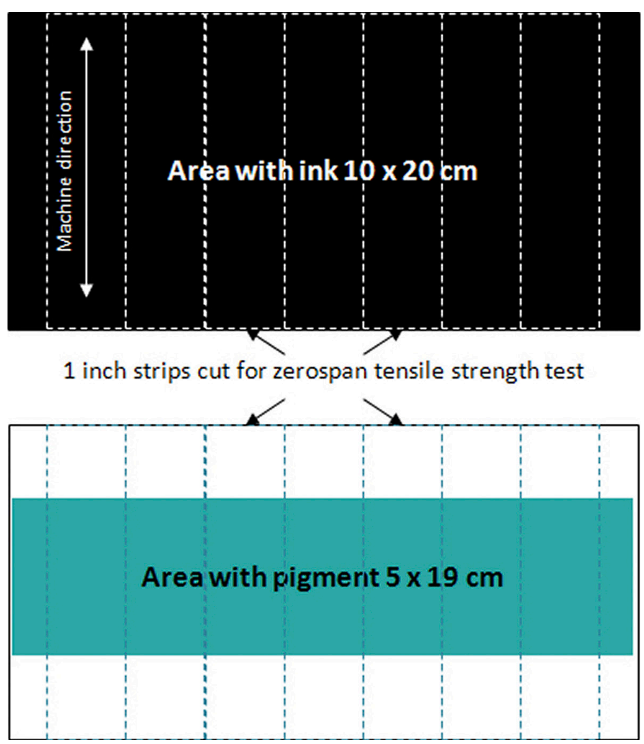

Fig. 5. Diagram of ink and pigment samples

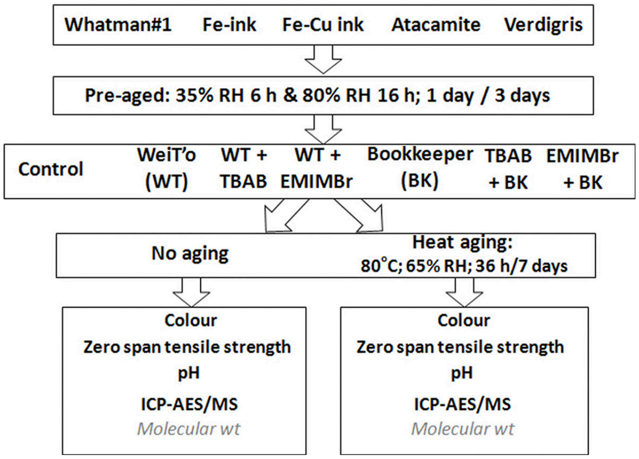

Fig. 6. Sequence of treatment, aging, and analysis

TREATMENT

Figure 6 shows the sequence of pre-aging, treatment, accelerated heat aging, and analyses. Each set of pre-aged samples was divided into seven groups of five sheets each and subjected to six separate treatments: Wei T'o alone (WT); Wei T'o followed by TBAB (WT+TBAB); Wei T'o followed by EMIMBr (WT+EMIMBr); Bookkeeper alone (BK); TBAB followed by Bookkeeper (TBAB+BK); and EMIMBr followed by Bookkeeper (EMIMBr+BK). One group of samples was kept as the untreated control group. The application of Wei T'o to samples prior to treatment with antioxidants was intended to simulate the deacidification of the Haggadah in 1987, prior to possible future treatment with an antioxidant.

Wei T'o solution was applied to samples by brushing through a layer of Reemay. After application of the Wei T'o, samples receiving further treatment were left for seven days before treatment with an antioxidant. TBAB and EMIMBr (0.03 M) solutions were prepared by dissolving the powders in anhydrous ethanol (Kolar et al. 2008). Samples were immersed in antioxidant baths for 20 minutes, with a ratio of five sheets per 200 ml of solution. Treated samples were then air dried. Bookkeeper deacidification solution was applied by spray to selected dried samples.

Accelerated heat aging

Two of the five sheets of each of the treated samples and untreated controls were subjected to heat aging in an ESPEC environmental chamber at 80°C and 65% RH. The inks were aged for only 36 hours; the Whatman controls and the pigment samples were aged for 7 days.

Analysis

Color measurements were taken using a Minolta CR300 Chroma Meter with a D65 illuminant. Pigmented samples were analyzed on the recto (pigment side) and the verso (paper side), and the inked samples and Whatman paper controls were analyzed only on the recto, as they showed no difference in color between the recto and verso. Color measurements were taken after pre-aging and before treatment, after treatment, and after heat aging.

Zero-span tensile strength was measured using a Pulmac tensile tester following the TAPPI standard (TAPPI 1985). The samples were cut into strips 1 in. (2.54 cm) wide along the machine direction, and were conditioned at 23°C and 50% RH for at least three days before testing.

The TAPPI standard (TAPPI 1988) for measuring pH was modified for small samples. Deionized water (8.5 ml) was added to samples (~0.12 g) and extracted for 1 hour. Measurements of the extract were taken using an Orion EA940 Ionanalyzer with an Orion ROSS® Ultra-flat pH combination electrode. The pH of the deionized water was also measured.

A multi-element scan of selected samples was conducted by Caduceon Environmental Laboratories Ottawa (Caduceon 2012) using inductively coupled plasma atomic emission spectroscopy (ICP-AES, EPA method 6010).

RESULTS AND DISCUSSION

Color change after treatment

The change in color and appearance immediately after treatment is an important factor for evaluation. Treatments that cause significant changes in color or appearance will not be used even if they are beneficial to the paper. Figure 7a summarizes the change in color coordinates of the samples after treatment; Figure 7b indicates color change after heat aging.

The Whatman papers were yellowed slightly after Wei T'o treatment. The iron and iron-copper inks darkened and became more yellow with time, even without treatment. All the inks treated with Wei T'o and an antioxidant became darker (decrease in L*) and less blue or more yellow (increase in b*). Visually, the inks appeared more saturated. Some ink samples treated with Bookkeeper had an uneven white deposit of magnesium oxide (MgO) on their surfaces, which accounts for their increased L* values.

After deacidification, both the verdigris and atacamite samples showed very little change in color, with or without antioxidants, both on the pigment and the paper sides. The Bookkeeper-treated samples were slightly lighter on the pigment side, likely from the MgO deposit.

Color change after heat aging

After heat aging, both the Bookkeeper- and Wei T'o-treated Whatman papers became darker (decrease in L*) and more yellow (increase in b*) compared to the untreated controls, and Wei T'o-treated samples were more yellow than Bookkeeper-treated samples. Slight yellowing is commonly

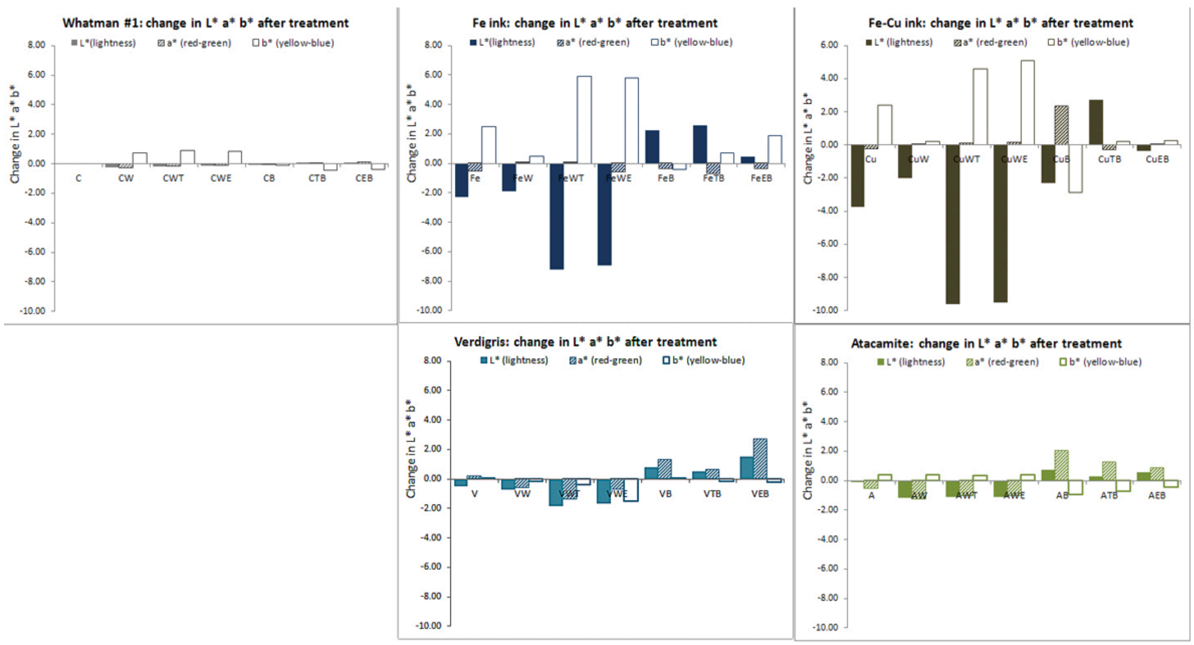

Fig. 7a. Change in L* (lightness), a* (red–green), and b* (yellow–blue) after treatment (C=Whatman #1 control; Fe=iron-gall ink; Cu=iron-gall ink with copper; V=verdigris; A=atacamite; W=Wei T'o; B=Bookkeeper; T=TBAB; E=EMIMBr)

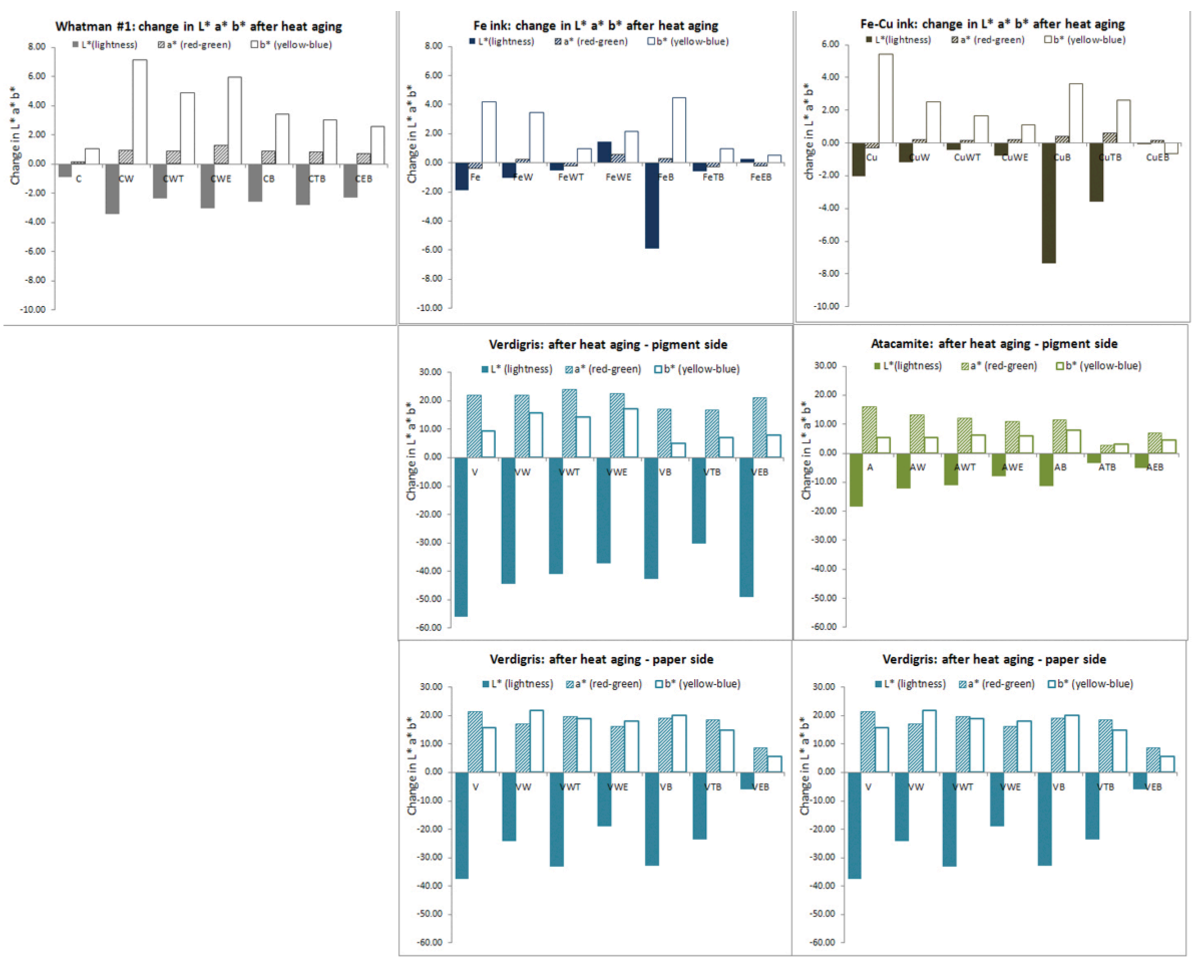

Fig. 7b. Color change in L* (lightness), a* (red–green), and b* (yellow–blue) after heat aging (80°C, 65% RH; inks for 36 hours; Whatman #1 controls and pigments for 7 days)

observed with magnesium-deacidified papers, especially ligneous papers such as newsprint. The benefits of deacidification with magnesium compounds have been demonstrated despite this yellowing (Dupont et al. 2002), and the results of this study confirm them.

After heat aging at 80°C, the ink samples treated with antioxidants showed the least color change. Both untreated control inks became more yellow (increase in b*) and slightly darker (decrease in L*). The samples treated with Bookkeeper but without an antioxidant showed the most darkening and yellowing.

Heat aging caused verdigris to decompose, forming a dark brown copper oxide. Most of the measured color change on the pigment side is a result of this conversion. A heavy white deposit on the pigment side of the Bookkeeper-treated samples became very prominent on the dark brown pigment. Compared to the untreated control, all of the treated samples were less dark. On the paper side, a combination of the dark copper oxide coming through the paper and copper-catalyzed oxidation of the paper resulted in darkening (decrease in L*). The treatment that reduced this darkening most significantly was EMIMBr+BK.

After heat aging, atacamite samples became darker on both the pigment and the paper sides. Darkening on the paper side was mainly caused by copper-catalyzed oxidation. The three treatments that resulted in the least color change were TBAB+BK, EMIMBr+BK and WT+EMIMBr.

pH

Paper stability is largely determined by pH (Zou et al. 1994; Bégin et al. 1998; Strlič et al. 2004). Below pH 7.3, the rate of cellulose deterioration is a function of pH: the lower the pH, the higher the rate (Strlič et al. 2004). Figure 8 shows the pH of all the samples after treatment and after heat aging. Both Wei T'o and Bookkeeper deacidification increased the pH of Whatman #1 paper from 6 to 10. Neither treatment with antioxidants nor heat aging changed the pH.

Without treatment, the two heat-aged sets of ink samples had a pH of approximately 2.5. Both Wei T'o and Bookkeeper treatments, with and without antioxidants, increased the pH of the inks to varying degrees, but the inks remained acidic (below pH 6). This means not all the acids were neutralized.

In general, the iron-gall inks with copper had lower pH than iron-gall inks without copper after treatment. For the iron-gall inks without copper, Wei T'o-treated samples had higher pH than Bookkeeper-treated samples. The Bookkeeper-treated ink samples increased marginally in pH. The WT+EMIMBr combination produced an anomalously high pH, possibly due to an uneven application of Wei T'o. Neither treatment with antioxidants nor heat aging changed the pH.

Both Wei T'o and Bookkeeper treatments increased the pH of the atacamite samples from 6 to 10. Wei T'o-treated samples had higher pH than Bookkeeper-treated samples. Heat aging lowered the pH for all the samples to different degrees. Those treated with antioxidants had higher pH.

Verdigris samples had a pH of 6 prior to treatment. Wei T'o treatment increased the pH to 10; after heat aging, the pH decreased to 8. The Bookkeeper-treated verdigris samples showed an unusual pattern. After treatment, the pH of the pigmented areas remained at 7, while the surrounding paper had a pH of 10. The lower pH in the pigmented areas could result from a reaction between the magnesium oxide in

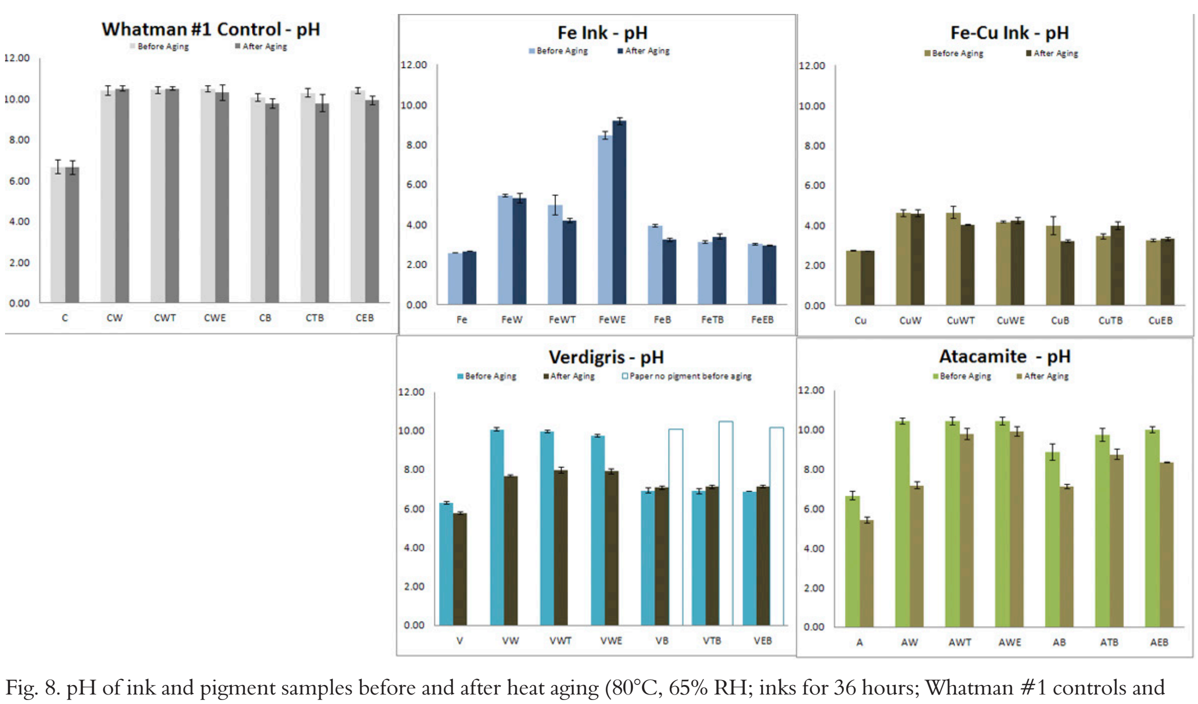

Fig. 8. pH of ink and pigment samples before and after heat aging (80°C, 65% RH; inks for 36 hours; Whatman #1 controls and pigments for 7 days)

Bookkeeper and the copper acetate in verdigris, perhaps forming a buffer. After heat aging, the pH of the pigmented areas did not decrease, as it did in the case of the Wei T'o-treated verdigris, but remained at 7. The addition of antioxidants did not change the pH.

ICP-AES: Concentration of copper, iron, and magnesium in samples

Table 1 summarizes the concentrations of copper, iron, and magnesium ions in the ink and pigment samples. The magnesium content of the samples reflects the deposition of the two deacidification agents: methyl/ethyl magnesium carbonates in Wei T'o and magnesium oxide in Bookkeeper. Magnesium content ranges from 90 to 550 µmol/g of sample. The differences are largest among the iron-gall ink samples. Overall, Wei T'o-treated samples, especially those with antioxidants, have the highest concentrations of magnesium.

As expected, iron concentration is significant only in the two sets of ink samples. The concentration is quite uniform among all the ink samples, with an average of 264 µmol/g for iron-gall ink samples without copper, and 175 µmol/g for iron-gall ink samples with copper.

The copper concentration was the main interest for this study. The average copper content in the samples of iron-gall ink with copper was 120 µmol/g with a copper:iron ratio of 0.68, confirming the molar ratio of the original ink preparation. For the pigment samples, though the application was not unusually heavy, the copper content of the samples was much higher than in the copper-containing inks. For verdigris it was 1270 µmol/g, and for atacamite, 2060 µmol/g. While these concentrations are higher than those found in other studies (Kolar et al. 2008), they are representative of a single application of a pigment solution to paper, like the colorants found in the Haggadah.

		No treatment	WeiT'o	WeiT'o + TBAB	WeiT'o + EMIMBr	Bookkeeper (BK)	TBAB + BK	EMIMBr + BK
Whatman#1								
Mg	umol/g	0.82	281	547	531	324	210	356
Fe	umol/g	0.13	0.11	0.14	0.16	0.36	0.30	0.30
Cu	umol/g	0.11	0.28	0.08	0.11	0.13	0.47	0.19
Iron gall ink								
Mg	umol/g	5.35	551	328	90	291	181	118
Fe	umol/g	283	206	269	244	297	272	276
Cu	umol/g	0.25	0.13	0.19	0.19	0.16	0.27	0.22
Iron Copper ink								
Mg	umol/g	4.94	420	317	356	220	312	156
Fe	umol/g	171	201	172	150	177	171	179
Cu	umol/g	120	124	120	105	126	118	124
Atacamite								
Mg	umol/g	5.35	206	292	275	168	167	150
Fe	umol/g	0.36	0.52	0.36	0.38	0.52	0.50	0.43
Cu	umol/g	2110	2457	1780	2000	2236	1953	1890
Verdigris								
Mg	umol/g	6.17	234	412	347	247	377	128
Fe	umol/g	0.52	0.04	0.04	0.04	0.23	0.30	0.16
Cu	umol/g	1277	1276	1387	1080	1669	1124	1069

Table 1. ICP-AES Results: Concentration of copper, iron, and magnesium in samples

Zero-span tensile strength

Zero-span tensile strength is a sensitive test for measuring paper fiber strength. There is a good correlation between zero-span tensile strength and the molecular weight of paper (Jerosch et al. 2002). While molecular weight analysis is very sensitive to changes, especially with undegraded paper, zero-span tensile strength tests are sensitive even for degraded papers (Caulfield and Gunderson 1988). The zero-span tensile strength results are expressed as percent retention after heat aging: a ratio of the strength after aging to that before aging (fig. 9). The lower the percentage of retention, the weaker the paper after aging. These results were used to determine the effectiveness of treatments in protecting paper.

Whatman paper without inks or pigments is a stable paper. Its zero-span tensile strength did not change after seven days of heat aging. Deacidification and antioxidant treatments did not affect fiber strength, even though the paper became slightly darker and more yellow after heat aging.

For the two acidic inks, both Wei T'o and Bookkeeper deacidification greatly improved the zero-span tensile strength of the paper, even though for some of the Bookkeeper-treated samples, the pH was increased only marginally. Wei T'o-treated samples, with a higher pH, retained more strength than Bookkeeper-treated samples. The addition of antioxidants did not improve strength retention beyond that achieved by deacidification alone. Figure 10 shows the change in percent retention of tensile strength with the corresponding pH. Below pH 6, small increases in pH are correlated with substantial increases in fiber strength retention.

With atacamite samples, deacidification alone improved paper strength marginally. The combination of deacidification and antioxidant treatments resulted in marked improvement in paper strength compared to no treatment or deacidification alone. Bookkeeper with antioxidants gave the best results.

Results from the verdigris samples were not definitive. Treatment with Wei T'o, with or without an antioxidant, did not improve paper strength even though the pH of the samples was very alkaline. Bookkeeper-treated samples showed some improvement in paper strength, especially with EMIMBr.

Summary

Cellulose or paper deterioration follows two main pathways: acid-catalyzed hydrolysis, the predominant reaction below pH 7 (Strlič et al. 2004), and oxidation, a process catalyzed by ions of transition metals such as iron and copper, and predominant at neutral or slightly alkaline pH. For treatment

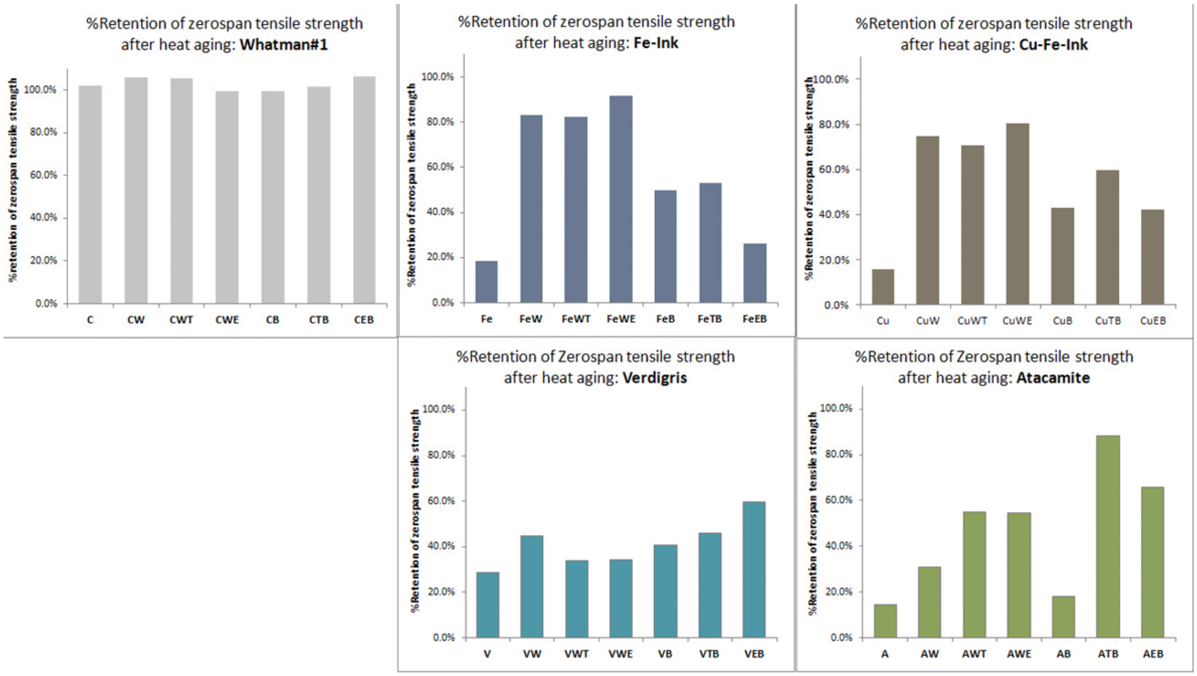

Fig. 9. Percent retention of zero-span tensile strength with and without heat aging (80°C, 65% RH; inks for 36 hours; Whatman #1 controls and pigments for 7 days)

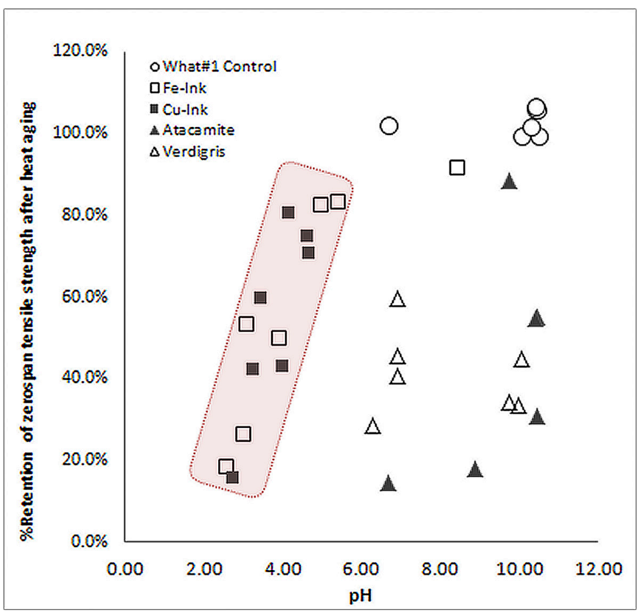

Fig. 10. Correlation of percent retention of zero-span tensile strength (after heat aging) with pH (before aging)

decisions, if the paper is acidic, the priority is to neutralize the acids. Deacidification treatments do not automatically ensure neutralization of all the acids. It is important to verify the pH of the inked lines on the manuscript, not of the surrounding paper alone. If the paper is not acidic, then the priority is to mitigate oxidation by interrupting the effects of transition metal ions.

The acidic ink samples from this study showed that even a small increase in pH will stabilize paper against strength loss. Since the inks remained acidic (below pH 6) after deacidification, deterioration by hydrolysis will continue, albeit at a lower rate. Because of the predominance of hydrolysis, the benefits of antioxidants presumably were not evident in these samples because of their acidic pH. While deacidification increased the stability of the paper, treatment with Wei T'o made the inks appear more saturated, darker, and more yellow. Treatment with Bookkeeper left white deposits and caused the inks to appear slightly darker.

In 2007, the pH of the inked areas on the Haggadah was determined to be 5.0, an increase from 3.6 prior to the 1987 Wei T'o treatment. While the ink is still slightly acidic today, it is believed that the Wei T'o treatment has delayed corrosion. Deacidification was necessary, but it was not sufficient.

With the verdigris samples, very little change in color or appearance was observed after treatment. Heat aging at 80°C resulted in conversion of verdigris to copper oxide; these results may not be representative of natural aging. In terms of retention of fiber strength after heat aging, the only treatment that showed some benefits was EMIMBr+BK. Any benefits from other deacidification treatments, with or without antioxidants, were not clearly evident, despite the neutral to alkaline pH of the treated samples.

The atacamite samples showed very little change in color or appearance after treatment. After heat aging, the WT+EMIMBr, TBAB+BK, and EMIMBr+BK samples showed the least color change. Deacidification alone, with Wei T'o or Bookkeeper, increased the pH from 6 to 10, but there was no improvement in paper strength after heat aging. The addition of antioxidants improved paper strength after heat aging. Samples treated with Bookkeeper and an antioxidant had the highest strength retention.

CONCLUSION

The Haggadah manuscript has been mechanically stabilized, and it is being stored at 40% RH and 18°C in the dark, with restricted access. Results from this study show that, for iron-gall inks, the benefits of the two antioxidants studied are not expected to be evident when the inks are still acidic. However, the Wei T'o treatment in 1987 is believed to have significantly slowed the rate of corrosion by neutralizing some of the acids. This study also showed that TBAB and EMIMBr are effective in protecting paper with atacamite. The method of application would be important to ensure that sufficient antioxidant remained in the affected area.

This study has added to the body of knowledge available on treatment using antioxidants. However, the results do not show clear benefits from using the two antioxidants to treat iron-gall inks or verdigris. Further research and confirmation of their efficacy is needed before they can be used in treatment of the Haggadah.

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REFERENCES

Banik, G. 1989. Discoloration of green copper pigments in manuscripts and works of graphic art. *Restaurator* 10(2): 61–73.

Banik, G., and J. Ponahlo. 1982. Some aspects of degradation phenomena of paper caused by green copper-containing pigments. *The Paper Conservator* 7: 3–7.

Bégin, P. L., D. W. Grattan, N. Gurnagul, J. G. Iraci, E. Kaminska, D. Woods, Xuejun Z., and S. Deschatelets. 1998. The impact of lignin on paper permanence: A comprehensive study of the ageing behaviour of handsheets and commercial paper samples. *Restaurator* 19(3): 135–154.

Caduceon Environmental Laboratory. 2012. Report B12-03526. Unpublished analytical report, Ottawa.

Caulfield, D. F., and D. E. Gunderson. 1988. Paper testing and strength characteristics. *TAPPI Proceedings of the 1988 Paper Preservation Symposium. October 19–21.* Washington, DC: TAPPI Press, Atlanta. 31–40.

Daniels, V. 1987. The blackening of vermilion by light. In *Recent advances in the conservation and analysis of artifacts: Jubilee Conservation Conference, London 6–10 July 1987.* London: University of London, Institute of Archaeology, Summer Schools Press. 280–282.

Daniels, V. 2002. Aging of paper and pigments containing iron and copper: A review. In *The broad spectrum: Studies in the materials, techniques, and conservation of color on paper*, ed. H. Stratis and B. Salvesen. London: Archetype Publications. 116–121.

Dupont, A.-L., J. Barthez, H. Jerosch, and B. Lavédrine. 2002. Testing CSC Book Saver, a commercial deacidification spray. *Restaurator* 23(1): 39–47.

Helwig, K., and M.-C. Corbeil. 2008. Analysis of samples from a Haggadah manuscript. Unpublished Analytical Research Laboratory Report 4538. Ottawa: Canadian Conservation Institute.

Henniges, U., G. Banik, and A. Potthast. 2006a. Comparison of aqueous and non-aqueous treatments of cellulose to reduce copper-catalyzed oxidation processes. *Macromolecular Symposia* 232: 129–136.

Henniges, U., U. Bürger, G. Banik, T. Rosenau, and A. Potthast. 2006b. Copper corrosion: Comparison between naturally aged papers and artificially aged model papers. *Macromolecular Symposia* 244: 194–203.

Jerosch, H., B. Lavédrine, and J.-C. Cherton. 2002. Study on the correlation between SEC and mechanical tests of different paper types for degradation state evaluation. *Restaurator* 23(4): 222–239.

Kolar, J., A. Možir, A. Balažic, M. Strlič, G. Ceres, V. Conte, V. Mirruzzo,T. Steemers, and G. de Bruin. 2008. New antioxidants for treatment of transition metal containing inks and pigments. *Restaurator* 29: 184–198.

Kolar, J., M. Strlič, M. Budnar, J. Malešič, V. S. Šelih, J. Simčič. 2003. Stabilisation of corrosive iron gall inks. *Acta Chimica Slovenica* 50: 763–770.

Kolbe, G. 2004. Gelatine in historical paper production and as inhibiting agent for iron-gall ink corrosion on paper. *Restaurator* 25: 26–39.

Mairinger, F., G. Banik, H. Stachelberger, A. Vendl, and J. Ponahlo. 1980. The destruction of paper by green copper pigments, demonstrated by a sample of Chinese wallpaper. In *Conservation within historic buildings: Preprints of the contributions to the Vienna Congress, 7–13 September 1980*, ed. N. S. Brommelle, G. Thomson, and P. Smith. London: International Institute for Conservation. 180–185.

Maitland, C. 2007. Where archival and fine art conservation meet: Applying iron gall ink antioxidant and deacidification treatments to corrosive copper watercolours. Paper presented at the 2007 ANAGPIC Conference, Harvard University Art Museums, Straus Center for Conservation and Technical Studies, Cambridge, Massachusetts. http://www.ischool.utexas.edu/~anagpic/2007pdf/2007ANAGPIC_Maitland.pdf (accessed 06/27/12).

Malešič, J., J. Kolar, M. Strlič, and S. Polanc. 2005. The use of halides for stabilization of iron gall ink containing paper: The profound effect of cations. *e-Preservation Science* 2: 13–18.

Malešič, J., J. Kolar, M. Strlič, and S. Polanc. 2006. The influence of halide and pseudo-halide antioxidants in Fenton-like reaction systems. *Acta Chimica Slovenica* 53: 450–456.

Nevell, T. P. 1985. Degradation of cellulose by acids, alkalis, and mechanical means. In *Cellulose chemistry and its applications*, ed. T. P. Nevell and S. H. Zeronian. West Sussex, England: Ellis Horwood Ltd. 223–231.

Pataki, A. 2009. Remoistenable tissue preparation and its practical aspects. *Restaurator* 30(1/2): 51–70.

Šelih, V. S., M. Strlič, J. Kolar, and B. Pihlar. 2007. The role of transition metals in oxidative degradation of cellulose. *Polymer Degradation and Stability* 92: 1476–1481.

Shahani, C. J., and F. H. Hengemihle. 1986. The influence of copper and iron on the permanance of paper. In *Historic textile and paper materials: conservation and characterization,* ed. H. L. Needles and S. H. Zeronian. Advances in Chemistry Series 212. Washington, D.C: American Chemical Society. 367–410.

Strlič, M., J. Kolar, D. Kočar, and J. Rychlý. 2004. Thermo-oxidative degradation. In *Ageing and stabilisation of paper*, ed. M. Strlič and J. Kolar. Ljubljana: National and University Library. 111–132.

TAPPI. 1985. Zero-span breaking strength of pulp (dry zero-span tensile), T231 om-85. Atlanta: Technical Association of the Pulp and Paper Industry.

TAPPI. 1988. Hydrogen ion concentration (pH) of paper extracts (cold extraction method), T509 om-88. Atlanta: Technical Association of the Pulp and Paper Industry.

Titus, S., R. Schneller, E. Huhsmann, U. Hähner, and G. Banik. 2009. Stabilising local areas of loss in iron gall ink copy documents from the Savigny estate. *Restaurator* 30(1/2): 16–51.

Williams, J. C., C. S. Fowler, M. S. Lyon, and T. L. Merrill. 1977. Metallic catalysts in the oxidative degradation of paper. In *Preservation of paper and textiles of historic and artistic value*, ed. J. C. Williams. Advances in Chemistry Series 164. Washington, D.C: American Chemical Society. 37–61.

Wilson, H., P. Cruickshank, M. Hacke, R. Stacey, C. Carr, V. Daniels, and M. Rigout. 2011. Investigation of non-aqueous remedial treatments for iron-tannate dyed textiles. In *Preprint of ICOM-CC 16th Triennial Conference, 19–23 September 2011,* ed. J. Bridgland. Lisbon: Critério. n.p.

Zou, X., N. Gurnagul, T. Uesaka, and J. Bouchard. 1994. Accelerated aging of papers of pure cellulose: Mechanism of cellulose degradation and paper embrittlement. *Polymer Degradation and Stability* 43(3): 393–402.

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The Mysterious Voynich Manuscript: Collaboration Yields New Insights

ABSTRACT

One hundred years ago, a book dealer named Wilfred Voynich acquired a mysterious vellum manuscript, apparently written in an unknown language. He developed an intense interest in the manuscript and eventually traced its history back to the 17th century court of Rudolf II of Bohemia. Surviving documents show that the meaning and origins of the manuscript were unclear to scholars at that time. Some speculated it was written by the 13th century English natural philosopher Roger Bacon, a theory that Wilfred Voynich ultimately favored. Many scholars have studied the volume over the last four centuries, including 20th and 21st century cryptanalysts who have grappled with the question of whether the book is an encoded text based on a known language, a previously unknown language, or nonsense.

The Voynich Manuscript, as it has become known, was donated to Yale University's Beinecke Rare Book and Manuscript Library in 1969. In late 2008 an Austrian film crew approached the Beinecke with a proposal to conduct materials testing on the Voynich Manuscript and make a film about it. This prompted an exciting collaboration between curators; scientists from McCrone Associates in Westmont, Illinois, who characterized the inks and paints; the NSF-Arizona AMS Facility at the University of Arizona, which carbon-dated the parchment; conservators from Yale, who performed conservation treatments and oversaw the materials testing; historians; Voynich experts from around the world; and filmmakers. The collaboration resulted in significant advances in understanding this extraordinary object. This paper summarizes those findings, outlining the history of the Voynich Manuscript, some of the theories about this extraordinary manuscript's origins, its conservation treatment, materials testing, and parchment radiocarbon dating. The advances, though significant, are humble: the Voynich Manuscript's authorship and meaning remain a complete mystery.

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Research and Technical Studies–Book and Paper Group Joint Discussion Session 2012: Mass Deacidification Today

ABSTRACT

The Book and Paper Group and the Research and Technical Studies Group presented "Mass Deacidification Today" in a joint session. Moderator Jo Anne Martinez-Kilgore began with a brief introduction to the topic before opening the stage to presenters. Representatives from each of the popular producers of mass-deacidification products were asked to offer their perspectives on the effectiveness of their past and present treatments. To round out the session, two independent presenters were also invited to share their recent research into the risks and effectiveness of popular mass-deacidification processes currently in use in libraries and archives. Following the presentations, an audience question-and-answer period allowed participants to have an open dialogue with presenters about their respective talks.

Representatives of mass-deacidification products included James Burd of Preservation Technologies L.P., Michael Ramin of Nitrochemie, and Dick Smith of Wei T'o Associates. Independent presenters included Fenella France of the Library of Congress and Nora Lockshin of the Smithsonian Institution Archives, in lieu of Anna Friedman of the National Archives and Records Administration, who could not attend.

This open discussion took place on May 11th, 2012, during the 40th AIC Annual Meeting in Albuquerque, New Mexico. The moderator provided panelist introductions and organized a subsequent question-and-answer discussion. Readers are reminded that the moderator does not necessarily endorse all the comments recorded, and every effort was made to record and present the proceedings accurately.

SUMMARY OF PRESENTATIONS

JAMES BURD

BOOKKEEPER DEACIDIFICATION: THE CHEMISTRY BEHIND THE PROCESS

James Burd debuted the new corporate logo for Preservation Technologies, L.P. (PTLP), which is celebrating its 20th year of commercial operation, and introduced a new division for the preservation of film and video. He provided a brief outline of his discussion, which included three main talking points addressing the effectiveness and chemistry of the Bookkeeper deacidification product. He reminded the audience that the Bookkeeper deacidification process is used throughout the world by many large institutions whose thorough vetting processes provide one basis for judging the efficacy and safety of the product.

According to Burd, Bookkeeper is widely used by conservators because it safely alkalizes books and documents. In treating these materials, conservators are primarily concerned with moisture exposure, odor production, and any changes in color or texture of the paper, inks, dyes, or any other materials commonly associated with books and documents. Burd cited early work at the Library of Congress that dealt with the safety of the Bookkeeper system, testing more than 100 different types of paper and books from the 1870s onward. This study reported that the inert fluid used in the process had no visual effect on test samples and created no immediate color changes in paper substrates. The study did, however, find color shifts in samples of blue highlighter and gamboge, as well as a lightening of dark images. Burd reported that this lightening was the result of a heavy application of magnesium oxide, which leaves abundant white particles on the surface of treated papers. He also provided a short list of materials that are known to be incompatible with Bookkeeper chemistry. Of these, he noted which items should remain acidic (e.g., blueprints) and which should be left untreated due to their historically important material composition (e.g., the Declaration of Independence).

Burd reported that there were also no known safety issues with Bookkeeper technology, either to the user or the environment. He noted that the treatment process itself has no odor, is nonflammable, and operates at safe temperatures. The residual magnesium oxide left in the paper of treated items is also nontoxic and therefore safe for handling. He further explained that the process was fully vetted for the Library of Congress by the Environmental Protection Agency and found to be environmentally acceptable and safe for atmospheric ozone. He added that Bookkeeper is a closed system that uses no solvents and has negligible effluence. Burd described how the system naturally filters out some dirt from materials and does require emptying.

The presentation then moved on to the effectiveness of the Bookkeeper system, with a description of the process and ingredients. Burd outlined the components of the system as a fine magnesium oxide powder suspended in an inert fluid. The process deposits a pure alkaline reserve into the substrate of the paper; the electrostatic charge of the liquid attracts the particles to the cellulose fibers. This method allows Bookkeeper to achieve a uniform coating of the alkaline reserve, whose activated particles adsorb and neutralize existing acids.

As part of this discussion, Burd addressed common questions regarding the particles deposited on the paper. Conservators often ask whether particulate systems differ from solvent-based systems, and whether the size of the particles matters. Burd stated that the particles used in the Bookkeeper system are 1 micron in diameter and generally fall between 2–3 microns apart. According to Burd, this coverage is sufficient because the activated magnesium oxide particles have immense internal surface area, giving the deposit of a 1% alkaline reserve five times the surface area of the paper for adsorption of acids.

Burd then discussed the importance of the distribution of the solution with regards to any long-term effects that might be observed. He stated that dipping or evenly spraying the Bookkeeper solution onto collections are the best application methods to achieve a uniform appearance in the treated material. If there is any darkening or yellowing as a result of treatment, these methods will make it uniform across the entirety of the material. He further stated that the acidic components of books and documents migrate through treated objects to the alkaline particles on the surface and are adsorbed, the single most important factor in the effectiveness of the Bookkeeper product. Burd cited studies in which both volatile and nonvolatile acids were shown to migrate between sheets of paper. He stated that all acids—regardless of whether they are treated with a solvent- or a particle-based system, or whether the treatment is applied to the surface alone or penetrates completely through the paper substrate—will migrate and be adsorbed by the alkaline reserve.

Burd then described the methods used to determine the efficacy of the Bookkeeper solution. Standardized sealed-tube accelerated-aging tests, which were developed by the Library of Congress and are preferred by PTLP, produce results that look more like naturally aged paper. Burd briefly described several nonstandard and less vetted tests, which cycle temperature and humidity, before describing the physical characteristics of artificially aged paper samples he had brought. The sample that had not been treated with Bookkeeper before accelerated aging had darkened and was very brittle, while the Bookkeeper-treated sample darkened very little by comparison and retained flexibility. He noted that studies have shown that temperatures used in accelerated-aging tests have little to no effect on the results, especially when it comes to testing alkaline reserve.

In conclusion, Burd noted that 29 years after pioneer Dick Smith first gave presentations on mass deacidification, the same discussions continue. The reason, he stated, is that conservators have not accepted the technology completely. He then questioned whether the conservation community is doing enough, since there is so much material that remains untreated. He suggested that the greatest risk of mass deacidification is doing nothing at all.

James Burd, President And Ceo, Preservation Technologies, L.P.

DR. MICHAEL RAMIN

DURABILITY, QUALITY CONTROL, AND INK-CORROSION TREATMENT WITH THE PAPERSAVE SWISS MASS-DEACIDIFICATION PROCESS

Dr. Michael Ramin opened by thanking the audience for inviting him to come and speak about the Papersave Swiss mass deacidification process. He commented on the importance of preserving our cultural heritage and on the particular risks associated with acid decay and ink corrosion in books and archival materials. He noted that mass deacidification provides a cheaper alternative to digitization in ensuring the longevity of research materials.

He began the talk by describing the chemical basis for the solution as magnesium titanium alkoxide dissolved in the nontoxic solvent hexamethyldisiloxane (HDMO). Dr. Ramin commented on the relative safety of the process for both the user and the objects in treatment. He described the practical aspects of the process, indicating that there is no agitation necessary to achieve the desired result, thereby limiting the overall physical risk. Although the treated objects remain stationary, he claimed that the active compound penetrates the paper fully. During drying, the deposited magnesium titanium oxide reacts with water and carbon dioxide to produce magnesium bicarbonate, titanium dioxide, and ethanol.

Dr. Ramin then described the equipment, treatment protocols, and typical batch size for the Papersave Swiss process. Each 800 kg batch of material is placed into a 10,000 L tank of solution. Every treated batch requires a pre-drying step, which is necessary to stave off an early reaction that can cause particles to be left on the paper surface. During the drying stage after treatment, all residual HDMO solvent is removed and the alkaline reserve is built. He noted that most archival documents and dry permeable materials can be treated with this system. He also stated that all of the chemicals are produced by Nitrochemie and are fully recyclable. Dr. Ramin reiterated the importance of Papersave's ability to neutralize acidic decay, though he was careful to point out that it cannot be used to reverse existing deterioration and brittleness.

Moving on to the advantages and durability of a solvent-based process, Dr. Ramin produced a cross-sectional representation of a single sheet of paper with magnesium deposited throughout. He explained that the greater penetration of the solvent-based Papersave Swiss system allows for greater neutralization of acids compared to the particle-based process used by competitors. Treated samples are tested for durability and tensile strength after controlled artificial aging. Such tests, which are conducted all around Europe to compare different mass-deacidification processes, abide by a German standard.

Dr. Ramin then described the quality-control protocols Papersave Swiss uses to ensure successful treatment. For each batch treated by the Papersave Swiss system, the company collects data on alkaline reserve, surface pH, consistency of treatment, and color shifts. He reported that, in addition to these protocols, the company has also retested objects five years after treatment and observed no significant changes. Papersave Swiss is currently planning 10-year tests, along with a plan to compare the data with those collected for similar, untreated items.

Dr. Ramin briefly touched on how Papersave Swiss is used to treat ink corrosion on paper. He stated that the process exposes the objects to no mechanical stress, as it uses organic solvents rather than water, which can swell the cellulose structure of paper. He stated that the iron ions in the ink are immobilized as the acids are neutralized. He claimed that nearly no damage or change is observed in papers after treatment of ink corrosion.

In conclusion, Dr. Ramin reiterated that the Papersave Swiss treatment results in minimal stress to paper objects, with high consistency of penetration in each batch. He reminded the audience that Papersave Swiss puts each of its treatment batches through a rigorous quality-control protocol.

Dr. Michael Ramin, Project Manager Research/Analytics, Nitrochemie

DR. RICHARD D. SMITH

WEI T'O PAPERGUARD: COMPREHENSIVELY DEACIDIFYING, STABILIZING, AND STRENGTHENING PAPER

Dr. Smith began by introducing Wei T'o Associates and his main objective in founding the company: to develop a one-time, comprehensive mass-deacidification process. Although the Wei T'o system was initially a single-function deacidifying process, it has been developed further to protect against fungus, insects, and oxidative attack as well. He noted that Wei T'o PaperGuard may also be used to strengthen weak paper and to minimize disaster-related damage. The system itself can also be transformed into a disaster-recovery system if needed.

Dr. Smith has been dedicated to the invention of a comprehensive preservation treatment for paper since 1969, when he first determined that paper permanence would require more than mass deacidification alone. In 1972, he received his first Canadian patent for the preservation treatment of cellulosic materials. The Wei T'o pilot plant, built for Public Archives and the National Library of Canada, was initially designed to test and develop mass-deacidification treatments for a short period before being rebuilt to protect books more fully against aging. The plant, which operated from 1981 to 2002, proved to be so successful at mass deacidification that it was never rebuilt to deliver a more comprehensive treatment. However, according to Dr. Smith, the early pilot plant process had many limitations. Although the first Wei T'o system was perfectly safe for use and won awards for its environmentally safe application, the early deacidification solutions had short storage lives, were somewhat unstable, did not strengthen paper, and did not protect against biological or oxidative attack. Dr. Smith developed PaperGuard to address these limitations.

The first step of the nonaqueous PaperGuard system is vacuum drying of the objects to be treated, followed by forced penetration of a liquified hydrocarbon gas solvent containing aluminum-, magnesium-, titanium-, or zinc-based organometallic alkoxides as deacidifying and biostatic agents. The excess solution is then removed, and the biostatic alkaline reserve is deposited. Vacuum and air-conditioning processes then recover any residual solvent through condensation, and the components of the solution are recycled. Drying is followed by a strengthening phase that stabilizes the paper by catalyzing free-radical reactions between ethylene gas monomers and weakened and unstable cellulose. Finally, the treated books and documents are reconditioned to normal environmental conditions before being returned for reader use. Dr. Smith claims that the system is "environmentallly sustainable, emits no contaminants, and deposits only stable, safe residues" (Smith 2012, 2). It also takes advantage of advances in chemical engineering, combining single- and double-metal alkoxide treatments for improved deacidification, the stabilization of chemical residues from papermaking, and strengthening of weakened or brittle paper.

According to Dr. Smith, PaperGuard has the unique ability to customize treatment for a wide range of materials and applications. He added that its sterilization and vacuum freeze-drying components allow PaperGuard to be converted into a full-spectrum disaster-recovery system. He noted that the PaperGuard system can recover up to 99.5% of solvents, eliminate treatment defects, lower maintenance costs, and increase operational safety and reliability. However, Wei T'o Associates requires business partners to implement the PaperGuard system and make it available worldwide.

Dr. Smith's presentation was cut short due to time constraints, but he provided a handout and flowchart describing both the PaperGuard system and a new, high-RH, "dry" aqueous mass-deacidification system for rare and valuable books and works of art on paper. This handout (Smith 2012) was used to provide a transcript of his entire talk.

Dr. Richard D. Smith, Owner, Wei T'o Associates

JEANNE DREWES AND DR. FENELLA FRANCE

TAKING THE MEASURE: TREATMENT AND TESTING IN MASS DEACIDIFICATION

Dr. Fanella France first described the acidic collections of the Library of Congress, which cover more than 150 years of history and continue to grow yearly. The library's mass-deacidification program was started by Ken Harris, who headed the program until his retirement in 2011. It now operates under Jeanne Drewes, who was unable to attend the session.

The Library of Congress's interest in mass-deacidification processes began in the 1970s. In the 1990s, the library began to further scrutinize the use of diethyl zinc (DEZ), identifying process-related problems with the system and finding ways to eliminate them. Library staff also began to examine the Bookkeeper process, as well as other technologies, in order to determine which had the best potential to meet Library of Congress standards for deacidification. In 1996, it was determined that the Bookkeeper process met these requirements.

The Library of Congress has rigorously tested all of its deacidification treatment batches with test books and papers, and library staff continue to work closely with Preservation Technologies, L.P., (PTLP) to ensure that the same standards are met for alkaline reserve and longevity of material. In general, the Library of Congress attempts to raise the pH to 6.8–10.4, and deposits a 1.5% alkaline reserve. Dr. France commented that the partnership between the library and PTLP allows for quality control and standardized testing of the process. She added that these safeguards further ensure successful and safe treatment.

Dr. France then outlined the Library of Congress's 35-year deacidification plan, which calls for treating 250,000 books and 1 million individual manuscript sheets per year. As of 2010, the library has treated 3 million books and 8 million individual sheets. She briefly described the selection process and reiterated that acidic collections are still being acquired by the library. She commented on the common misconception that acidic materials are generally older in manufacture; acidic materials are still generated around the world. Even now, she said, 20–40% of Indian publications and 2–3% of papers from the United States require deacidification, since publishers source papers from outside the United States.

Dr. France encouraged the audience to use and download the digital resources available on the Library of Congress website. She noted that an annotated bibliography of published mass-deacidification research was prepared as a basis for assessing consistency among research programs around the globe. In 2011, the Library of Congress attempted to compare research data in order to draw conclusions about available mass-deacidification processes, but no useful comparisons could be made due to inconsistent research methods. However, Library of Congress scientists were able to identify some areas that are normally overlooked: the internal structures of books, for instance, are rarely tested consistently.

When testing the results of mass deacidification, Dr. France challenged researchers to ask the right questions: Can we be sure treatment penetrates the spines of books? Does accelerated aging mimic real-life conditions? What approach is most cost effective? Dr. France noted the difference between focusing on immediate change and the long-term effects of treatment and emphasized that the usability and longevity of collection materials over a significant period of time is most important. She also questioned whether researchers are adequately testing cost-effectiveness, given the limited resources in our economic climate.

Dr. France reiterated how difficult it is to gain an accurate measure of the different deacidification processes based on existing reserach. She noted that different units are used around the world, different components and effects are tested, and accelerated-aging protocols vary. In testing paper strength, for example, different researchers used different methods (e.g., tensile, folding, or tear-strength tests) with different units of measurement on different materials (e.g., books, papers, or surrogate papers). Dr. France went on to discuss a wide range of questions generated by the comparison of existing studies and suggested how some of these issues might be addressed in future research. She suggested that researchers could gain more informative results by redefining which information is important.

Dr. France then revisited the idea of cost effectiveness and described how the Library of Congress attempts to balance mass deacidification, digitization, and environmental control to maximize care of and access to its collections. She suggested that testing parameters for mass deacidification should be standardized across the board for all the various processes, and that testing should be conducted by independent researchers, not manufacturers or vendors. Then, she added, conservators will have solid data to support the best means of caring for the world's collections.

Jeanne Drewes, Chief and Program Manager, Binding & Collections Care/Mass Deacidification Program, and Dr. Fenella France, Chief, Preservation of Research and Testing Division, Library of Congress

ANNA FRIEDMAN, PRESENTED BY NORA LOCKSHIN

EVALUATING DEACIDIFICATION AFTER 20 YEARS OF NATURAL AGING

Nora Lockshin began by acknowledging Anna Friedman, who was awarded the Smithsonian Institution Post-Graduate Fellowship in Conservation to study the effects of natural aging on architectural drawings that had been deacidified between 1989 and 1991. The material reviewed for this project originated from Smithsonian Institution Archives Record Unit 92, and was comprised of drawings and prints dating from 1880 onward, mainly depicting Smithsonian buildings. Prior to the establishment of the current preservation unit at the archives, archivists selected objects from this collection and sent them to the Northeast Document Conservation Center (NEDCC) for treatment. Lockshin noted that the selection criteria for these items were unknown, but the documentation shows that slightly fewer than 100 of the treated items were deacidified, either by immersion in an aqueous magnesium bicarbonate bath or with Wei T'o Soft Spray.

Lockshin then offered some historical perspective on the treatment documentation, providing an image of one of the old documentation forms and noting the differences between what was considered appropriate then and what conservators might prefer today. She commented that the earlier records were missing important rationale and treatment notes that are often included as part of current practice.

Lockshin then described the extensive architectural drawings database (ADDS) that was used to select the sample sets for this project. She explained that Friedman had chosen her two treated sample sets based on whether items were treated with Wei T'o Soft Spray or immersed in a magnesium bicarbonate solution, eliminating items that had no explicit record of deacidification treatment either way. Friedman also eliminated items that might have been washed as a deacidifying step prior to non-aqueous alkalization. The ADDS was also used to choose the control sets, which featured untreated items from the collection that were similar in date and fabrication to those in the treated sample sets.

The drawings were subjected to both qualitative and quantitative observations that were explained in detail during the talk. The bulk of the quantitative data consisted of surface pH and colorimeter readings. Qualitative data included physical observations made by the researcher to determine whether any other treatment-associated problems existed. Lockshin noted that, in some cases, data collected during tests did not support the treatment documentation. She gave an example in which the pH of the recto of an object was rather low, while the pH of the verso was quite high, indicating that the object had only been treated on one side.

Lockshin used graphs to explain how the quantitative data from the sample group was compared to data from the control group to identify any trends. A pH range of 4.5–5.5 was observed for the untreated controls, while a slightly higher pH range of 4.5–10 was observed for the sample items treated with magnesium bicarbonate (most measured in the range of 6.5–8.5). The Wei T'o-treated samples produced the greatest pH range, with the lowest pH readings appearing in items that had only been sprayed on one side. Friedman found that tracing cloth impregnated with starch was the support most resistant to deacidification. Lockshin reported that in a few cases objects from the control group yielded pH readings greater than 10, suggesting that their treatment records are lost or incomplete.

The qualitative data also revealed an interesting phenomenon. In visually examining the drawings, the researchers were particularly curious to see whether any visual effects resulted from either the Wei T'o Soft Spray or the magnesium bicarbonate bath. Lockshin described how some differences were observed on the treated sides of items under long-wave UV radiation, indicating that Wei T'o spray affected the fluorescence of the item. She provided minimally processed digital photos of both the recto and verso of one such treated object to illustrate what was observed during examination. A fluorescent pattern indicating areas of higher saturation—including finger marks, which may have concentrated the absorption of the treatment solution—was notable under UV light. The grid pattern where the pH measurements had been taken was visible as a quenching of the fluorescence.

Friedman's findings were consistent with other existing research. Her data supported the results of other artificial-aging studies and further illustrated that, after 20 years of natural aging, treated items for the most part remain less acidic than untreated items. In particular, Friedman's work demonstrated that aqueous treatment by immersion in a magnesium bicarbonate solution provides more consistent results than nonaqueous spray. Friedman also used her results to perform a cost-benefit analysis of deacidification options and to develop a decision tree for use by repositories as they consider treatment protocols for similar items.

Anna Friedman, Conservator, National Archives and Records Administration (NARA); Presented by Nora Lockshin, Paper Conservator, Smithsonian Institution Archives

MASS DEACIDIFICATION TODAY: DISCUSSION SESSION

Moderator: Are the available solutions appropriate and effective for single-item, nonaqueous treatment of individual documents or books with acidic ink? Which processes are available commercially for single-item treatment?

Dr. Ramin: With the Papersave Swiss treatment it is not possible, because [single items] react too fast with water.

Moderator: So it is only a mass-deacidification process?

Dr. Ramin: Yes.

Moderator: Dr. Smith, your PaperGuard process will also only be a mass-treatment process?

Dr. Smith: Yes, I spent all this time developing a treatment that is really comprehensive. It would do all kinds of mass and sizes of books and newspapers. Single sheets, though, [could be treated] by spraying, dipping, or immersion. There is a whole host of equipment that is being developed for odd kinds of things like wallpaper, [equipment] you could carry like a backpack. There is nothing by comparison that is as universal in its potential, including the possibility of combining single-alkoxide and double-alkoxide solution systems.

Audience Member: I have a question for Jim [Burd], coming from the perspective of an end user. I have checked out a lot of new fiction books from the Library of Congress that have been treated with Bookkeeper, and I notice that as I am reading there is a gritty particulate texture, so much so that I feel like I need to wash my hands afterwards. Can you comment on that?

Burd: Sure. The Bookkeeper process depends on how much material is deposited onto the paper and the weave, the openness of the paper. Usually any sensation that comes from touching the paper is more of a drying of your hands than a coating of your hands. The particles are very absorbent and will absorb the water and moisture from your skin. Normally that goes away, so I don't know the age at which the material was treated, but as it absorbs water and ages over time it usually goes away. Some of the earlier material we treated was more heavily treated, and since then we have made changes with the process. So it is possible that it was older material. In most cases, you should not tell the difference [after treatment]. We do not expect people to know that it's been treated; it is our goal that you cannot tell.

Dr. France: I just wanted to follow up on that. On some earlier materials we were still developing the lower micron size for dispersion, so I would suppose it was from that earlier time period. I would be interested to know the particular details. We could take those items and test them. So if you can contact me, I would be really interested.

Burd: Can I comment real quickly on the ink that you mentioned earlier? For those who missed the talk by Season Tse from CCI, deacidification of ink is quite effective on acidic inks. It was quite a nice report and would be good to look at. For those of you who do not stay abreast of Europe so much, there is a terrific project called InkCor there;[1] they took a look at principally iron-gall inks, but there are a lot of other acidic inks. Deacidification by itself is not the solution for those, although there is normally a significant improvement just with deacidification, whether it is Bookkeeper or any other deacidification process.

Lockshin: I would like to respectfully disagree, until we look at Season's published paper. What I took away from that presentation is that the tensile strength of paper was increased universally, but a lot of things do remain acidic if there is not a chelating process involved. So the chemistry of inks still can be separate from the paper. It's great that the tensile strengths are increased overall, but I would look to her paper.

Audience Member: The Italians and a lot of people still say that the Bookkeeper process changes the feel of paper—not only the grittiness, but makes it feel like a different substance altogether, like plastic. They have given papers at the American Chemical Society ... . I have been asked to address that issue in the past, and I was just wondering if James Burd can address that issue in some sort of systematic way, other than saying that the process ... used to be less consistent in the past and is better now. So do they have plans for dealing with that question ... ?

Burd: Sure. When we talked with the conservators in Italy in the past, first of all, Italy's focused on water washing and rather opposed to looking unilaterally at nonaqueous deacidification. So there is tremendous interest there in furthering aqueous deacidification. So, I am not familiar exactly with the talk that they gave at the ACS. I will say that we have lots of customers in this room. To some extent, it's up to the individuals to determine whether they can tell the difference. I can tell you that in normal situations, with books that come out of our treatments, it is very difficult to tell it's been treated. I can't dispute if someone says that they can feel it. Perhaps that's true and perhaps it depends on how the particular material is treated, but it is possible. If you spray documents—and you can do so today if you like, I have some spray—it will be impossible for you know that it's done. So, I can't tell if it's an issue of quality control. I don't know the answer to that, sorry.

Audience Member: I was thinking not aqueous versus your organic solvents, ... just the organic solvent treatments ... . I was wondering if there was any other sort of response to that [question] other than ... quality control by Bookkeeper ... ?

Dr. France: Just wanted to note, though I know it doesn't actually answer the question: We have 20 years of test papers and test books. ... I have now located all of those and [will] be starting to go through those [to] start to more effectively address that question. So I will be looking at some of the earlier papers, at the slightly earlier treatments, and adding up that qualitative component as well.

Audience Member: I don't think preservation is the issue, but ... also appearance, and I think they got that down, but this is kind of an unanswered question.

Dr. Smith: I would like to maybe comment first. There have been a lot of questions about different kinds of particles and chemicals used in deacidification. Some scientists and conservators have been concerned about particle size in treatments, and I noticed that in Jim's talk today that he was recommending the TAPPI-544 test [aging of paper and board with moist heat]. TAPPI stands for the Technical Association of the Pulp and Paper Institute; they are the organization, plus one or two others, who establish methods. TAPPI's latest specifications, or most recent, have mentioned that particular method [T544] should not be used for evaluating permanent papers, or the permanence of papers. I would suggest that it's worthwhile running a test. ... In 1995 The Pulp and Paper Institute of Canada recommended a patented method of doing book deacidification where papers were interleaved with alkaline paper [and humidified]. That method used about one-fourth as much water as the TAPPI method does. My question is whether or not a deacidification treatment might be occurring [during moist-heat aging in papers treated with alkaline particles] before the aging occurs? It's pretty simple to check that. I would suggest that it may be worthwhile [for] somebody [to do] a study on that. I would also propose doing, say, an overnight [TAPPI-544] test [on particle-treated materials] using 50% RH & 90 degrees centigrade ... and then simply run a test dry-aging with very little moisture, and see how they compare. That is kind of where the controversy exists, and ... my concern is simply, are we measuring what we think we are measuring? And is the test absolutely applicable? It just doesn't seem to me that somebody can use so much less water and get an increase in permanence, and use more water and find that there is not going to be a deacidification treatment occurring ... .

Audience Member: A question of terminology for Jim Burd and a slightly more substantive question for Dick Smith. My first question is that you mentioned the term "pure alkaline reserve." What do you mean by pure alkaline reserve?

Burd: Well, I guess what I mean to say is, first of all, that [what] we are putting in the paper in terms of the magnesium oxide is very high-purity material. Really, what I meant by that was, we are not putting any solvents in; we are not putting any other ingredients other than magnesium oxide into the paper. When you get your paper and books back, what you get is magnesium oxide. You won't have any other chemistry in it at all because everything else is fully recovered.

Audience Member: OK, that clarifies it completely. The question for Dick Smith is, you mentioned very briefly that you're developing methods to optimize the pH, to select specific pH for material. You said it was [for] artists' materials, [so] I would assume you're not doing that as a part of mass treatment—that would be more of an item-by-item treatment. The question would be ... , what is your approach to getting a specific pH when you deacidify?

Dick Smith: I'm not sure I understand the question. Was the question how might one get to be able to establish treatment solutions that produce different pH values in the treated paper?

Audience Member: You were proposing this as a solution for various artists' materials, that you were interested in optimizing pH for this reason. Did I understand that correctly?

Dr. Smith: Yes, I don't know if there is a specific pH for artists' materials because they use different materials. What I am thinking is that with this use of double alkoxides—which you can make ... soluble in non-aqueous solvents and combine ... with single alkoxides—you would be able to produce, I think, even acidic pH values, neutral pH values, or very much a range of pH values. Then, my question is whether or not we should be using more zinc, which would protect against bio-attack, fungus, and that kind of thing permanently. Also, that would handle most of the different art-type problems, simply using a zinc- or zinc-aluminum type double alkoxide. At the time when I started on single alkoxides, this kind of chemistry was not available. It's progressed into doing wonderful things. There's been enormous change over the years in the kinds of chemicals and materials that are available, both in their variety and their purity. I lived through this change. When I went through school, as a little background, we used things that came out of the mine, and they varied. Nowadays, you can buy purified materials and so forth to a large extent. But the kinds of things we are talking about take highly purified materials. Chemists have learned since to build molecules with very special properties. These chemicals are expensive, but the quantities that are necessary for deacidification, and the benefits which they give, make them cost affordable. By combining the double alkoxides, which are highly soluble, with single alkoxides that are not so soluble, you can get the beneficial properties from both kinds of treatments.

Audience Member: That does answer the question, and it sounds like the compounds that you are depositing—you may have not identified them, or are not vocalizing them exactly. But they will optimize pH and potentially do other things to those materials to restore health. So that does answer my question.

Audience Member: I am curious to hear a little bit more about how the inks benefit from deacidification using the Bookkeeper system. You mentioned this in your comments, and I was curious about the chemistry behind this. How was it measured? Especially those inks that are manufactured using acidic technology [that] are supposed to stay acidic. I would like to hear more about it. My second question: Is there a certain quantity of materials that darken or yellow in reaction to the Bookkeeper system? If so, I'm curious if the ratio of materials which react this way has been measured.

Burd: First of all, acidic inks. In most cases, if you have ink that you want to be acidic and need to stay acidic—because of color, or you may lose information—clearly that's not something you want to deacidify. But if you have an acidic ink like iron-gall ink, then we want to stabilize the iron-gall. You can't just do that with deacidification. Then, we need phytate solution or something along those lines. In conjunction with that, we need to protect the substrate and stabilize those inks. We don't want to convert them necessarily to alkaline inks, but we want to stabilize the substrate and therefore protect it from further ink corrosion.

Audience Member: So you are saying you would exclude those materials that may possibly contain those types of inks?

James Burd: Well, we don't exclude iron-gall ink—certainly it benefits, that kind of ink benefits. We need to make a distinction between inks and pH-sensitive colors. The real issue is, do we want to allow color change or would we lose information with a color change? In that case, you certainly don't want to deacidify, but an acidic ink like iron-gall ink can be put through the process, although that is not the whole solution for iron-gall ink.

Dr. Ramin: For the iron-gall inks, if ... it's possible to treat them in a nonaqueous solution and you don't have to add any mechanical stress, then you have no damage of the manuscripts. If you don't want to lose the information, and you can live with a slight color change, then this is maybe better than to lose the manuscripts. You have to think about, is it the most important thing to change nothing in the original and wait until it is brittle and [has] lost information, or can you live with a small change of the color?

Audience Member: OK, thank you. That is what I was hoping to hear; I just thought that maybe there was something else missing.

Dr. Smith: I ... have a little thought: Here is a concern about yellowing in the paper from treatments. My original reaction—a long time ago, when Wei T'o was criticized because the paper yellowed—was that [the yellowing] was a measure of how good the penetration was. It was absolutely down to the molecular level, and I still raise the possibility that that exists. I believe that one of our evaluation techniques should be how [treated items] are going to look about 100, 500, or even 1000 years [after treatment]. ... Are these discoloration consequences that Michael mentions worthwhile because you sacrifice a little to gain centuries?

Burd: To address the yellowing of Bookkeeper: First of all, in solvent-based processes, it's a much more complicated chemistry with the treatment. You have alkoxides that are reacting immediately with some materials, you have alcohols that are formed and [that] can react with some materials, so it is very different kind of reaction, but in general you will see a darkening very quickly with those processes—not unlike what you will end up with anyway, with natural aging. In the case of Bookkeeper, those other complex reactions do not occur because none of that chemistry is there in the first place. That is why when you first spray it there is no immediate change to be seen. In many cases, if you do CIE L*a*b* readings and look for yellowing, you don't see that—but you can in some cases. My comment in terms of yellowing is simple: Because there [are] different yellowing effects once you spray Bookkeeper on, then you want to have a uniform coating, so that however it ages, it looks relatively uniform.

Audience Member: Did you have a chance to conduct any kind of analysis of ... the percentage of the materials that darken versus those that don't darken?

Burd: Well, to some extent the problem is [that] you have to do accelerated aging to see the darkening. There's really almost never any prompt darkening of materials. So unless you have an extended period of time—and, really, 20 years is hardly anything in these cases—you can only really address [the question through] accelerated-aging of materials, and that makes it a little difficult.

Dr. Ramin: We measure the color changes after each batch, and normally, for lignin-free paper, the delta E value is about 1, so you can measure it but you cannot see it. And for ground wood or newspaper there would [be] delta E between 2 and

3, so you see it, but if you wait some years, the untreated paper is much darker or yellower than the treated paper.

Audience Member: My question is about Wei T'o. It was mentioned that it protects against microorganisms, and I am curious to hear a little more about the chemical process. Through what part of the process does this happen?

Dr. Smith: The Wei T'o process traditionally does not [protect against microorganisms]. The kind of chemistry [that] the Library of Congress developed is a diethyl zinc treatment where the zinc is the deacidification agent. They have definitely proved it is a good deacidification agent. They recognize in some of the literature that they didn't push it, but that it was an acceptable biocide. I know of one academic study in Poland where a master's or PhD student compared zinc oxide or zinc carbonate impregnated in the paper, against the best known—in his opinion—chemical ... that had a very high standard result in protecting against fungus—and, I believe, insects, though most of his tests were with fungus. The results simply showed that zinc did a better job, and I think we can put that into an agent and use it. If you look at your medicine shelf and look at the various kinds of chemicals that you use, particularly on your skin, you will find zinc in almost all of them. You may not know this, but small quantities of zinc are put into roofing felts—you know, for roofs of houses—in ... urinals, all kinds of places like this, to prevent fungus and other kinds of things. ... There is no way that paper is going to come into that kind of treatment, you know, as we handle it. I just cite that it's effective and there is no reason we can't use it.

Dr. Ramin: Also a comment for mold: We look at paper with mold damage. We have two days of vacuum; we kill the mold. With the treatment we change the pH of the paper, and mold already in the paper likes to taste acid paper. ... After treatment, we have alkaline paper; this kind of mold doesn't like the paper any more. We kill the living mold on the paper, and normally after treatment the paper is under ideal storage conditions, so I don't think you need any further substance in the paper to avoid the mold.

Burd: There have been a couple of studies in the U.S., in fact, about mold [and] Bookkeeper deacidification. They show that the process seems to be a good improvement of mold prevention.

Dr. Smith: There is one negative aspect of zinc as a possibility: that certain types of it can be changed by light, which is why it was used in a photocopy method. It was effective, but it was temporary. It darkened the paper. I don't think it's going to occur in treatment, but it was simply something that in our evaluations we have double-checked to make sure it doesn't happen.

Audience Member: I am personally interested in hearing about studying the natural aging of papers treated with any of these processes. I would like to encourage institutions that have done this in small or large scale to try and do what Nora presented and do studies of the natural-aging characteristics. So my questions: For Fenella, I understand ... that you are now nearing about 10 years of data for collections that you have treated with the Bookkeeper process. Are you undertaking any studies of the natural-aging characteristics of those collections? For Nora, I was curious ... whether there was any data available on post-treatment storage of treated collections, and whether the treated collections were stored differently than those that you used as controls?

Dr. France: Thank you very much. Due to the time frame [of the talk] I didn't have time to go into it. And also because of budget cuts we are low on staff at the Library [of Congress] at the moment. But we are initiating a long-term study of the papers we have. We have papers back from the first testing in the 1990s from all of the different tests. The first thing we had to do is actually decide how to select from that, because there is just no way we could test all of them. Plus, we have the test books, which I mentioned, we have both the single sheets and the test books to actually see long term what's happening with the natural aging. We'll be initiating that study, hopefully within the next six months. So, please get in contact with me.

Lockshin: Thank you for that question, because it does get to address something that I was unable to discuss because of time. One thing I can say, that is really a great thing for most of the materials that were treated by NEDCC, is that almost every object—at least according to the documentation that we have, and the physical reality of what we have in our collections—is that almost every object that was treated with a deacidification and alkalization protocol was rehoused in a sealed Mylar encapsulation on all sides. We opened these to access them for the research. In some cases, one or two may have already been opened. With the exception of those outliers in the control group that were measuring in the 9–10 [pH] range—perhaps those had been unsealed by some of our prior colleagues, I don't know—or perhaps they were missed in terms of sealing, or were not desired to be encapsulated. For the most part, given the pH data that was pulled off of the fronts and backs of those drawings, we were very pleased to have an encapsulation that could otherwise be looked at as an interleaving layer.

Audience Member: May I follow up? Were the controls also encapsulated, untreated, or were the controls left as they were?

Lockshin: You know, I would have to go back to Anna for that. We did rehouse all of the materials that had been previously encapsulated, right back in; we simply didn't seal the weld that we slit open. So the ones that were reported as having been treated, I believe Anna did create some new encapsulations for them.

Audience Member: Before you went to testing and you chose the controls, were the controls also encapsulated, even though they were not treated?

Lockshin: Not necessarily.

Audience Member: No. So the controls were left as they were, in folders or ... ?

Lockshin: Probably. What happens here is about 500 drawings went to NEDCC. How they were selected, we're not sure—probably the value of the image and [its] appropriateness to the mission [and] history of the Smithsonian. Some were chosen for mending, you know, not everything went for deacidification treatment. The controls included items that were sent and [were] picked by fabrication style, not necessarily because they were the same treatment. They were actually picked because they didn't necessarily have a deacidification treatment. ... If I go back to the paperwork, I would assume those controls did not have encapsulations on them.

Post-conference clarification from Anna Friedman: All of the documents treated by NEDCC that I tested as part of my test groups (for both types of deacidification) were cut out of their encapsulations at the time of testing, then replaced in those same Mylar enclosures, as L-sleeves, when returned to the stacks. The control drawings were selected to be of similar fabrication and similar age to the test items, with no record of their ever having been treated. None of the control drawings had been encapsulated. They were deliberately selected from drawings in Records Unit 92 not sent to NEDCC to reduce the possibility they'd been treated. They were just in folders in the stacks.

Audience Member: I have a comment, then a question. This is an audience of people who know a lot about the complexity of paper, the complexity of mediums on paper, and we can make judgments about what we think are suitable materials to be deacidified, no matter how that is actually done. What I find really disturbing is the literature, the ads, the conservation supply catalogs, and trade show exhibitions, where perhaps unsophisticated audiences get the impression that deacidification should be done as a blanket treatment—that if you don't do these things, you are not going to have a collection that is going to last very long. I would request the vendors to kind of tone the rhetoric down and emphasize not only the benefits that their various processes can do, but also emphasize that the selection of materials has to be done extremely carefully—that these are never to be considered as blanket approaches, even [though they] are being sold as mass-deacidification processes. ...

My other statement, which is going to lead to a question, is [that] most of the brittle materials that we deal with—that are extremely brittle to the point of objects being unusable—usually consist of alum-rosin-sized ground-wood papers that contain a great deal of lignin. It has been reported within the last few years that if you increase the pH of the papers containing large amounts of lignin, that you actually destabilize the lignin, that it itself is more stable at pH 4 or around there. I am wondering if anybody has actually looked into the role that deacidification at very [high] pH [plays], or [does it] have an effect on the destabilization of these papers?

Lockshin: If there had been no other mention—if we had a little open time—I was going to bring this conversation back around to the theme of outreach. In my very public position at the Smithsonian Institution, we receive calls constantly about use of some magic ingredient, some silver bullet, that someone can spray on their object to preserve it and save it. So those questions sometimes speak directly to a product that they've seen curiously in a magazine, or a catalog, some newspaper report, or another one of the catalogs that is out there. Now with the Web, it is so much easier to find these options, including Bookkeeper and Archival Mist, and the preservation "save your genealogy" work kits that are out there. So, with that background in mind, I have to say, an outcome of our research—which is very notably small scale, I mean, I am surprised and pleased that we were included in this mass deacidification talk—essentially, we are talking about single-item treatment. But if we extrapolate the single to the hundreds, certainly dozens of calls I receive directly—hundreds that are out there and thousands who are potentially looking at websites, at the Library of Congress, National Archives, and Smithsonian Institution for guidance—we have to extrapolate that this is a mass treatment with spray products available on the consumer market. I have to say, the products used in our research do not make me feel comfortable recommending their use by the regular consumer without the proper selection factors in mind. We always advocate looking for a conservator first, asking whether treatment is really necessary and if that is in fact the goal of the person's use of that object. We highly recommend preventative conservation whenever we can as the biggest bang for the buck, and the safest option is going to a conservator. For smaller archives and libraries that can't afford to have a conservator on board and want to do something, we still advocate preventative conservation.

Moderator: We still need to address the lignin question before we move on to other questions.

Burd: I am delighted to hear you are having thousands of consumers ask about stuff, because they are not flocking to products like that. There are a couple quick issues regarding lignin and whether our products attack and destabilize lignin—that has been reported to some extent in literature. I can't speak definitively on those issues except to say that the least useful thing to deacidify is something that is so fragile you really can't handle it. We don't strengthen the paper, so from a selection criteria, the last thing we would recommend is that you deacidify something like that. Not because we are worried about the lignin, certainly, but simply because it's not a good value in treating the material. So I can't tell you that it is going to make it weaker faster at that point, or rather tend to slow it down, continue to slow it down—it already has very little structural strength left.

Secondly, about outreach in terms of vendors, really, there [are] not enough people doing deacidification these days, and certainly not to the extent that they need to. Companies like Creative Memories that come along and tell people to throw away their newspaper clippings because they are acidic are not doing a service. So we came out with a product called Archival Mist, but Bookkeeper and Wei T'o have been on the market a long time. The issue there is simple: People have materials to treat—they have newspaper clippings and old letters and different things. They are not going to get conservators: The best they are going to do is stick their stuff in a shoe box in improper conditions. It would be much better for them to spray it. We are not talking historical value, we are talking about family value. We don't try to mislead anybody with our product, and for the most part, it is perfectly safe to spray your newspaper clippings. So we don't really feel bad about that. What I feel bad about is that most people don't do it. Most people do not preserve their family artifacts instead of just throwing them away.

Dr. France: I just wanted to make a very quick comment. One of the things I consider a huge part of my role is educating administration about the role of preventative conservation and how we need to care—in terms of the code of ethics—for reversibility of anything we recommend. So thank you.

Audience Member: We just started a project on mass deacidification with Bookkeeper. When [Jim Burd] said, "Not doing anything's the greatest risk," I'm not sure if I agree, because the handling that is involved with Bookkeeper is extreme. I would like to point this out as a comment. I was also wondering if there is any plan on finding out better handling techniques, like [in] the Papersave Swiss process? I also want to go back to the white deposit. We had an extremely high amount of white deposits. That brings me to the question, does Bookkeeper appear in the core of the paper as much as it appears on the outside, on the surface?

Burd: About the handling of books: First of all, we have to open the books because you have to be able to get the particles to the structure of the paper. We have to be able to open them and immerse them in our solution. You can't do this in a closed option. You have to use a solvent-based process if you don't want to open the books at all. The advantage of Bookkeeper is that there are no solvents, and the disadvantage is that you have to handle [the materials]. In most cases, people aren't going to send us materials that can't be handled. If there is material that needs to be handled differently, we can address that issue, certainly. In terms of extreme handling, you need to ship it to us. We open it carefully and put it on a holder, treat it, and put it back. It is very neutrally buoyant and very low stress, but you do have to handle the paper. In terms of white material on the surface of the paper, it is distressing to hear you feel you have a lot of material on the surface of your paper. I'll be sure to address this issue. I would say that is not a typical response. I would not expect to hear that. As for your question of whether the Bookkeeper particles are in the paper as much as they are on the surface of the paper, as I mentioned in my talk, it completely depends on the porosity of the paper. It is not essential that it is through the structure of the paper to do what it needs to do.

Audience Member: Our program is called Heritage Science for Conservation, and I'm pleased to announce that we are done with our data gathering. We still have some data workup on a project that is headed by book conservator William Minter on polyester film encapsulation. We have—and I think this has been a big question in this community—seen some effects after 22 weeks of aging on the questions of whether or not to deacidify, the importance of deacidifying prior to encapsulation. We are going to be writing those up in the coming months and hopefully that will add to this discussion as well.

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NOTES

1. For more information on the InkCor project, see http://ink-corrosion.org/.

REFERENCES

Smith, R. D. 2012. Wei T'o PaperGuard: Comprehensively deacidifying, stabilizing, and strengthening paper. Handout provided at the joint Research and Technical Studies–Book and Paper Group session on mass deacidification, AIC 40th Annual Meeting, Albuquerque, New Mexico.

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Early 20th Century Pastels: An Anoxic Case?

ABSTRACT

The preservation and display of early 20th century pastel drawings on colored paper can present a challenge for institutions. The materials used in the preparation of early 20th century pastel drawings are often not stable. The paper is typically acidic and can contain appreciable quantities of groundwood pulp, making it susceptible to both hydrolysis and photo-initiated yellowing. Additionally, the dyes used to color the paper present complex chemistries and can promote oxidative degradation pathways through the generation of reactive oxygen species, possibly resulting in both photo-tendering of the paper support and catalytic fading of dyes in admixture. Furthermore, these objects in museum collections often exhibit signs of advanced degradation (i.e., brittle and discolored paper) as well as fading of colorants. At first glance, anoxic display seems to be a logical solution to enhance both the preservation of and access to these objects.

This case study of several pastel drawings by the Polish artist Witkacy also provides a summary of the research findings from the Anoxic Project conducted by the National Museum in Kraków and the Jagiellonian University. This project produced three micro-fadeometer designs, technical art history studies of several pastel drawings by Witkacy, digital reconstructions of severely faded drawings, the beginning of a mass spectral library of paper dyes, a library of micro-fadeometry library results of both historic and contemporary dyed papers under anoxic and ambient atmospheres, and a frame design that can be used to construct either anoxic or sealed micro-climate cassettes.

Paper accepted for presentation at the Book and Paper Group Session, AIC's 40th Annual Meeting, May 8–11, 2012, Albuquerque, New Mexico.

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