The Book and Paper Group ANNUAL

VOLUME THIRTY-SEVEN 2018

The American Institute for Conservation of Historic and Artistic Works

AIC
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Book and Paper Group

AIC
AMERICAN INSTITUTE FOR CONSERVATION OF HISTORIC AND ARTISTIC WORKS

The Book and Paper Group
of the
American Institute for Conservation of Historic and Artistic Works

2018

THE BOOK AND PAPER GROUP

ANNUAL

VOLUME 37 2018

Papers presented at the Book and Paper Group Session, AIC's 46th Annual Meeting, May 29–June 2, 2018, Houston, Texas

Cocktails and Mixers: Ethanol-Modified Treatments for Iron-Gall Ink (abstract)
JULIE BIGGS, LYNN BROSTOFF, CINDY CONNELLY RYAN, CLAIRE DEKLE, CYNTIA KARNES, YASMEEN KHAN, SUSAN PECKHAM, AND ANDREW DAVIS 5

John Singer Sargent: New Insights into His Watercolor Materials and Techniques (abstract)
MARY BROADWAY, VERONICA BIOLCATI, KEN SUTHERLAND, FRANCESCA CASADIO, EMELINE POUYET, AGNESE BABINI, GIANLUCA PASTORELLI, DANIELLE DUGGINS, AND MARC WALTON 6

The Conservation Treatment and Scientific Analysis of an 18th-Century Armenian Prayer Scroll
XIAOPING CAI, EMILY WILLIAMS, SYLVIA ALBRO, LYNN BROSTOFF, CLAIRE DEKLE, AND MEGHAN WILSON 8

Improved Methods of Authentication and the Resulting Shifts in Decision-Making in Parchment Conservation
PATRICIA ENGEL, MATTHEW COLLINS, SARAH FIDDYMENT, CARLA SOTO, MATTHEW TEASDALE, AND JIRI VNOUCEK 21

Looking Back and Taking Stock—A Journey through Past Projects (abstract)
ELMER EUSMAN 30

Édouard Manet's Pastels on Canvas
RACHEL FREEMAN, CHRISTINE CONNIFF-O'SHEA, AND DON H. JOHNSON 31

Branded by Fire: Treatment of *Primeros Libros* (abstract)
JEANNE GOODMAN 41

"Not Always for Ornament:" Transparent Liquid Colors for Maps, Plans, and Prints
JOAN IRVING 42

Think Outside of the Box: Displaying Paper Objects Without Using Classic Method (abstract)
JEN JUNG KU, HSUAN-YU CHEN, AND CHI-CHUN LIN. 51

Small but Bulky: Rebinding a Portable 15th-Century Book of Hours
KIMBERLEY KWAN 52

Caring for Electrophotographic Art: A Case Study of the Pati Hill Archives at Arcadia University
GILLIAN MARCUS 60

Multispectral Imaging and the Digitization of the Dead Sea Scrolls
ASHLYN OPRESCU, ORIT ROSENGARTEN, AND PNINA SHOR 71

Washi: Understanding Japanese Paper as a Material of Culture and Conservation
BROOK PRESTOWITZ AND YUKI KATAYAMA 77

The Unintended Effects of Some Book Treatments on Original or Early Binding Structures and Materials (abstract)
OLIVIA PRIMANIS. 92

Chancery Master Exhibits—Piecing It Back Together (abstract)
SONJA SCHWOLL, LORA ANGELOVA, AND ROSE MITCHELL 93

Stone Paper: Examination of Géricault's *Lion Devouring a Horse* Lithographic Printing Matrix (abstract)
CHRISTINA TAYLOR, GEORGINA RAYNER, KATHERINE EREMIN, AND CHRISTOPHER WALLACE 94

Screenprint on Plastic (Some Assembly Required): A Case Study of Joe Tilson's *The Software Chart* 1968
JOAN WEIR, ERIC HENDERSON, AND VINCENT DION 95

Optically Cleared Repair Tissues for the Treatment of Translucent Papers
ROGER S. WILLIAMS 96

Papers presented at the General Session, AIC's 46th Annual Meeting, May 29–June 2, 2018, Houston, Texas

Managing Expectations in Scrapbook Conservation Approaches
JENNIFER HAIN TEPER AND NATALIE LEONI 111

The Painting's Life, Silk or Paper: Materials and Methods for Lining a 15th-Century Chinese Handscroll at the Cleveland Museum of Art
YI-HSIA HSIAO 118

Smudges, Snakeskins, and Pins, Oh My!
NORA S. LOCKSHIN AND R. WILLIAM BENNETT III 125

Martín Ramírez's Creative Compulsions: The Composition, Construction and Conservation of His Monumental Collaged Drawings
HARRIET K. STRATIS, MARY BROADWAY, AND KEN SUTHERLAND 143

The Colors of Desire: Examination of Colorants in the *Beauties of the Yoshiwara*
JOAN WRIGHT, MICHELE DERRICK, RICHARD NEWMAN, AND MICHIKO ADACHI 149

Tips presented at the Book and Paper Group Session, AIC's 46th Annual Meeting, May 29–June 2, 2018, Houston, Texas

Tip: Local Cleaning with Gels: Acknowledging the Challenges and Successes
SOPHIE BARBISAN 152

Tip: A Hot Tip! The Use of a Soldering Iron for Conducting Polyester Encapsulation of Paper Objects
SETH IRWIN 156

Tip: Movable Pocket and Crossbar Hinge
EMILY KLAYMAN JACOBSON 160

Tip: Gellan Gum Tips
SUSAN RUSSICK, NICOLE DOBROWOLSKI, BASIA NOSEK, AND ROGER WILLIAMS 162

Tip: Mending Paper with the Lightest Available Japanese Tissue
CHRISTOPHER SOKOLOWSKI 165

Tip: Single-Day Treatment of Extremely Fractured, Varnished, Fabric-Lined Map Sections
DENISE STOCKMAN 168

Tip: Using a Compact Hanging Screen and Magnets for Temporary Installation of Oversized Unframed Works on Paper
TINA C. TAN 171

Tip: Minor Treatment for Chinese Folding Fans
HSIN-CHEN TSAI 173

Tip: Enhancing Watermark Images: A Photoshop Method
CLAIRE VALERO 178

Tip: *Shimbari* at the Book Conservator's Bench
ROGER S. WILLIAMS 181

Summaries of discussion groups at the Book and Paper Group Session, AIC's 46th Annual Meeting, May 29–June 2, 2018, Houston, Texas

Archives Conservation Discussion Group/Electronic Media Group 2018: Preserving the Protest: Collection and Care of Social Movement Archives
STEPHANIE GOWLER AND DAWN MANKOWSKI 183

Library Collections Conservation Discussion Group 2018: Matters at Hand: The Evolution of Staffing and Prioritization in Library Conservation Labs
ANGELA ANDRES, SONYA BARRON, AND JESSAMY GLOOR 194

Summary of symposium, AIC's 46th Annual Meeting, May 29–June 2, 2018, Houston, Texas

Pre-Meeting Symposium: The Current Use of Leather in Book Conservation
HENRY HEBERT AND MARIEKA KAYE 202

The Book and Paper Group Annual

Editorial Office: bpgannual@gmail.com

Online Version: www.conservation-us.org/bookandpaper

The *Book and Paper Group Annual* is published once each year in print format by the Book and Paper Group (BPG), a specialty group of the American Institute for Conservation of Historic and Artistic Works (AIC).

The *Annual* is distributed as a benefit of membership to those who were members of the BPG in the date year of the issue. Additional copies or back issues are available from AIC. All correspondence concerning subscriptions, memberships, back issues, and address changes should be addressed to:

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The *Book and Paper Group Annual* is a non-juried publication. Papers presented at the Book and Paper Session of the annual meeting of the American Institute for Conservation of Historic and Artistic Works are selected by committee based on abstracts. After presentation authors have the opportunity to revise their papers before submitting them for publication in the *Annual*; there is no further selection review of these papers. Independent submissions are published at the discretion of the BPG Publications Committee. Authors are responsible for the content and accuracy of their submissions and for the methods and/or materials they present. Publication in the *Annual* does not constitute official statements or endorsement by the BPG or by AIC.

ISSN 0887–8978
Printed in the United States of America by Edwards Brothers, Inc.

The paper used in this publication meets the minimum requirements of ANSI/NISO Z39.48–1992,
American National Standard for Permanence of Paper for Publications and Documents in Libraries and Archives.

Cocktails and Mixers: Ethanol-Modified Treatments for Iron-Gall Ink

The admixture of ethanol to aqueous treatment solutions is commonly used by conservators to mitigate the solubility of water-sensitive media. Prior research and direct observations by Library of Congress conservators have likewise indicated promising applications for the addition of ethanol to treat manuscripts with water-sensitive iron-gall ink. Building on the pioneering research initiated by the Netherlands Cultural Heritage Agency, which demonstrated the efficacy of calcium phytate and calcium bicarbonate to significantly slow the deteriorative mechanisms of iron-gall ink, a team of conservators and scientists at the Library of Congress sought to identify effective "cocktails," or ratios of ethanol and other components in the preparation of phytate and bicarbonate solutions.

This talk presented the results of a multiyear study comparing treatments on artificially aged iron-gall ink, including washing in ethanol-water mixtures, varying proportions of ethanol in phytate and bicarbonate solutions, comparing ethanol-modified magnesium phytate with ethanol-modified calcium phytate, and ethanol-modified magnesium phytate at different pH values and solution concentrations. The presentation also discussed the impact of the research on future treatment choices and procedures for iron-gall ink on paper.

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Papers presented at the Book and Paper Group Session, AIC's 46th Annual Meeting, May 29-June 2, 2018, Houston, Texas

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John Singer Sargent: New Insights into His Watercolor Materials and Techniques

As imaging technology continues to be developed in the service of material identification and mapping, long-standing assumptions about artists' media and processes can finally be tested. Analytical methods such as GC-MS, SERS, XRF mapping, and hyperspectral imaging represent opportunities to breathe exciting new life into exhibitions of works by artists who have become perennial favorites. John Singer Sargent is one such artist on whom numerous tomes have been written and about whom it may seem there is nothing more to say. This talk contradicted that notion by presenting new insights into Sargent's materials based on the coordination of close visual observation, scholarship, and material analysis using established scientific techniques as well as techniques that have only recently become available, such as hyperspectral imaging and macro-XRF mapping. The exhibition *John Singer Sargent and Chicago's Gilded Age* afforded the opportunity to conduct a technical study of eleven of Sargent's watercolors at the Art Institute of Chicago. Though the sample set is small for such a prolific artist, the works span nearly 40 years of the artist's watercolor production. He sustained passion for the medium throughout his life and, as analysis revealed, he sometimes experimented by altering his media. These discoveries were made possible through collaboration between curators, conservators, and scientists who are innovators in fields ranging from computer science to spectroscopy. They stress the importance of establishing a scientific basis for claims made about artists' processes, even if they originate from primary and secondary sources. This information adds to the extensive body of technical work that has already been published on the largest American collections of Sargent's watercolors, namely those at the Museum of Fine Arts, Boston, the Brooklyn Museum of Art, and the Worcester Art Museum.

Papers presented at the Book and Paper Group Session, AIC's 46th Annual Meeting, May 29-June 2, 2018, Houston, Texas

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The Conservation Treatment and Scientific Analysis of an 18th-Century Armenian Prayer Scroll

INTRODUCTION

Armenian Christianity has a rich tradition of contemplative prayer and religious instruction. Over the centuries, the community developed forms of personal devotion to address the desire for protection from physical and metaphysical danger. Amulets and talismans with Christian themes abound (Maranci and Meyer 2016). The *hmayil* is a typical example of an Armenian talisman in the form of a scroll. It was believed to protect the bearer, whether traveler, invalid, or other faithful in need. Traditionally, a prayer scroll would include Armenian religious iconography, as well as prayers, magical formulas, stories of healing, prayers against sickness, and protection against spells (Badmagharian 2016; Nersessian 1987). Early examples of *hmayil* were manuscripts; however, with the advent of movable type, printed scrolls became common from the 17th century onward (Avdoyan 2012).

The Library of Congress's African and Middle Eastern Division is home to one of the U.S.'s most extensive collections of Armenian research materials, including three Armenian prayer scrolls. All three scrolls were printed in Constantinople at approximately the same time. Although they contain very similar text and woodcut images, the palettes used for hand-coloring differ greatly (figs. 1–3).

Over the past 16 years, all three Armenian prayer scrolls have been treated by conservators at the Library of Congress. Since the initial condition of the scrolls upon accession varied considerably, an individual treatment approach was taken for each one. Hmayil Number 1 arrived in somewhat fragmented condition, and was reinforced, mended, and rehoused as separate panels following the original sequence. Hmayil Number 2 was in good condition and is still preserved in its original scroll format. This paper focuses on the recent conservation treatment of Hmayil Number 3, which was accessioned in severely compromised condition. The project was a collaborative one between book and paper conservators along with the Armenian specialist at the Library of Congress.

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DESCRIPTION

Acquired by the Library of Congress in 2012, Hmayil Number 3 was a gift from Michaux Burchard. It was printed in Constantinople in 1729, a time when these types of scrolls were very popular and readily available for purchase (Maranci and Meyer 2016). The text was printed, using movable Armenian type, by Astuatusatur Konstandupolsets'l, whose family had operated a printing house for 150 years (Sanjian 2012). The text appears as a single column running the length of the scroll, interspersed with woodcut illustrations of biblical stories and characters.

In its original form, the scroll would have been approximately 457 cm (15 ft.) long (fig. 4). More than 17 lengths of paper, each approximately 8.5-cm wide and 40-cm long, were glued together end to end. The scroll was printed on medium weight, cream-colored, handmade laid paper. Three different watermarks were identified, including several versions of the Tre Lune, a watermark with three crescent moons set side by side, often found in Venetian papers from the early 1700s made for Turkish export (fig. 5) (Ahmed 2016).

Like many other *hmayil*, Number 3 comprises a series of prayers, Gospel readings, and sermons. The text of the scroll is in classical Armenian, a written language in use from the 5th to the 19th centuries (Badmagharian 2016). In addition, as was customary, personal inscriptions in black ink were added to the printed text.

The decoration and iconography is also similar to that of traditional handwritten Armenian prayer scrolls, and is characterized by zoomorphic initials, side frames, and vignettes. Though incomplete in its present condition, the scroll has at least 30 illustrations of different provenance, most of which are signed "ԳՐ" (GR), the initials of Armenian artist and printer Grigor Marzuanetsi. In accordance with contemporary practice, Marzuanetsi used woodblock prints that were not his original works (Kouymjian 2015). For instance, the illustration "Tree of Life," which can be seen at the beginning of the scroll, was copied directly from the work of Christoffel van Sichem II, a well-known 17th-century Dutch artist whose woodcuts were used in the popular Dutch language Biblia Sacra. Marzuanetsi substituted his own initials, "GR,"


Fig. 1. Woodcut image from Hmayil Number 1, Constantinople, ca. 1725.


Fig. 3. Woodcut image from Hmayil Number 3, Constantinople, 1729.


Fig. 2. Woodcut image from Hmayil Number 2, Constantinople, ca. 1725.


Fig. 4. Hmayil Number 3 before treatment.

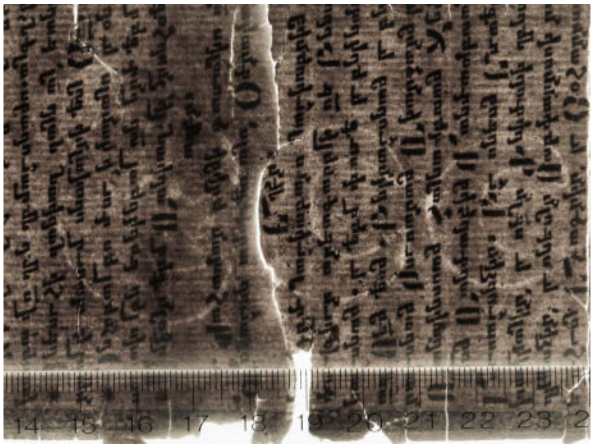

Fig. 5. Printed paper with Tre Lune watermark shown in transmitted light.

for van Sichem's "cVs" (figs. 6 and 7). All illustrations in the scroll were hand-colored, using shades of orange, red, green, pale brown, and yellow watercolor, and a metallic pigment.

CONDITION

Hmayil often suffer deterioration in serving their intended function, and Hmayil Number 3 was no exception. Many attempts to repair separating parts, using pieces of heavier weight laid paper, layers of coarsely woven cloth, and silk linings were apparent on Hmayil Number 3. During the treatment it became clear that paper patches were used at an early stage of the scroll's life, both because they were underneath the first fabric lining, and because many of the repair papers contained Tre Lune watermarks. Some repair papers also had drawings and inscriptions in various languages. Due to three centuries of unrolling and rolling, poor storage conditions and crude repairs, some text and imagery from the scroll had been lost.

When acquired by the library, the scroll was in 14 broken fragments of varying lengths, accompanied by a boxful of small "puzzle" pieces. The paper was very dirty and darkened overall, with considerable localized staining, especially along the edges. Medium to dark brown liquid stains appeared throughout the scroll. Amorphous black stains similar to mold damage were present throughout, particularly on the fabric backings. Intermittent, whitish, crumbly accretions were present on the surface of both text and illustrations.

Fig. 6. The Tree of Life, Grigor Marzuanetsi, Hymail Number 3 after treatment. Note the initials "ԳՐ" (GR) in the lower left corner.

Fig. 7. The Tree of Life, Christoffel van Sichem II, The Morgan Library & Museum, PML 126380, p. 513. Note the monogram "CvS" in the lower left corner.

Fig. 8. Section 7 before treatment, showing paper losses, creases, and tears through the image and text.

The paper was very worn, brittle, stiff, and full of breaks and tears. Numerous losses compromised the scroll's integrity (fig. 8). Across the width of the scroll, multiple repairs were stitched in blue, red, or undyed thread to reattach fragments—often in the wrong places (fig. 9).

On the verso, two layers of cloth linings once held sections together, but they no longer functioned well as backings. The crude wheat paste used to attach the paper patches and cloth linings had deteriorated significantly, contributing to the inflexibility of the scroll. The cloths had darkened with age, transferring discoloration to the scroll. The paper was delaminating from the linings. The scroll was severely tented and broken up, with numerous fragments folded back upon themselves or detaching.

The hand-coloring had changed considerably with age in some instances. While the oranges and reds were still vibrant, the yellow and brown colors appeared somewhat faded. The green colorant had sunk into the paper, turning it brown on the verso, in the manner of copper-containing pigments. Most areas of the metallic halos had darkened and lost their shine. Some particles had changed into black specks.

TREATMENT

When it arrived in the Conservation Division, the Hmayil Number 3 scroll was so fragile that it could not be served to researchers, or even handled for cataloging. Extensive

Fig. 9. Details of stitched repairs: (a) stitched repair in red thread, (b) stitched repair in undyed thread, and (c) two different images stitched together.

treatment was needed to enable access and for long-term preservation. Two senior conservators developed a phased approach to the project, but with the help and energy of two advanced conservation interns, the multiple steps required for conserving and mounting the scroll were completed within three months.

A number of decisions were required before practical work could commence. Given the size of the object and the labor-intensive treatment, a numbering system and a treatment protocol sequence were developed to make sure all the fragments and sections of the scroll could be tracked and would receive the same treatment.

After the condition and structure had been thoroughly documented, the cloth backings and stitching were removed mechanically and retained. Some well adhered paper repairs on the verso of the scroll remained in place at this stage. Local humidification with a steam pencil was used to facilitate opening creased fragments and smoothing curled edges. A soft brush and additive-free polyurethane sponges were used to reduce heavy accumulations of surface dirt and desiccated wheat paste.

WASHING

The solubility of all colorants was tested with deionized water, a mixture of 50% deionized water and 50% ethanol, and 100% ethanol. Testing demonstrated that the colorants were not immediately soluble in either water or ethanol, but immersion was not considered due to their slight friability. Capillary washing was selected to control the washing of the brittle, fragmented paper. Tek Wipe was chosen for its strong vertical capillary action and its ability to support small fragments during wet treatment (Molina and Hughes 2016). Since it can be rinsed and reused repeatedly, it was also a sustainable choice.

Following humidification in a Gore-Tex sandwich for about 30 minutes, fragments were washed face-up on a capillary unit of two Tek Wipe supports, using deionized water adjusted with a saturated calcium hydroxide solution to pH 7.5. Tek Wipe supports were changed three to four times, until no further discoloration emerged.

During each washing step, a dry sheet of Tek Wipe was placed directly on the fragments to draw out soluble discoloration from the front. Following the final wash, while the paper was still damp, paper seams were separated and remaining brown paper patches and residual adhesive on the verso were removed mechanically. Many of the paper patches were retained as historical components in the final housing of the scroll.

RECONSTRUCTION

After all the fragments had been washed, they were arranged according to the locations where they were first found, but placement of the large number of detached or misaligned fragments remained a challenge. Comparison of the scroll to the library's other two Armenian prayer scrolls proved a useful tool for assembly; many similarities in sequence were observed. In Hmayil Number 3, 27 of 30 images appeared to be better preserved in Number 1 or 2. A test tracing on polyester film demonstrated that the images were of identical size and detail, suggesting they were probably printed using the same woodblocks. Therefore, the two intact scrolls were used as references for piecing together the image puzzles of the third scroll (fig. 10). Despite the woodblock print similarities, Hmayil Number 1 and 2 were less useful in reassembling the fragmented text of Number 3. For these areas, pieces were realigned according to the edges of the paper, and with help from Tamara Ohanyan, a senior book conservator and Armenian language specialist at the Library of Congress.

PRIMARY LINING

Small groups of fragments of the scroll were assembled with a preliminary lining of lightweight kozo paper to provide a

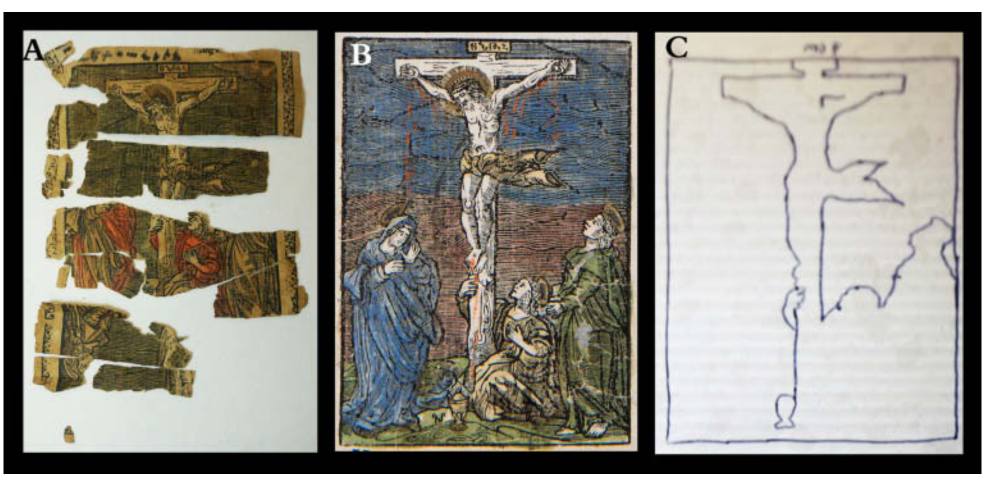

Fig. 10. Reconstruction of the fragmented image of the Crucifixion: (a) during treatment, photograph showing the fragmented condition of the Crucifixion, (b) a complete image of the Crucifixion scene in Hmayil Number 2, and (c) a tracing of the image on a piece of polyester film.

clearer interpretation of the final sequence of images and text pieces. Polyester film tracings of images from the other two scrolls were again important tools, making it possible to create accurate spacing in instances of substantial loss.

Prior to application of the first lining, fragments were humidified in Gore-Tex sandwiches. With the help of prepared tracings, they were transferred and aligned face-down on silicon-release polyester film over a light box. Strips of rayon paper[1] cut along the same grain direction as the scroll paper were placed along all four borders of the assembled fragments on the polyester film. A lightweight lining of RK1 paper was applied with dilute wheat starch paste to the assembled fragments, bordered with rayon paper. The lined assembly was placed between polyester web and thick felts to dry, with no weight on top. Use of the rayon paper strips reduced lateral shrinkage and ensured that the linings would dry flat (figs. 11 and 12).

To prepare the RK1 paper for use as the first lining and to impart an alkaline reserve, the RK1 paper was misted with a magnesium bicarbonate solution and allowed to dry. Research conducted at the library has indicated that magnesium bicarbonate can provide a moderate protective effect to counteract copper-green pigment degradation of paper.

SECONDARY LINING

On a scroll with less damage, losses might be filled individually with toned papers of similar thickness and weight, both to reestablish aesthetic unity and to achieve more consistent tension in the laminate structure. For Hmayil Number 3, the deterioration of the scroll as well as the large number of losses argued against individual fills. After discussion with the library's Armenian specialist, conservators decided to compensate for all losses with a uniformly toned second lining. Where the size of large losses could be determined accurately from the aforementioned tracings taken from Hmayil 1 and 2, spaces would be maintained in the reconstructed sequence of

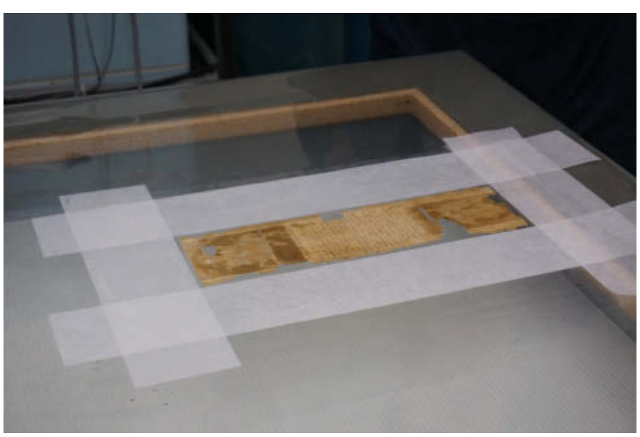

Fig. 11. Positioning four strips of rayon paper around the edges of the fragment.

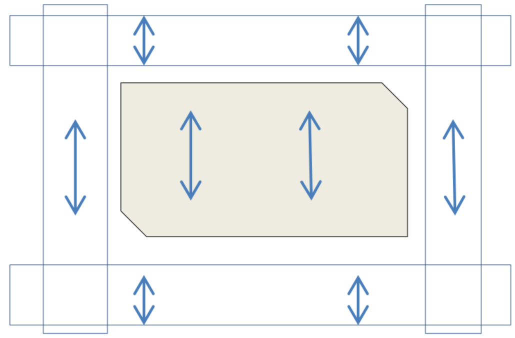

Fig. 12. Diagram showing the grain direction of the scroll fragment and the strips of rayon paper.

the text and images. It was also decided that Hmayil Number 3 would be mounted and housed flat, to help prevent future delamination of the scroll from its linings.

In preparation for the second lining, the scroll's original paper sections were identified during backing removal by overlaps in the papers and comparison to the other scrolls. A total of 17 sections were identified, some more complete than others (fig. 13). The small fragments lined with RK1 were joined together to reconstruct the original 17 sections.

For the secondary lining, a medium weight, handmade kozo tissue was chosen. Uda-gami has expansion characteristics and a laid finish similar to the paper of the scroll. It contains an alkaline buffer of Japanese clay, hakudo, which gives it a degree of opacity that is desirable for use as a fill paper. Uda-gami is also produced in a long format, well suited to the grain direction of the Armenian scroll paper. The dimensions of the secondary lining paper were determined by measuring a reassembled section. Aligning the Japanese fiber direction parallel to the grain direction of the scroll minimized curling upon drying (Nielsen and Priest 1997). To reduce the visual distraction of numerous losses, the lining paper was lightly toned on one side with acrylic paint applied by airbrush. As with the primary linings, the toned, secondary lining paper was sprayed on the verso with magnesium bicarbonate solution and left to air dry before use.

The fragment assemblies lined with RK1 were humidified and joined together face up to form the 17 original sections identified during backing removal. The RK1 lining margin along the bottom of the top fragment was retained, whilst the excess RK1 at the top of the adjoining fragment below was trimmed (fig. 14). For each assembly of RK1-lined fragments, the retained bottom margin was pasted out with dilute wheat starch paste, and the adjoining fragment positioned on the overlap and adhered into place.

Prior to application of the secondary lining, the assembled, humidified individual sections were placed face down onto a sheet of silicone-release polyester film with strips of moistened rayon paper along the sides, following the procedure

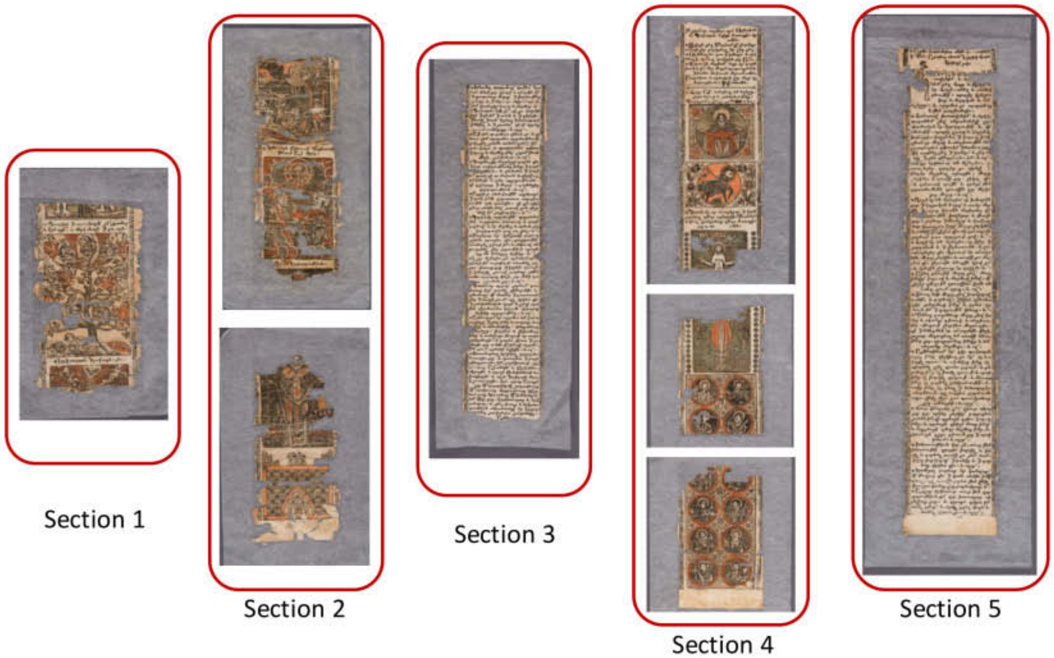

Fig. 13. Diagram showing the arrangement of the first five sections.

outlined for the first lining process. Dilute wheat starch paste was applied to the uda-gami paper which had been placed on a blotter to absorb excess moisture. The pasted lining paper was lifted on a stick and laid down at an angle onto the humidified assembled sections and brushed into place with a Japanese smoothing brush. Further melding of the secondary lining with the sections below was done by gently tapping with the ends of the Japanese smoothing brush bristles through a sheet of polyester web. At this stage, the uda-gami paper was pressed into the voids of the scroll losses from the back with a bone folder, to level the layers of the backing and original plane when seen from the front. The lined sections were sandwiched between polyester web and pressed between felts, weighted lightly with an acrylic sheet. When the lined sections were dry, the rayon strips were removed and the excess lining paper was trimmed.

A total of 42 linings was undertaken to both group the fragments together and to form cohesive images or segments of text into sections. After the final drying, a few of the linings had slight undulations along the edges, perhaps due to slightly imprecise positioning of the rayon paper. To reduce these undulations, the sections were humidified in Gore-Tex and friction dried between lightly moistened kozo paper of similar thickness, matching the grain direction of the scroll, brushing the layers of paper together, and drying them again between thick felts weighted lightly with an acrylic sheet (fig. 15).

REHOUSING

While the scroll sections are now stable, have an attractive appearance, and can be handled with care, they do not have the structural integrity to function again in a rolled format. As the Library of Congress Armenian Collections include a similar prayer scroll in its original rolled format, it was decided that the sections of Hmayil Number 3 would be mounted in custom-cut window mats, three sections per mat. The

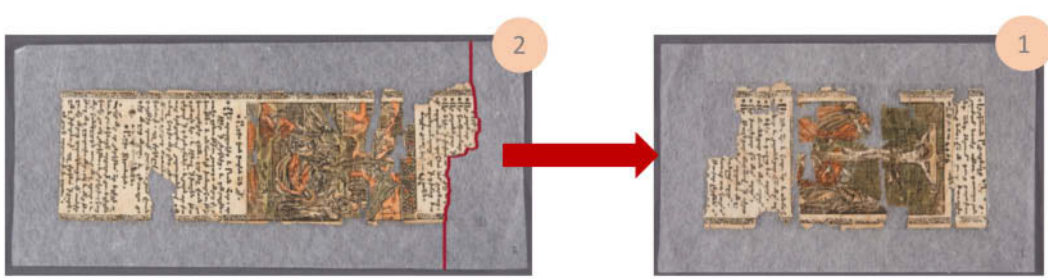

Fig. 14. Joining together the smaller lined fragments.

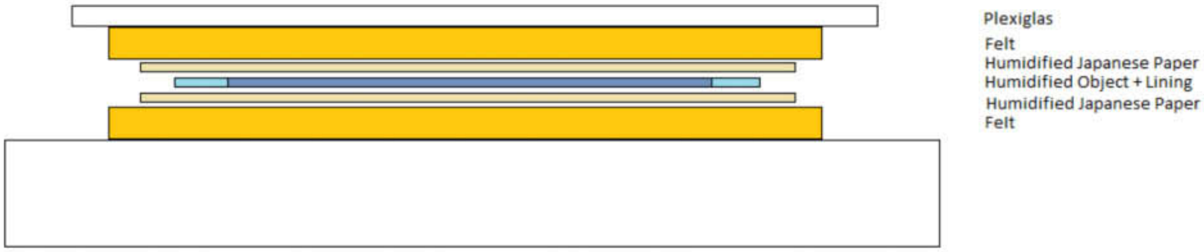

Fig. 15. Diagram showing the drying set up for the friction-drying stack.

mounting would allow for research use and facilitate digital reproduction. Three different mounting options were prepared for consideration, as seen in figure 16. The Armenian specialist and the conservators jointly chose the third option as the mounting template, because it shows the original sequence of the scroll while allowing readers to imagine areas that are missing.

Lined sections were placed into archival window mats made from museum mounting board and secured with small "half-moons" of polyester film adhered to the mounting boards with double-sided tape. This attachment allows easy mechanical removal of the sections. To protect the surface of the scroll and prevent the sections from lifting along with the window mats, a sheet of polyester film was placed within each mat and attached to the back mat with transparent tape along the upper edge. The lower edge of each polyester sheet was tucked into a channel of polyester film attached to the back mat.

The mounted sections, the historical components, and all the old repair materials were housed together in a custom box of archival corrugated board that is light enough to easily transport from shelf to reading room (fig. 17).

SCIENTIFIC ANALYSIS

Historical Armenian artists' materials and methods remain an area of interest in the cultural heritage community at large, and an area of research at the Library of Congress. As mentioned earlier, the individual palettes used to color the images of the three scrolls differ greatly. The completion of treatment of the three scrolls presented an opportunity for analysis to identify and compare the colorants used in 18th-century Armenian printed scrolls. Since the identification of colorants on the other two scrolls has not yet been completed, this paper will focus solely on Hmayil Number 3.

The colorants present on the scroll were analyzed using the noninvasive techniques of multispectral imaging and qualitative x-ray fluorescence (XRF) spectroscopy in the Preservation Research and Testing Division (PRTD) at the library.

Spectral imaging was conducted using PRTD's multispectral imaging system, supported with advanced image processing via principle component analysis and spectral curve analysis. The system is outfitted with a 50-megapixel monochrome camera with attached filter wheel, light panels

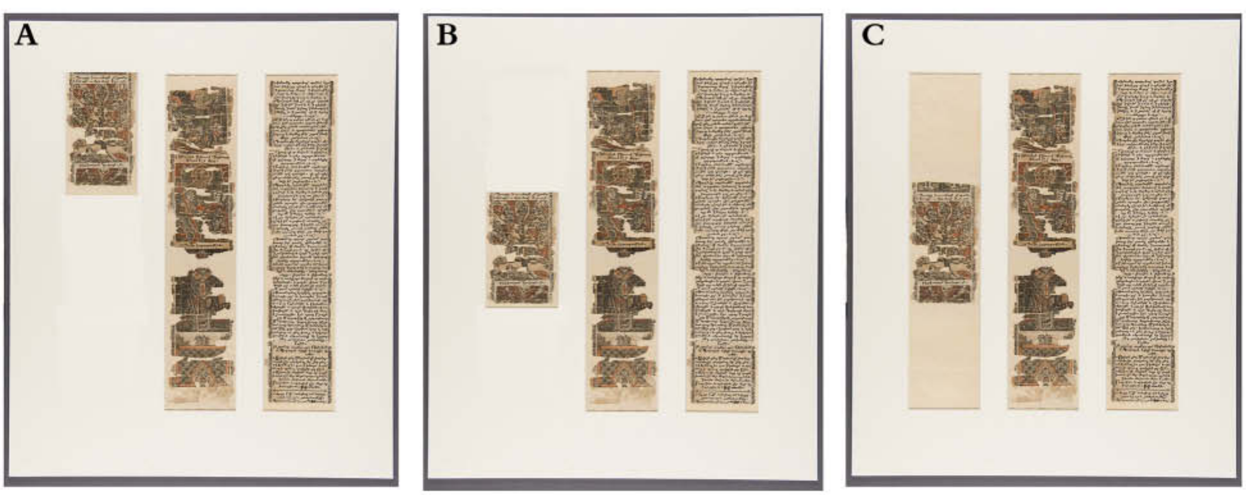

Fig. 16. Mounting options: (a) Option 1 was to trim any extra lining paper and align the sections along the top edge, (b) Option 2 was to trim away any extra lining paper and position the fragment in its original position with a custom-sized window, and (c) Option 3 was to leave the excess lining paper and keep the original section size to highlight the areas of loss.

Fig. 17. Rehousing: (a) custom storage box constructed for Hmayil Number 3, (b) four-flap enclosure for paper and thread used for previous repairs, and (c) custom storage box constructed for the textile backings used in the historic repairs.

containing LED illumination spanning 365 nm–940 nm, and integrated capture software. Each image sequence included 26 registered images. Further image processing was conducted via principle component analysis and spectral curve analysis using ImageJ and ENVI software. Principle component analysis, which was conducted by assigning a false color to areas that respond as spectrally similar, provided information on the distribution of the same pigments in the illustrations. Spectral curve analysis was used to identify different pigments by analyzing their spectral signatures and comparing to those of available reference samples in the form of spectral libraries.

XRF spectroscopy was conducted noninvasively with a Bruker Artax 400 spectrometer, which has a spot size of about 100 micrometers. The instrument is outfitted with a rhodium x-ray tube, polycapillary focusing optics, an integrated camera, and mapping capability.

ANALYSIS RESULTS AND DISCUSSION

Since each scroll's illustrations were colored using a limited palette, and many of the colorants appear on a single illustration, four sections were analyzed: (1) Section 4, Agnus Dei and Apostles images; (2) Section 6, Crucifixion and Deposition images; (3) Section 11, carpet design; (4) Section 13, horse armor (fig. 18). Analysis focused on the black ink, orange/reds, greens, yellows, and dark haloes. Measurements of the lined paper support were also taken for comparison.

ORANGE/RED

To the unaided eye there appears to be a difference in the red and orange pigments in various areas of the scrolls. For instance, the color of the sleeves of the Christ and the flowers appear red, and the color of the background of Agnus Dei

Fig. 18. Sections from Hmayil Number 3, Constantinople, 1729: (a) Section 4m, (b) Section 6, (c) Section 11, and (d) Section 13.

appears orange, as seen in figure 18a. With magnification of the image, redder areas appear to be an orange pigment on top of black print lines, which interfere with the eye's perception of that colorant. This conclusion was supported by principle component analysis, which shows that these areas are likely to be the same colorant, mixed with varying degrees of black print underneath. In addition, spectral curve analysis shows the similarity of the colorant in these areas (fig. 19).

XRF analysis of the orange/red areas reveals that this colorant contains major amounts of lead (Pb) with trace levels of cadmium and possibly also phosphorous (fig. 20). While phosphorus may arise from an organic medium used in the colorants, the finding of trace cadmium is unexpected and interesting. Rather than indicating the use of a modern red pigment, however, its consistent trace presence may possibly be linked to the lead ore used to manufacture the pigment used throughout the illustration. In addition, the lack of other detected elements, such as mercury expected in vermilion, suggests that a distinctive pigment was used throughout the scrolls examined.

YELLOW

The yellow colorant used throughout the scroll is dilute and faint. The spectral curve analysis of this yellow colorant, in comparison to reference samples, suggests that the yellow colorant is similar to gamboge or weld. XRF spectra show that this colorant contains only minor to trace elements, including aluminum, sulfur, potassium, minor to trace copper, and trace iron (fig. 21). These results generally suggest that the yellow areas contain an organic laked pigment.

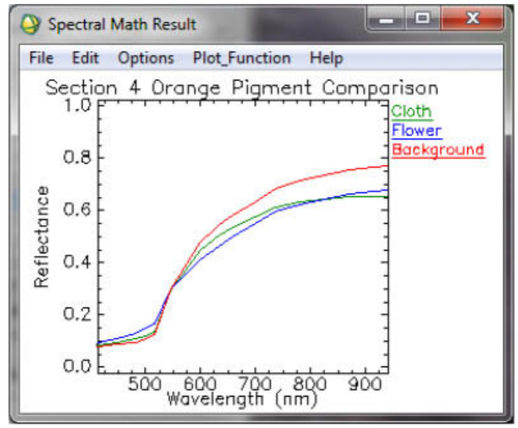

Fig. 19. Section 4: Curves plotted from spectral imaging data for red/orange pigment on the cloth of Christ's robe, the flower, and background.

Although it is possible that the trace elements arise from the source of the colorant as well as from mixed colorants. A yellow area in the cross of section 6 appears to have only minor variations of the above elemental make-up, suggesting a slightly different pigment mixture and/or contamination from nearby colorants.

GREEN

Various green areas were examined in the different sections. Under ultraviolet (UV) illumination, the green tends to absorb UV radiation, suggesting the presence of a heavy

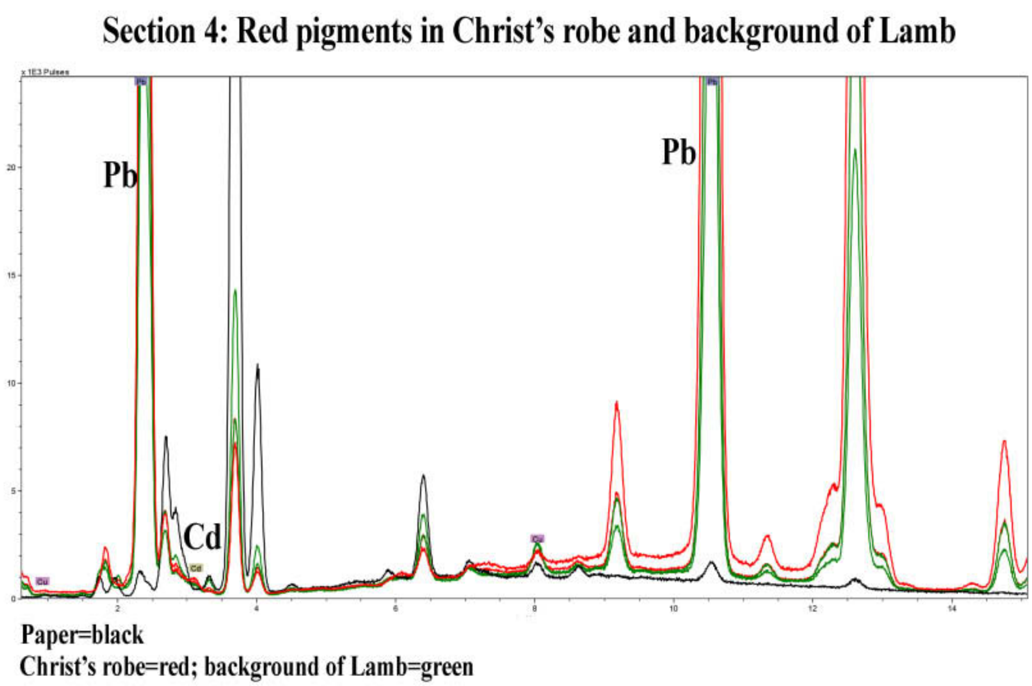

Fig. 20. XRF spectra comparison of the red/orange pigments on Christ's robe and the background of lamb.

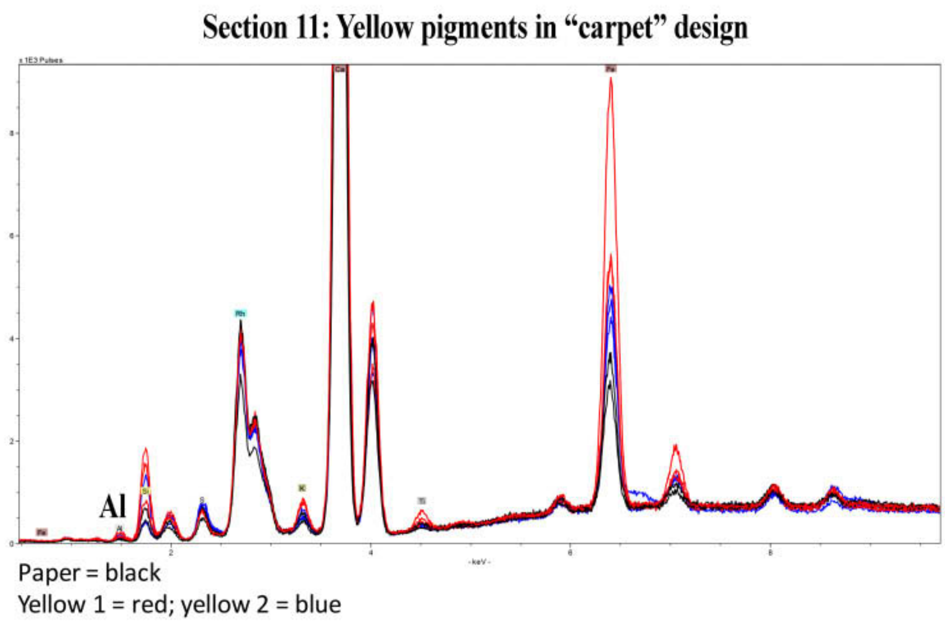

Fig. 21. XRF spectra of the yellow pigments on image of "carpet" design.

metal, which, in this case, is likely to be a copper-based pigment. In comparison to reference samples, spectral curve analysis of the green pigment also points to the organo-copper green pigment known as verdigris, mixed with a yellow colorant. XRF analysis also indicates the possibility of a mixture of copper-based green and yellow pigments for the green colors in some areas since spectra from selected areas show significant levels of copper, as well as sulfur and sometimes trace lead (fig. 22). In some green areas, minor to trace levels of iron, silicon, and possibly aluminum are also detected, possibly suggesting an admixture of a colorant such as yellow iron ochre. In particular, additional trace elements, including aluminum, potassium and iron, detected in the copper-green-colored areas of the sash and sleeve in the Christ figure in section 6 again may indicate that the copper-based green is mixed in these areas with an organic yellow pigment. This

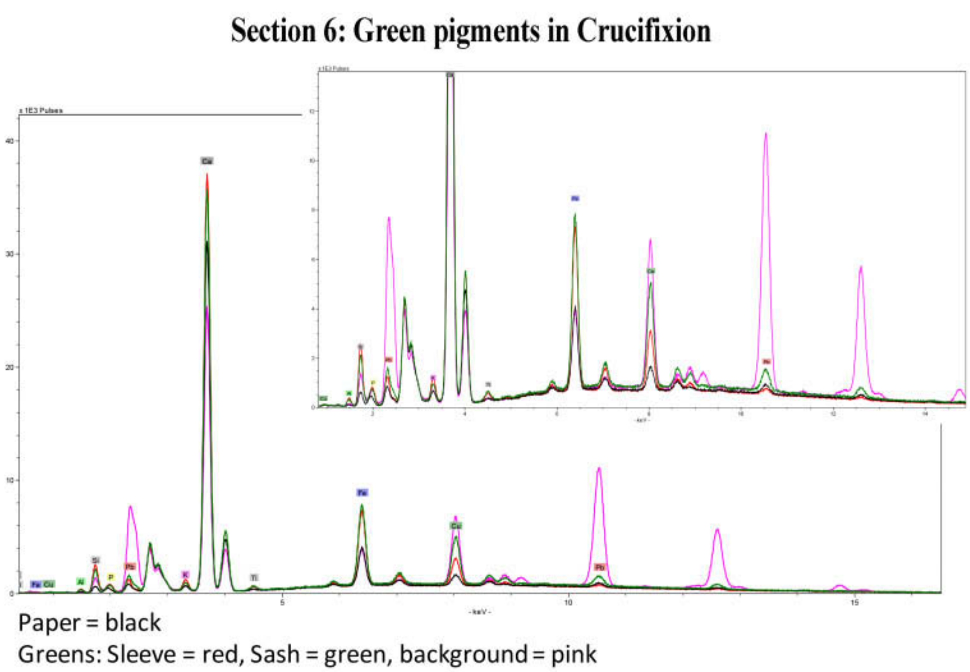

Fig. 22. XRF spectra of the green pigments in the Crucifixion.

is most apparent in comparison to the background green of the same print, which shows only the presence of copper with minor to trace lead. Overall, results for the main green colorant in the various areas are consistent with the use of an organo-copper pigment, such as verdigris, which is known to alter visibly over time to a darker, brownish green color, and was often mixed with yellow colorants to offset its original greenish blue hue.

HALOES

Although the halos appeared slightly different to the naked eye, XRF analysis of selected areas shows that, in all cases, an elemental signature for copper and zinc exists. This strongly suggests the use of so-called bronze powder. The presence of copper and zinc indicate that the pigment would more properly be termed "brass powder," although the distinction was not made historically. Additional minor to trace iron and silicon in some areas may indicate the presence of an additional pigment, applied, for instance, as a glaze or a type of bole, although none is visible. Very trace mercury in most of these areas may arise from a gilding method, although if that was the case, it is expected that mercury would be more significant.

CONCLUSION

Printed in early 18th-century Constantinople on Venetian paper, illustrated with Dutch woodcut images amongst Armenian text, Hmayil Number 3 is a unique representation of historical cultural exchange. Examination of the physical evidence uncovered the intertwined history behind its birth and life. Conservation treatment, which included Western and Eastern conservation materials and techniques, has greatly improved the condition of the scroll, making it safe for researchers to access and handle. XRF analysis with spectral imaging of the scroll indicates fairly consistent use of pigments across the scroll, including lead-containing red, organic yellow, organo-copper green, and a halo color identified as a bronze composition. The lessons learned from conserving this scroll and analyzing its colorants may inform future preservation of and research on similar scrolls.

ACKNOWLEDGMENTS

The treatment and study of this prayer scroll would not have been possible without the assistance of Library of Congress Armenian Collection Specialist Levon Avdoyan and Rare Book Conservator Tamara Ohanyan and their invaluable help in interpreting the Armenian text. The authors would also like to thank our colleagues in the Conservation Division at the Library of Congress.

NOTE

1. Rayon paper is a semisynthetic material made from cellulose, mostly wood-pulp, which undergoes chemical treatment to turn it into a soluble compound. Filaments are produced to create a synthetic fiber made from almost pure cellulose. Rayon paper comes in different thicknesses, it can be in very thin or heavier weight sheets, and it is smooth and translucent. Traditionally, rayon paper is most commonly used in conservation of Asian art as a facing material or used for friction drying and interleaving. As it originates from cellulose, rayon paper stretches when it is wet (Hare 1998).

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SOURCES OF MATERIALS

Golden Fluid Acrylic Colors
Dick Blick

RK-1 machine-made kozo paper roll
Paper Nao

Handmade uda-gami paper
Hiromi Paper, Inc.

Rayon paper; silicone-coated polyester film rolls
Talas

Tek Wipe
Polistini Conservation Material LLC

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Improved Methods of Authentication and the Resulting Shifts in Decision-Making in Parchment Conservation

INTRODUCTION

Shifts in decision-making in the conservation of cultural heritage can be understood by comparing former instructions in conservation literature with our current perception of the results of previous conservation treatments and the current ideas of what appropriate conservation treatments should be. Through understanding old methods and materials, we can estimate past conservators' objectives and gain insight into the complex environment of conservation as it existed then.

Technical changes, including better analytical methods and shifting societal norms, lead to different perspectives on cultural heritage and to the emergence of innovative treatments. One very recent example of a technical development relevant to the conservation of cultural heritage items is the decoding of proteomes and genomes that aid in the investigation of animal skins, which relies heavily on parchment manuscripts as a base of information.

To demonstrate this, the authors started with an analysis of Otto Wächter's 1982 work, *Restaurierung und Erhaltung von Büchern, Archivalien und Graphiken.* This narrowed the topic to parchment conservation, as recent molecular research applies specifically to this area. The question was: Did old conservation treatments alter parchment in such a way that biological information stored in the material was damaged, changed, or overlaid and consequently made uninterpretable? If so, could we, with improvements to current methods, "deconvolute" the data to read the original signal?

The choice of Wachter's book was based on two considerations: First, it was very influential in its time and, second, it is a difficult work to interpret if you were not a pupil of Otto Wächter himself, which the principal author happened to be.

Since Wächter's time, our knowledge of material features has improved greatly, as has our procedures for decision-making in conservation. Our view of old methods has changed in a way that allows us to understand that some treatments can have a significant impact on the biological information carried by materials, which is considered of added value in research today.

The project results have made scholars:

1. Understand how old methods and materials in conservation changed historical material.
2. Appreciate different types of biological data that can be recovered, which can be used to infer information about livestock management, craft production, and historical use of an object.
3. Understand how we might gather and interpret this palimpsest of biological and craft information, such as kind, sex, or breed of animal, breeding history of the flock or herd, the process of parchment manufacturing, etc.
4. Explore changes imposed by subsequent conservation and understand how to avoid conservation methods that either overprint with new biological signals or destroy the original ones and identify a conceptual framework for alternative methods.
5. Examine which types of modification induce changes that can be detected and isolated, thereby recovering the original biological signal.
6. Explore how new methods might fulfil conservation objectives without changing the original information carried by the material or alter the demands of conservation aesthetics.

METHOD

Wächter provides treatment recipes and procedures in a summary style, which makes it necessary to recall practical work with Wächter in the 1970s and 1980s in order to interpret what was actually meant in the text. In many cases, no solution concentrations and no description of how to apply a substance are given.

As a first step, all the materials had to be gathered or specifically prepared. Unfortunately, there are several materials that are not available anymore, of which natural sperm whale

Papers presented at the Book and Paper Group Session, AIC's 46th Annual Meeting, May 29–June 2, 2018, Houston, Texas

oil is the most significant to this research. Due to changes in environmental law, harvesting of sperm whale oil is now prohibited and therefore can no longer be procured.

In some instances, Wachter's original application techniques could be simulated without recreating the original condition issue while, in other instances, re-creation of the condition issue prior to undertaking his intended treatment method was necessary. This decision was based upon whether or not the research question (Did the conservation method and material alter the parchment and its internal information?) could be answered without re-creation or only by recreating the condition issue.

TESTING MATERIALS

In all cases, the re-creation of damage, conservation material, and conservation treatment method have been documented. All treatments were performed in an environment as closely resembling that of Otto Wachter's original environment as possible: all treatments were performed at around 18°C and with a relative humidity of approximately 50%. All parchment samples were made at the National Research and Development Institute for Textiles and Leather in Bucharest, Romania (Table 1).

All samples except one were derived from a single skin. Aged samples were used when treatment was intended to soften the skin. Aging was done for 60 days with a fluctuating temperature between 10°C and 35°C and a fluctuating relative humidity between 55% and 15%, changing every 12 hours.

Wachter's conservation recommendations for parchment fall into three main groups: cleaning or stain removal, softening of hard parchment, and repair (Table 2). Particularly fortunate was the fact that the authors still had a bottle of parchment glue made by Wächter himself [1], which could answer the questions: Did he produced the glue according to his own recipe? What parchment did he use for making parchment glue?

There were other materials—in particular, formaldehyde—which may promote changes in parchment structure by promoting crosslinking; however, they were prohibitive due to chemical restrictions and access.

HYPOTHESIS

In general, the hypothesis was summarized as follows: Wächter's materials and techniques suggest that we are in danger of altering the information we can extract from original material with today's means and measurements, as the approach to conservation treatments has changed over time. This hypothesis was considered from a philosophical-ethical viewpoint and from a scientific viewpoint.

Specifically, we presumed that all applications utilizing water (numbers 1, 3, 4, 5, 11, 13, 14, 20, 21, 29, 30, 31, 32, 33, 34, 35) would lower the shrinkage temperature of collagen fibers in the parchment, which is a feature that equates to damaging or lowering the quality of the parchment (being, in a way, a starting point of damage) and should be avoided in the course of a conservation treatment.

Soaking I	600% water at 20°C 4 hours
Drain fleshing (manual)	
Washing	400% water at 20°C; drained
Soaking II	600% water at 20°C, drain 600% water at 20°C 4% salt 0.2-0.4% detergent Stirred 3-4 hours; sat overnight
Drain	
Liming	400% water at 25°C 4% lime 4% salt 0.3% detergent pH 11.5-12
Post-liming	600% float at 25°C 2% lime 48 hours
Deliming	500% water at 30°C 1% ammonium sulphate Stirred40 minutes; sat overnight
Washing	400%-600% water at 20-25°C Stirred 60 minutes; sat overnight
Rinsing and stretching	

Table 1. Description of the manufacturing process of the parchment used for testing

Alterations to the biological information of parchment were also expected of all materials that contain DNA themselves (numbers 6, 7, 30, 31, 32, 33) and therefore would be added to the biological information profile of the original sample. Where use of DNA-containing materials is unavoidable, it makes sense to use a form that is as far distant as possible from the conservation target. Thus, it is sensible to avoid mammalian glues to repair cultural heritage objects made from mammalian tissues such as parchment and instead use isinglass (fish collagen), which is much less likely to obscure the original genetic signal than sheep or bovine gelatin. Conversely, in the treatment of fish leather, it would be more sensible to use cattle gelatin than isinglass.

In addition, the inorganic material used to chalk the parchment in the course of its production can potentially be traced geochemically. The use of earth alkali metals in conservation treatment can interfere with the biological information of the original material (numbers 8, 9, 10). The presence of borax may also interfere (number 26).

Furthermore, we should take into consideration that such finds would also have influence on our recent conservation decision-making and choice of conservation material and

Number	Sample preparation	Treatment applied to sample	Purpose	Observations	Hypothesis
1	An iron gall ink made after the recipe by Boltz von Ruffach was applied to the parchment on both sides with a stick at around 18°C room temperature and then the ink dried naturally.[2]	**Sodium hydrogen carbonate solution** (10% in water) was applied onto the ink line with a glass pipette. Barium hydroxide was not used due to its price.	Prevent ink corrosion		Lower shrinkage temperature.
2		Parchment was rubbed gently with eraser powder, a **Factis mix** (material from the 1980s, Archival Aids Draft Clean Powder DCP32lb by Ademco Limited), on both sides and then the powder was brushed off.	Dry clean		Factis crumbs will stay in the parchment structure by electrostatic forces and age slowly, giving the parchment an overall yellowish hue.
3		**Water: 70% ethanol 1:1 Vol %** mixed at room temperature. The parchment was immersed and massaged for two minutes with a brush, then taken out and placed on oil paper and weights were placed along the margins of the piece.	Wet clean		Lower shrinkage temperature.
4	Parchment was artificially aged for 60 days at a fluctuating temperature between 18°C and 35°C and fluctuating humidity between 55 and 10%RH, altering every 12 hours.	**Humidification chamber:** cold water mist was produced by natural evaporation of water from a basin for 2 hours; aged parchment was placed over bowl with cold tap water for 2 hours, then lightly pressed.	Soften		Lower shrinkage temperature.
5	Parchment treated like Sample 4.	**Glycerine** applied with hands.	Soften		Lower shrinkage temperature.
6	Old parchment glue with vinegar	Liquid **parchment glue** applied to parchment with a brush.	Soften		Alteration of information concerning animal.
7	Preparation of parchment glue: leftovers of parchment (animal not specified) cut into small pieces, cold water added, left to swell at least overnight (10 hours), then cooked in water bath for 24 hours. Heat solution (solution should not become hotter than 70°C, ideal temperature is 50°C); the water that evaporates must be substituted by new water constantly. Sift glue through a cloth. Add 7% vinegar, 1/3 glue, 1/3 alcohol, and shake.	**Parchment glue** applied to parchment with a brush.	Soften		Alteration of information concerning animal.
8a/b	Vegetable cooking oil used to create two stains.	**Benzine** mixed with **magnesium oxide or sepoilothe,** and applied onto the stain from the top. The poultice was left to dry at room temperature, then removed with a dry brush. Repeated twice.	Grease stain removal		Residues from the poultice might alter the information of any original treatment using inorganic powder (calcium carbonate, etc.). Information regarding the source of the powder might be irritated or made impossible.
9a/b	Vegetable cooking oil used to create two stains.	**Ether** dripped onto the stain from the top, with one stain on sepiolite and the other on magnesium oxide.	Grease stain removal		As 8/ab

(*continues*)

Table 2. Parchment conservation treatment materials and methods used by Otto Wächter

Number	Sample preparation	Treatment applied to sample	Purpose	Observations	Hypothesis
10a/b	Vegetable cooking oil used to create two stains.	**Chloroform** dripped onto the stain from the top, with one stain on sepiolite and the other on magnesium oxide.	Grease stain removal	The chloroform did not stay in the area where applied it, but ran all over the parchment sample.	As 8a/b
11	Author's blood applied to both sides of parchment and dried for 7 days.	Half of the stain was made wet with tap water from one side and put upside down over open bottle of 30% **hydrogen peroxide** for 1 hour at around 18°C.	Blood stain removal		Lower shrinkage temperature.
12	Ballpoint pen lines drawn on parchment.	**Dimethyl formamide** was dripped onto the area and the lines were rubbed off with a cloth.	Ink stain removal		
13	Parchment aged.	Aged parchment immersed into **milk** (3.5% fat) for 2 minutes, massaged, and then air dried.	Soften		Lower shrinkage temperature; slight fat-tanning.
14	Parchment aged.	Aged parchment immersed into 10% **urea** for 2 minutes, massaged, and then air dried.	Soften	The parchment became really stiff and not at all soft.	Lower shrinkage temperature.
15	Parchment aged.	Aged parchment immersed into **cedar oil** for 2 minutes, massaged, and then air dried.	Soften		Slight oil-tanning
16		Parchment dipped into **dimethyl sulfoxide**.	Stain removal		
17		Parchment dipped into **ammonia**.	Stain removal		
18		Parchment dipped into a solution of **soluble nylon** (from the 1980s) **in toluene** (supersaturated solution).	Fixative		
19		Parchment placed over the opening of a bottle holding 5ml 30% **hydrogen peroxide** and 3 drops of **ammonia** for 30 minutes.	Stain removal		
20	Wheat starch paste (1:4 wheat starch: tap water vol% boiled for 2 minutes, and then cooled to room temperature	**Paste** brushed onto flesh side of parchment.	Tear mending		Lower shrinkage temperature.
21	Wheat starch paste (Sample 20); after paste cooled, **Nipagin** added.	**Paste with Nipagin** brushed onto flesh side of parchment.	Tear mending		Lower shrinkage temperature.
22		Parchment dipped in 5% **oxalic acid** for 1 minute, taken out, and dried at room temperature without rubbing.	Rust stain removal	Parchment curled up while drying.	Shrinkage.
23		Parchment immersed into 3% **hydrochloric acid** for 1 minute, taken out, and dried at room temperature without rubbing.	Rust stain removal		
24		Parchment immersed in 10% **Titriplex** in water for 1 minute, taken out, and dried at room temperature without rubbing.	Rust stain removal		
25		Parchment immersed in 1:1 **hydrogen peroxide: ether** vol% for 1 minute, taken out, and dried at room temperature without rubbing.	Fly excrement removal		

(*continues*)

Table 2. Parchment conservation treatment materials and methods used by Otto Wächter (*Continued*)

Number	Sample preparation	Treatment applied to sample	Purpose	Observations	Hypothesis
26		Parchment immersed in warm 10% **borax** solution for 5 minutes, taken out, and dried at room temperature without rubbing.	Milk stain removal	When the parchment was dry, the crystals were shiny on the surface of the parchment.	
27		**Nitroverdünnung** (nitro-thinner is a mix of organic solvents such as ketones, esters, and alcohol) dropped over parchment three times on both sides and then the parchment was dried at room temperature.	Synthetic adhesive removal		
28		Parchment immersed into **acetone** for 1 minute, taken out, and dried at room temperature without rubbing.	Synthetic adhesive removal		
29		**Hot water and turpentine soap.** Parchment massaged for 1 minute with turpentine soap foam made with a brush first dipped into hot tap water and then moved over the turpentine soap. The soap was then washed off the parchment with warm water and the sample left to air dry at room temperature.	Cleaning ink stains		Lower shrinkage temperature.
30	Fish bladder soaked in cold water overnight and warmed in a water bath the next day over several hours. The fish bladder was from an old source in USSR.	**Isinglass** brushed onto parchment, then the sample was left to dry at room temperature.	Adhesive		Change of information about animal; lower shrinkage temperature.
31	Parchment leftovers were soaked in cold tap water for 2 days and then warmed in a water bath the next day over several hours.	**Parchment glue** brushed onto parchment, then the sample was left to dry at room temperature.	Adhesive		Change of information about animal; lower shrinkage temperature.
32	Parchment glue with vinegar and ethanol added. 1:1:1 parchment glue (as made for Sample 31): vinegar: ethanol.	As in 31.	Adhesive		Change of information about animal; lower shrinkage temperature.
33	**Parchment glue** (as made for Sample 32) mixed with small amount of stiff 20% **hydroxypropyl cellulose** in water and very small amount of **PVAC**. Six droplets of **toluene** were then added.	The “salat dressing” was brushed onto parchment sample and left to dry at room temperature.	Consolidate flaking paint layers		Change of information about animal; lower shrinkage temperature.
34	**Methyl cellulose** from the 1980s was soaked in water and, after swelling, mixed with **PVAC** (2:1 MC: PVAC).	Mixture applied onto surface of parchment, then the parchment was allowed to dry at room temperature.	Adhesive		Lower shrinkage temperature.
35	1:1 **wheat starch paste** (Sample 20): **parchment glue** (Sample 32); small amount of **Nipagin** was added.	Mixture applied to the surface of parchment, then the parchment was allowed to dry at room temperature.	Adhesive		Lower shrinkage temperature.

Table 2. Parchment conservation treatment materials and methods used by Otto Wächter (*Continued*)

techniques. If water is a material that endangers parchment severely, we should either avoid it or find alternative application techniques.

The instrumental analysis should verify whether or not the information carried by the parchment was obscured and, if so, in what way. This would allow for a sort of retranslation of the information gained into the information that was there originally. In an extreme case, all data gathered from the survey of manuscripts by means of instrumental analysis might need to be rewritten.

SURVEY

INSTRUMENTAL ANALYSIS

Peptide mass fingerprinting (PMF) was performed using matrix-assisted laser desorption/ionization—time of flight (MALDI-TOF) mass spectrometry (MS) to establish the species of animals used to make both the parchment and glue and to assess the level of damage (deamidation) present in the sample due to the manufacturing process. Testing was carried out using a noninvasive sampling technique based on triboelectric extraction involving the use of polyvinyl chloride erasers, which allows us to interrogate parchment manuscripts without having to use destructive techniques (Fiddyment et al. 2015).

Initially, the use of MALDI-TOF MS was chosen as it is fast, inexpensive, and a useful basic identification tool or screening method. PMF is based on the analysis of one protein (in this case, collagen) cut into smaller fragments (peptides) using an enzyme (in this case, trypsin). The mass of these peptides is measured using MALDI-TOF MS, which creates a profile or "fingerprint" of the protein, which can then be compared to a reference database. With this method, it was possible to determine the species used to make the parchment and also any additional species used to make the glue that might have been applied to the surface.

Our preliminary results are presented in Table 3. All samples were identified as goat, except for samples PE017 and PE018, where blood proteins mask the collagen. By this method, it is also possible to determine a general value of deamidation, a particular type of damage that occurs in the collagen molecule when the skin is exposed to hydrolytic chemical reagents during its production process, which is defined as the Parchment Quality Index (PQI).[3] This is expressed as a percentage, where a value of 100% corresponds to no deamidation, and therefore low or no exposure to chemical reagents, and a low percentage value points to high exposure and, subsequently, high damage to the molecule. Samples without a PQI value are due to issues with the obtained spectra or due to the collagen markers being masked by other proteins as is the case of PE017 and PE018. In this instance, where samples were treated with glue it was found that both the parchment and glue are made of the same species and, thus, it is much harder to determine where the damage is occurring (whether on the parchment as part of its production or from the glue) and will require further data analysis.

For selected samples, a more detailed analysis using liquid chromatography–tandem mass spectrometry (LC-MS/MS) will be performed. This method allows for in-depth sequence analysis of the proteins in a sample. This will give us highly detailed information on where in the protein this damage is occurring and how it differs, depending on the treatment used on the parchment.

It is hoped the information that was provided through our analysis will assist conservators in their decision-making and give us a greater understanding of the processes that affect parchment stability and deterioration.

CONSERVATION PHILOSOPHY ASPECTS

The opportunity to measure shrinkage temperature within the context of parchment conservation as a survey method for the identification of the state of decay was not available in the 1980s, nor was the possibility to identify the animal species used to make parchment. The Venice Charter mentioned the use of a suitable material for conservation, but even if the general idea was ground-breaking and still valuable today, no one involved in writing the charter in the 1960s could have imagined today's technical abilities, as indeed we cannot predict advances half a century from now (ICOMOS 1964). This means that the term "proper material" must be defined anew. It also means that all aspects made possible by technical innovation since this time could not be addressed by Wächter's conservation methods.

If we look at the types of treatment Wächter addressed with his instructions, which were cleaning, mending tears, and reattachment of flaking paint layers, we find them to still be mandatory conservation measures. The need for softening historic parchment is under discussion today. The question is: What would be the benefit of such a measure, both for the artifact and the reader? Cleaning and tear mending are also subjects of discussion today. Dirt, on the one hand, can contain harmful substances, such as mold spores and hygroscopic particles that can foster mold growth. On the other hand, dirt is considered a material that might hold information about the history of the artifact itself.

One example of this would be the results of the York Gospels survey, held in the York Minster Library and "[…] is the only surviving English Gospel book to contain the oaths taken by the deans, archdeacons, canons and vicars choral, dated to the fourteenth to sixteenth centuries, and is still used in ecclesiastical ceremonies today" (Teasdale et al. 2017). The authors performed protein and DNA analysis on it and were able to look at the metagenome (i.e., DNA from bacteria on the book) and we were able to say that it corresponded to the microbiome (bacterial community or environment) of human skin, which would make sense if it was extensively handled. However, we cannot attribute it to a particular bishop or time as this human DNA would have accumulated throughout history as a consequence of repeated handling.

Vnouček earlier pointed at the information value of dust (Vnouček 1991) and, later, Cédric Leliévre addressed "To dust or not to dust? Benefits and losses of dry-cleaning on manuscript registers" at the Care and Conservation of Manuscripts conference in Copenhagen in April 2018.

Engel showed the disadvantages of dry cleaning with eraser powder, which was recommended by Wächter, being the high number of crumbs staying with the artifact after the treatment. Electrostatic forces keep the small particles attached to parchment. While these particles become more yellow and brittle with aging, the overall appearance of the artifact becomes more yellow as well, because the small yellow dots work like pointillistic dots and alter the color.

Sample	Treatment	Species identification	PQI	Standard Error
PE001	6	Goat	93.83%	6.17%
PE002	6	Goat	89.79%	6.92%
PE003	Reference parchment A	Goat	83.85%	14.37%
PE004	Reference parchment B	Goat	88.03%	10.34%
PE005	1	Goat	80.37%	6.24%
PE006	2	Goat	81.92%	6.41%
PE007	Eraser powder only	Identification not possible		
PE008	3	Goat	80.11%	10.02%
PE009	4	Goat	80.39%	5.72%
PE010	5	Goat		
PE011	8a	Goat	80.83%	5.61%
PE012	8b	Goat		
PE013	9a	Goat	80.61%	6.05%
PE014	9b	Goat	77.68%	6.88%
PE015	10a	Goat	80.64%	6.19%
PE016	10b	Goat	79.21%	10.67%
PE017	11	Identification not possible		
PE018	11	Identification not possible		
PE019	12	Goat	81.36%	6.67%
PE020	13	Goat		
PE021	14	Goat	82.06%	5.61%
PE022	15	Goat	74.89%	13.48%
PE023	16	Goat	79.92%	5.98%
PE024	17	Goat	77.92%	11.15%
PE025	18	Goat	80.45%	10.14%
PE026	19	Goat	77.91%	5.48%
PE027	20	Goat		
PE028	21	Goat		
PE030	Reference parchment	Goat	76.89%	6.84%
PE031	Reference parchment	Goat	79.30%	5.15%
PE032	Reference parchment	Goat	79.67%	6.81%
PE033	Fragments I made glue of	Goat	92.22%	1.88%
PE034	22	Goat	76.19%	6.58%
PE035	23	Goat	89.27%	5.37%
PE036	24	Goat	81.30%	5.28%
PE037	25	Goat		
PE038	26	Goat	85.88%	4.77%
PE039	27	Goat	85.57%	4.49%
PE040	28	Goat	85.09%	4.25%
PE041	29	Goat	84.83%	6.91%
PE042	30	Goat	81.08%	11.08%
PE043	31	Goat	82.23%	5.02%
PE044	32	Goat	74.41%	8.65%
PE045	33	Goat		
PE046	34	Goat	83.03%	7.67%
PE047	35	Goat		

Table 3. Species identification and Parchment Quality Index of samples

Furthermore, the brittle crumbs work like small microabraders and mechanically damage parchment.

Mending tears might not be necessary in all cases as parchment, in contrast to paper, does not so easily continue tearing once torn. However, there might be possibilities where applying an adhesive is unavoidable. Using synthetic adhesives has been suggested, but the use of natural adhesives has advantages owing to their flexibility and other properties (Mayer 2002). However, natural adhesives contain water and endanger parchment by lowering the shrinkage temperature. As shrinkage temperature is a function of temperature and humidity, conservators can change the temperature of their environment during application. This has been done successfully by one of the authors for many years. The recommended procedure is to use a natural adhesive in a very cold environment.

Another issue is related to the specific collagen material in the glue. When Wächter writes "parchment leftovers" we know he had received old timpani heads from the Vienna Philharmonic to make glue. This signifies that he did not instruct his pupils to identify the source animal of the parchment scraps used to make the glue. It further signifies that a glue made of goat may be applied onto a manuscript page made of sheep skin. If the glue is used for a localized repair, survey results may be obscured; if it is for softening an entire charter made of parchment, the entire surface was covered with the parchment glue and may also obscure research results. To escape this problem, we suggest the use of isinglass, not parchment glue, to soften an artefact.

Finally, we looked back at nearly 40 years of professional conservation and rising public awareness of what proper conservation should be. We managed to implement the conservation theories by Brandi and Baldini and other forerunners in this field (Brandi 1978, Baldini 1963). The idea of a clean, straight, perfectly flat historic artifact was "relativated" by the knowledge that some of these goals can only be reached by actually damaging the artifact. This also holds true for the softening measures and materials suggested by Wächter. We know after René Larsen's research that treatment with water or water-containing substances and strong pressing thereafter makes the lively vital parchment page into a flat, semitranslucent folio of gelatin (Larsen, Poulsen, and Vest 2002). We find such gelatin examples in many libraries and archives. However, readers and museum visitors have now already grown used to seeing and accepting distorted, hard parchment manuscripts and fully value their authentic beauty.

RESULTS AND PERSPECTIVE

As a first result, we can conclude that the PQI from electrostatic zooarchaeology by mass spectrometry (eZooMS) samples allowed for both species identification and measure of deamidation. The conservation materials and methods used did not alter the parchment strongly enough to interfere with species identification. LC-MS/MS will allow for more in-depth sequence analysis of the proteins in these samples. This will give us highly detailed information on where in the protein this damage is occurring and how it differs, depending on the treatment used on the parchment.

Another suggestion in the hypothesis had been that the application of some of the products chould lower the shrinkage temperature of the collagen. For that, shrinkage temperature must be measured.

A third insight is that the original glue made by Wächter himself must have been goat glue, as otherwise the goat signal from the parchment would have been disturbed by signals of another species.

After this study, all samples were cut in half and were artificially aged. Tests will be conducted in the future on these samples.

There is much work to be done to understand the way in which 20th century conservation methods might have altered the information held in our cultural heritage material, of which only one material and one series of instructions have been discussed here. Nevertheless, we are already facing new challenges: nanocollagen as a conservation material (Bicchieri et al. 2018) and other nano products are used by conservators and librarians without having been fully vetted. Nano silver was applied to the shelves in Admont Monastery and was described in an oral presentation by Christian Moser at Arbeitskreis Austrian National Archives Vienna Meeting November 6-7, 2017 (Moser, pers. comm.). A test was also performed to identify the effect of this nano silver on parchment. The species could be identified, but the PQI did not yield a result. It is necessary that we fully understand the alteration of material by conservation methods and material. Only when we know what original information is disturbed, can we start to approach a change in decision-making in conservation.

NOTES

1. The authors would like to thank Helmgard Holle for having given us what Wächter had previously given her. Oil paper was kindly provided by the archives of the Technical University Vienna. The authors also thank Ralf Wittig for helping with some of the solvents needed.

2. "Good stable ink for writing texts you should prepare as the following:

Firstly find 4 or 5 good stable pots as we have it for urinating in the night. When you want to make ink take half a measure of good old rain water into the pot. Take also 2 quarters of a measure of good strong white vinegar and mix it into the rain water.

Then take 4 crushed gall nuts, which you have sifted through a mesh. Put this gall nut powder into another pot then pour half of the liquid from the first pot over the nuts and stir it well with a wooden stick. Take then 4 lots of well grinded vitriol, put it in again another pot and pour the second half of the liquid in the first pot over it. In the then remaining liquid in the first pot put 4 lots of well ground gum Arabic.

Cover these 3 pots well and have them rest for 3 or 4 days. However, stir each of the substances in each pot well several times a day with a wooden stick.

When the time is over, take the pot with the gall nuts and put it onto a moderate fire, so that it becomes hot but does not boil. In the moment when it is due to boil take it from the fire and leave it to cool down a bit. Pour it through a textile into the last pot. Do not press it through, but have it go through itself. Then add the substances from the other two pots into the pot and stir it all well.

Cover the pot and let it rest and let it stand for 3 days, but you should stir it well every day, so that the material mixes well. On the 4th day take the pot carefully so that the precipitations on the bottom do not come up and pour the liquid through a textile into a clean pot. There let it stand with a lid, and you have good ink." (Boltz, 1549)

3. The levels of deamidation are higher in reference parchment A (PE003 ~83%) and parchment B (PE004 ~88%) than either of the glues (number 6 (PE001 and PE002) ~91% and number 7 (PE033) ~92%). However, the errors are quite large on these numbers, which does not allow us to categorically say there is a real difference (especially for parchment B; in the case of parchment A, the difference is clearer). When a sample has a higher level of deamidation, this is because it has been exposed to lime for a longer period of time during the dehairing process (the alkali environment of the lime produces a side chain hydrolysis of the amide group of asparagines and glutamines, producing deamidation). Also, in the case of number 7 (PE0033), this is not actually glue but the fragments of parchment used to make the glue. Three separate pieces were analyzed, but only one of them gave a spectrum that allowed calculation of the PQI, so it cannot be determined if the overall glue would have that exact value as it is made up of different pieces.

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Looking Back and Taking Stock—A Journey through Past Projects

Since the 2018 AIC Annual Meeting theme had been expanded for the Book and Paper Group session to include reevaluation of materials used in historical conservation treatments, the speaker reflected back on more than 30 years of training and working in the conservation field and publicly reviewed some cases that provided great anxiety at the time or gave pause upon reflection today. He did in fact review his own—by now—historic conservation treatments. The cases ranged from unintended immediate physical and chemical modifications, to unexpected long-term changes that have an impact on the use of collection items. The speaker reviewed a number of conservation treatments and evaluated how they have stood the test of time. He also recounted his experience as a conservation student, damaging a 16th-century Albrecht Dürer print during a conservation approach that he has since no longer used. He discussed his experience with light bleaching a 19th-century drawing by Joseph Keppler, an action that created unanticipated chemical changes in the paper. And he delved into mechanical paper splitting and the unexpected long-term effects of this technique on 19th-century US newspapers. The speaker ended with an observation made using Russell-effect photography and wondered whether the widespread use of the mat window as storage container should receive closer scrutiny in case, in certain circumstances, this type of housing unintentionally creates an environment that will give rise to a higher oxidation rate within the confines of the window.

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Papers presented at the Book and Paper Group Session, AIC's 46th Annual Meeting, May 29-June 2, 2018, Houston, Texas

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Édouard Manet's Pastels on Canvas

INTRODUCTION

Pastels executed on prepared and stretched canvas present paper conservators with complex problems. The media, familiar to paper conservators, is friable and easily lost, while the canvas support presents its own problems as it often cannot be manipulated without disrupting the pastel. This paper gives a brief overview of the materials and techniques of two of Édouard Manet's (French, 1832–1883) pastels on canvas, and outlines some specific condition issues. This paper also describes how the Art Institute of Chicago stabilizes these artworks though a framing protocol that supports the canvas.

EDOUARD MANET'S PASTELS ON CANVAS

Manet's pastel paintings occupy a unique place in the artist's oeuvre. They were produced late in the artist's life, at a time when the artist's mobility and his capacity to stand at an easel were compromised by illness.

The Art Institute of Chicago owns two of Manet's pastels on canvas. *Portrait of Alphonse Maureau* (fig. 1), produced around 1878 or 1879, may be one of Manet's earliest pastels. It depicts the young Impressionist artist seated at a café table with a lacy curtain in the background. Manet signed this work along the right edge, possibly indicating that he considered the work finished. *The Man with the Dog* (fig. 2), a portrait of an anonymous wealthy gentleman with his large and shaggy dog, was likely executed in 1882. *The Man with the Dog* retains a wooden spacer, which was nailed through the front of the canvas. Small holes in the canvas of *Portrait of Alponse Maureau* indicate that it was outfitted with a similar spacer, which is now lost. Both artworks were in Manet's possession when he died in 1883. During a studio inventory, Manet's heirs used a knife to scrape away the pastel in the lower right corners of both works, and the initials EM were stamped in red ink.

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SUPPORTS

Both pastel paintings discussed here are executed on a fine weave linen canvas which is stretched over a keyed stretcher, and both canvases are primed with a single layer of a lead white and oil ground. The ground was applied before the canvases were stretched over wooden stretchers and tacked into place.

Manet's stretchers conform to the standard sizes listed in 19th-century French artist supply catalogues (Bomford et al. 1990, 46). At 547 × 452 mm for *Portrait of Alphonse Maureau*, the stretcher is a number 10 portrait canvas. *The Man with the Dog* measures 550 × 350 mm, and is on a number 10 marine canvas. The stretcher bars for both works are covered with papers from old dust covers and thus the colormen's stamps or embossments are either not visible or not present.

The fine weave linen canvases are cut from the same bolt of cloth. This was established by the Thread Count Automation Project. In the Thread Count Automation Project, computer-automated and computer-assisted thread count algorithms utilize radiographs, or photographs of the back of the canvases, to measure the vertical and horizontal thread densities. From this information, maps that record thread thickness and thread angles in the warp and weft are produced, and it is possible to track characteristics that indicate whether or not individual canvases are related. The maps are easily interpreted as they read as heat maps, with the warmer colors indicating a greater than average deviation in thread density or thread angle, and the coolest colors represent lower than average densities or angles.[1]

In images from the weave match report for the Art Institute of Chicago's Manet pastels (fig. 3), it is possible to see some correlation between the warp threads[2] for each artwork. Deformations due to tension from either the stretchers or the priming frame are also visible. For example, the cusping, or scalloping, on the right edge is very obvious. Figure 3 shows the orientation of the two pastels as they would have been aligned on the bolt. It is not possible to say how far apart the pieces of canvas may have been, because a bolt of fabric would have been up to 200 meters long.

Fig. 1. Édouard Manet (French, 1832–1883), *Portrait of Alphonse Maureau,* 1878/79, pastel on canvas, 547 × 452 mm. The Art Institute of Chicago 1950.123. Bequest of Kate L. Brewster.

Fig. 2. Édouard Manet (French, 1832-1883), *The Man with the Dog,* ca. 1882, pastel on canvas, 550 x 350 mm. The Art Institute of Chicago. 2007.287. Bequest of Brooks McCormick.

A brief digression into canvas priming is required to understand why it is impossible to determine the exact relationship of the two canvases. As mentioned above, colormen typically purchased a bolt of fabric, up to 200 meters long, from weaving mills. The colormen then cut the fabric into lengths of 10 meters, called a roll. The rolls were attached to priming frames for application of the size and ground layers. Thus, while a warp thread match does indicate that the canvases came from the same bolt, only a strong correspondence in weft threads (note 2) indicates that the canvases are so closely spaced that they come from the same roll (Johnson et al. 2010).

GROUNDS

The canvases are sized with glue and prepared with off-white grounds that are composed primarily of lead white and oil.

The presence of a glue size was first noticed in *The Man with the Dog*. The area at lower right, where the estate stamp is located, was examined with a microscope and the canvas fibers appeared to be saturated with a transparent coating. The presence of glue was later confirmed when samples were removed from the lower tacking margin (fig. 4).

For both works, the grounds are applied as a single layer, and like the canvas supports, the grounds are almost identical. Samples of the ground from *Portrait of Alphonse Maureau* were removed from lower left, where a hole created by a nail used to hold the now nonexistent spacer offered some small fragments. Samples were also removed from the tacking margins of both *Portrait of Alphonse Maureau* and *The Man with the Dog*. From these samples, FTIR analysis confirmed lead white in an oil medium as the primary components. SEM/EDS analysis also confirmed minor amounts of barium sulfate, commonly used as an extender. In samples from *Portrait of Alphonse Maureau*, traces of iron oxide rich pigments were visible. A wide variety of grounds were available from colormen including yellow and grey color grounds, however the color of the grounds on the Manet pastels appears, to the modern eye, to be off-white or light grey.

It is important to note that pastel canvases could also be bought in standard sizes, and were available in toned or colored grounds; however, the grounds for pastel canvases probably contained a gritty material, like pumice (Callen 2000), and the grounds examined here do not.

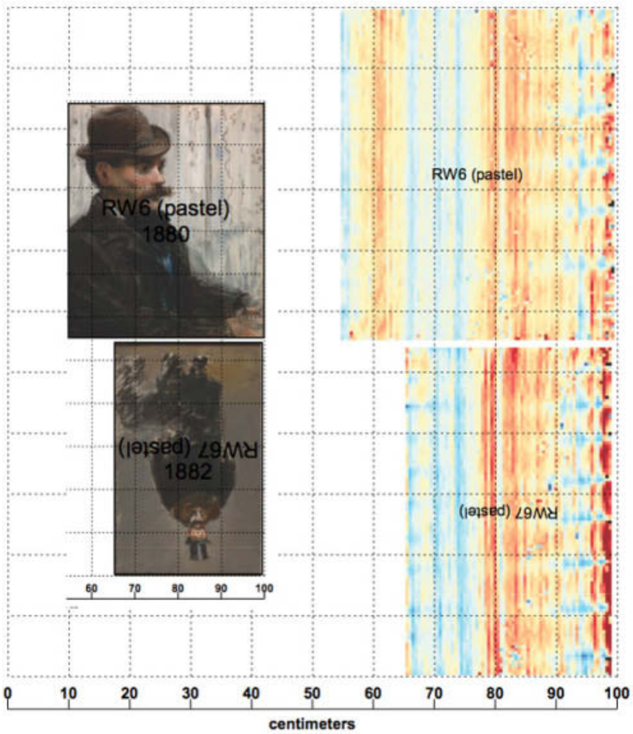

Fig. 3. Warp Weave Map for the Art Institute of Chicago's Manet pastels. The inset image of the pastels indicates the alignment of the works on the bolt. Credit: Thread Count Automation Project.

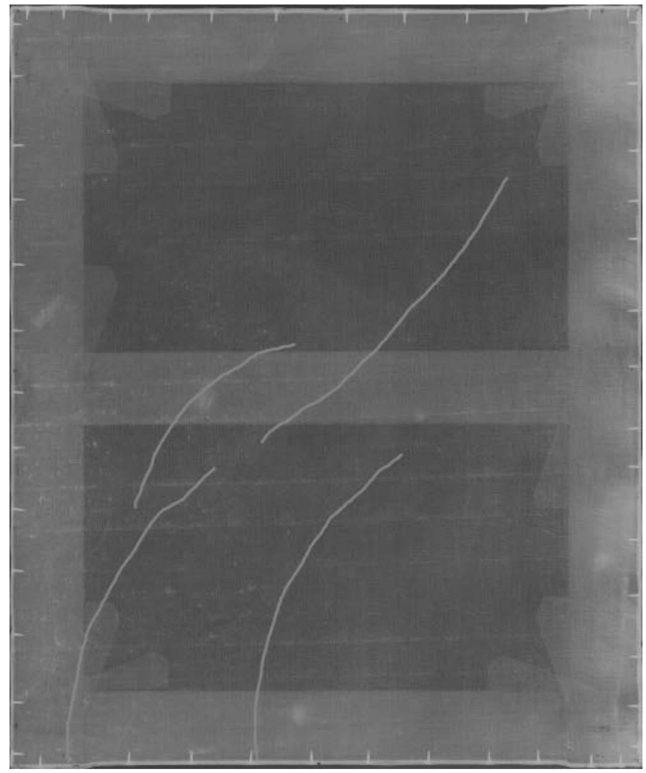

Fig. 5. Composite radiograph of the *Portrait of Alphonse Maureau*, with lines, in grey, indicating the marks left by the spatulas used to spread the ground on the sized canvas.

Examination of composite radiographs of the pastels gives some indication of how the grounds were applied to the canvas. *Portrait of Alphonse Maureau* has three long curved marks running through it (fig. 5). These are the marks made by long thin spatulas that were used to spread the ground on the sized canvas.

MEDIA AND TECHNIQUE

The scope of this research did not delve into the composition of Manet's pastels, however it is likely that he purchased his pastels readymade from colormen. In terms of technique, Manet brought the sensibilities of a practiced painter to his pastels. He delighted in a rich, velvety texture, and to create this look he often dampened his pastels or blended them with a brush.

Fig. 4. 50× dark-field image of a cross section taken from the lower tacking margin of *The Man with the Dog.* The sizing and ground layers are visible. The uppermost layer is adhesive from gummed tape or a paper dust cover.

Both works follow the same compositional development. Manet began by blocking out the forms with quick gestural strokes. Some of these are visible along the back of the unfinished dog in *The Man with the Dog*. The initial stages of composition relied on parallel shading, also seen in the figure of the dog, and the figures changed shape subtly as he worked. For example, in *Portrait of Alphonse Maureau* there are shapes that read like the back or arm of chair, but they also resemble a sleeve or shoulder.

Manet took some pains over the sitter's faces. He used the pointed ends of hard pastels to add skin tone and areas of color. In *The Man with a Dog,* the strokes in the sitter's face are made with a pointed pastel stick, and they contrast with the blending of the pastel in his coat (fig. 6). In *Portrait of Alphonse Maureau*, Manet blends the base layers of the face, but individual stokes give texture to the bushy mustache, a line of pink pastel highlights the curve of the ear, and small quick marks define the ruddy cheeks.

The underlayers of Alphonse Maureau's hat and coat are blended, but Manet used blunted pastels to create a shadow

Fig. 6. Detail from *The Man with the Dog*, showing the strokes of finely pointed pastel in the face.

Fig. 7. Detail of *Portrait of Alphonse Maureau*, executed with finely pointed pastel and blending of the underlayers.

in the collar of the coat, and the broad side of a pastel, with a stroke of varying pressure, to create highlights in the breast.

The backgrounds of each work were treated very differently. In *The Man with the Dog*, the background was applied last, and in transmitted light extends to the very edges of the figure. Manet may have applied the pastels wet, or applied the pastels to the canvas and then blended them with a dampened brush.

In contrast, Manet utilized the color of the oil-based ground in the *Portrait of Alphose Maureau* (fig. 7). He creates the illusion of a filmy curtain, by blending or partially blending grays and light blues behind the figure. A few tendril-like strokes of pointed pastel create a lacy pattern. These broad strokes, which evoke a window pane, were created with the long side of a blue pastel.

Both portraits are unfixed.

CONDITION CONCERNS

On both pastels, prominent losses are present along the thicker weft threads and there are areas of pinpoint loss (fig. 8). There are also areas where the pastel is tenting and lifting or flaking away from the support.

Why this is happening has not been identified, however three possibilities present themselves. (1) The most obvious possibility is that the grounds do not provide adequate

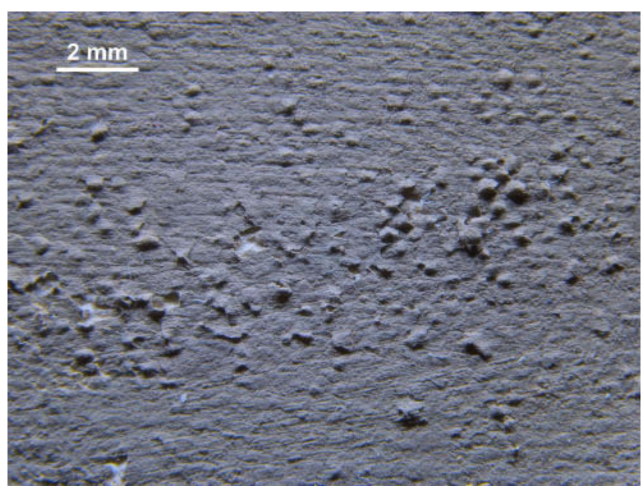

Fig. 8. Photomicrograph from the background of *The Man with the Dog,* illustrating lifting of the pastel in the background.

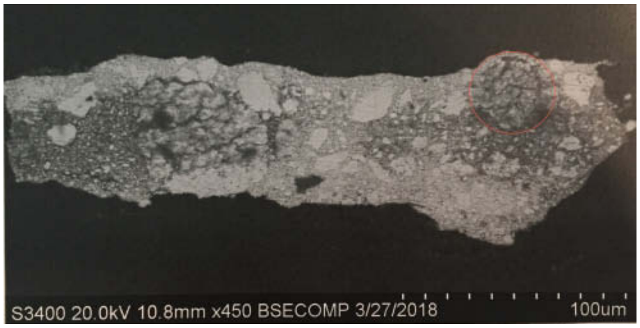

Fig. 9. Backscatter Electron photomicrograph of a sample of the ground from *Portrait of Alphonse Maureau*. The circled area is the location of possible lead salt formation.

purchase for pastel particles. (2) The canvas may be contracting or shrinking while the pastel layers are not (Bilson 1996) and the ground and pastel are separating from the canvas. (3) The final possibility is that the paintings are suffering from the formation of lead soap aggregates. Two locations in a backscattering electon microscope image show odd local differences in the proportions of binder and pigment (fig. 9). These may be the early stages of lead soap aggregate formation. The formation of metal soaps in oil paintings is an emerging area of conservation science. Essentially, oil paints containing certain metallic pigments don't dry completely and lead soaps form when lead-based pigments react with fatty acids in the oil mediums. The soap aggregates can move to the surface of the artwork where they create pin-prick size eruptions or craters in the paint films and grounds (Centeno and Mahon 2009).

The pastels have not been restretched. The canvases are both distorted, as seen in raking light. Due to the delicacy of the pastel surface, it is unwise to restretch the canvas or key out the deformations. Therefore, the Art Institute of Chicago endeavored to stabilize the artwork though a modified framing package that dampens vibrations.

REFRAMING *PORTRAIT OF ALPHONSE MAUREAU*

In 2012, The Art Institute of Chicago lent the *Portrait of Alphonse Maureau* to the Toledo Museum of Art. With the condition concerns outlined above, Harriet Stratis, then Senior Conservator in Paper Conservation, joined forces with Kirk Vuillemot, Associate Conservator for Preparation and Framing, at the Art Institute of Chicago to adapt a framing system that mitigates vibration by creating air pockets on either side of the pastel. The following is an explanation of the steps taken in the procedure to stabilize the pastel for transit.

INSERT MOUNT

Mitigation of vibration during transit was accomplished (in part) by the insertion of panels into the cavities of the pastel's stretcher. Panel inserts are instrumental in the creation of opposing air levels that balance the exchange of air, thus minimizing movement. Once *Portrait of Alphonse Maureau* was unframed, careful measurements of the cavities of the stretcher were taken (fig 10). Panel inserts were fabricated of basswood surface lined with eight-ply museum board. These panels mimic the contours and depth of each cavity less a 1/16″ allowance to ensure safe placement (fig. 11). The panels were marked with their respective locations (TOP/BOTTOM) and attached overall with PVAC adhesive to a piece of blue board 1″ bigger all around. For easier and safer handling, the panels mounted on blue board were positioned and attached to another, larger piece of blue board roughly the same size as the opening of the canvas. With the fabrication of an insert mount complete, preparation of an inner frame began.

INNER FRAME

For safer and easier handling, it was critically important to first house the pastel within an inner frame. The inner frame also creates a microclimate to protect the pastel by stabilizing the interior environment of the frame. To create the inner frame, the acrylic glazing was first perimeter-lined with a sealing tape made of a composite of Volara polyethylene foam tape, aluminum foil tape, and Marvelseal.

These sealing strips were assembled as follows. Volara tape was placed masked-side up and the masking was stripped.

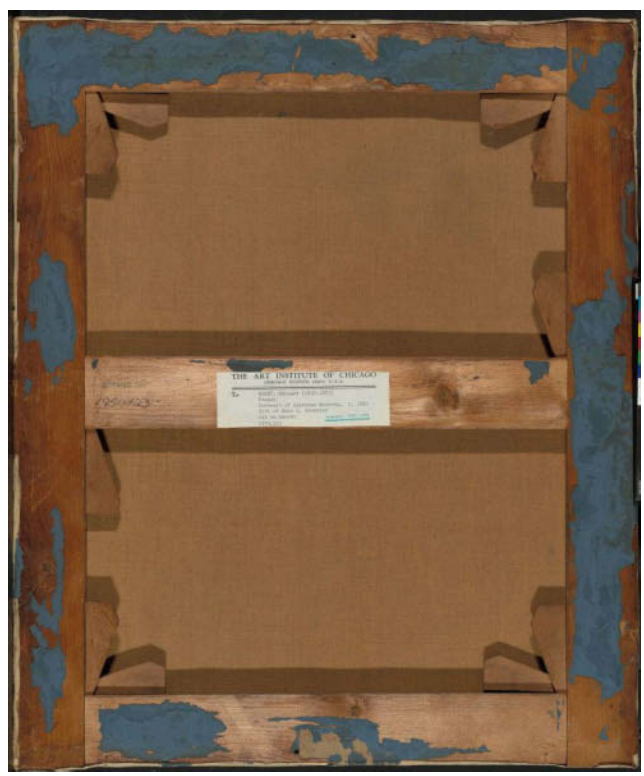

Fig. 10. The back of the canvas of *Portrait of Alphonse Maureau*.

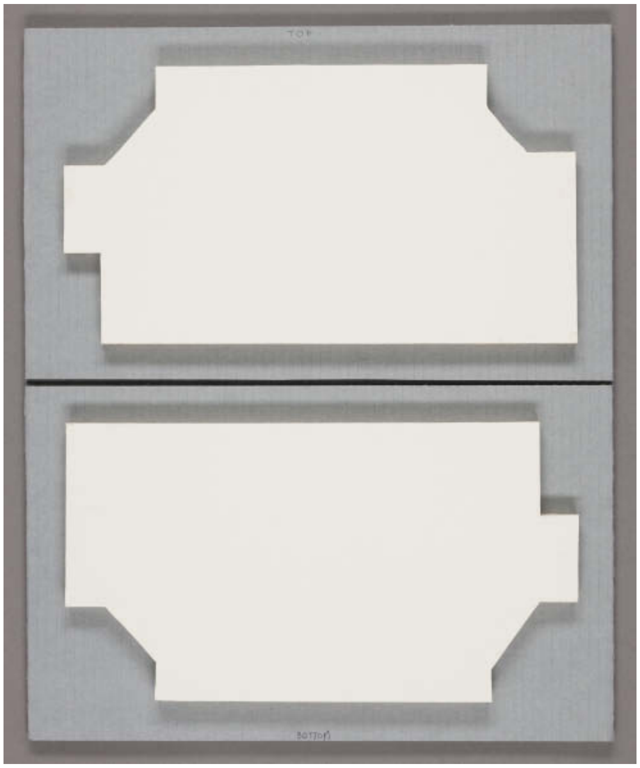

Fig. 11. Mounted panel inserts. Note: panels are mounted in reverse.

Fig. 12. All four sealing strips attached to the face of the Optium glazing.

Then the aluminum foil tape with the masked-side up was attached by 1/8″ along the edge of the Volara tape. Finally, the masking of the aluminum foil tape was stripped and the Marvelseal was adhered to the foil tape. The strips were as wide as the depth of the inner frame plus two fold-overs.

After the sealing strips were fabricated, the strips were attached to all four edges of the outward facing side of the glazing. The masking of the glazing was peeled back by 1″ all around to accommodate the attachment of the sealing strips (fig. 12). Once attached, the strips were cut at a 90-degree angle to the corners. The glazing, outward side face-down, was then placed on a clean and protected work surface and the masking was completely stripped off the side of the glazing that would face the pastel.

The original gilt liner (fig. 13) of the pastel's late 19th-century French Rococo Revival frame was placed on top of the inward side of the glazing. The liner was critical in that it created a distance between the surface of the pastel and glazing and created another pocket of air. To accommodate the additional depth of the pastel and the panel inserts, a basswood-backing frame had been attached to the back of the original liner of the frame. This was done in a stepped back fashion which created a new rabbet for the inner frame. The basswood back-frame was attached to the original liner with screws for easy reversibility (fig. 14).

With all the components of the inner frame in place, the sealing strips were wrapped around the sides and attached to

Fig. 13. Original gilt liner of the 19th-century French Rococo Revival frame.

Fig. 14. Basswood backing frame lined with four-ply museum rag board and attached to the back of the gilt liner with screws.

Fig. 15. Sealing strips wrapped around the sides of the basswood backing and attached to the back of the inner framed with 415 tape.

the back of the basswood addition with 3M 414 double-sided tape. An envelope was thus created in which all the component parts were securely attached to each other. Done in this manner, the inner frame would be relatively easy to reopen and then reseal should the need arise (fig. 15).

JOINING THE INNER FRAME, PASTEL, AND INSERT MOUNT

After prefitting the empty inner frame into the original frame so any necessary adjustments could be made, the masking was stripped off the outward side of the glazing and both surfaces of the glazing were checked for any unwanted dust, debris, or fibers.

The inner frame was oriented in its correct position and placed on an easel cushioned with a piece of Coroplast. The pastel was then fitted into the inner frame with the back of the pastel's canvas exposed. A piece of 3/16″ polyester batting was inserted in the hollow of the back of the stretcher and the batting was very carefully pulled under the center brace and tucked into the recesses of the stretcher and under the keys (fig. 16). The polyester batting rested gently, but directly, against the back of the canvas. This provides an air-permeable cushion that protects the canvas from the stretcher and cross bar while also providing the first layer of the multiple opposing air layers needed to minimize the movement of air and mitigate vibration.

Once the polyester batting was secure, the panel inserts were fitted within the recesses of the cavities of the canvas. The inserts were held in place by a final piece of blue board the same size as the back of the stretcher that had been perimeter-lined with 1″ strips of Art Sorb (fig. 17). Because of the amount of hygroscopic material already in use, only a small amount of Art Sorb was needed to help maintain the desired interior frame environment of 50% RH. The Art Sorb strips

Fig. 16. Margaret Sears and Kirk Vuillemot place polyester batting in the hollow of the stretcher.

Fig. 17. Kirk Vuillemot and Christine O'Shea fit the blue board backing that holds the panel inserts in the cavities of the stretcher securely in place.

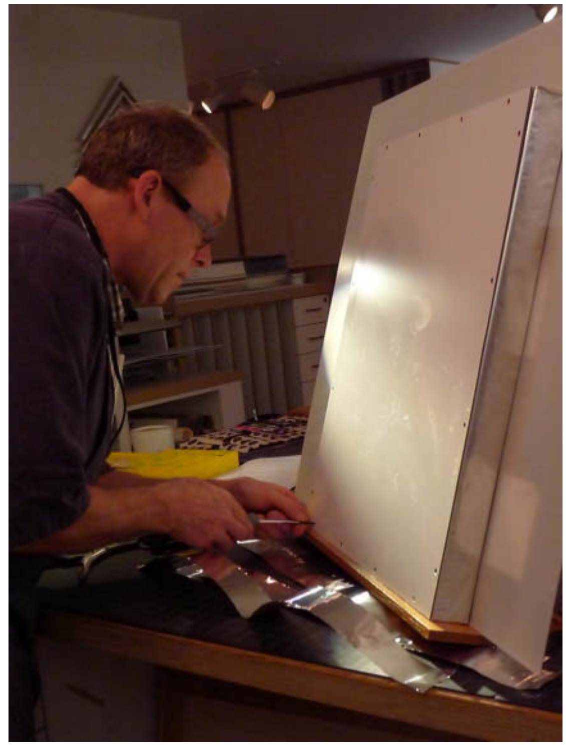

Fig. 18. Dibond backing attached to the back of the inner frame with screws.

also helped to evenly distribute pressure along the perimeter once the final backing was attached.

BACKING

A piece of Dibond was screwed into the back of the basswood addition of the inner frame to close the package (fig. 18). All screw holes were predrilled and hand screwdrivers were used during attachment. Dibond is an aluminum composite that consists of two thin sheets of aluminum enclosing a polyethylene core. It is relatively lightweight, rigid, and impermeable to the free exchange of gasses and, as such, is the preferred material with which to back a microclimate enclosure. After the Dibond was attached, aluminum foil tape was attached to the perimeter of the inner frame, concealing the screw holes and sealing the package.

When the pastel package was complete, it was fitted into the original late 19th-century French Rococo Revival frame to which the hardware had already been attached (fig. 19). A piece of Coroplast was then placed into the back of the original frame and mending plates (again all screw holes predrilled) were attached along the perimeter of the rabbet of the frame to hold the pastel package securely in place (fig. 20). Manet's *Portrait of Alphonse Maureau* is now safe for travel, exhibition, and eventually storage (fig. 21).

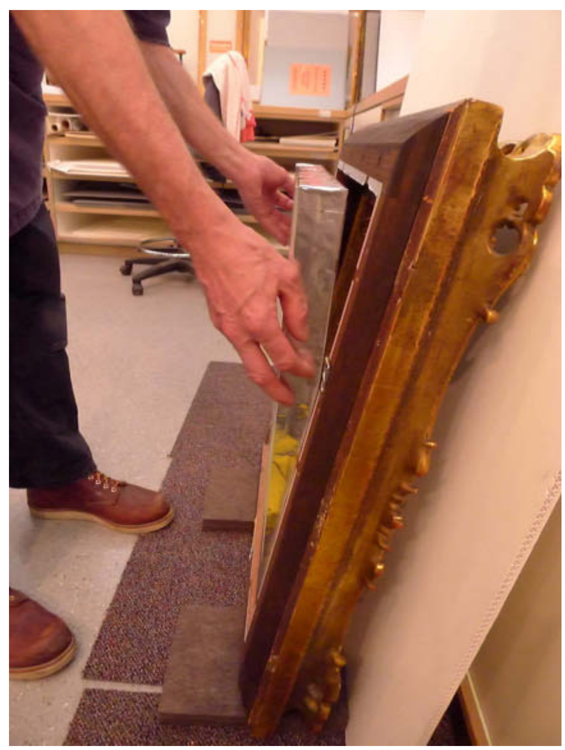

Fig. 19. The sealed pastel package is fit into the original 19th century French Rococo Revival frame.

Fig. 20. Back of the sealed frame.

Fig. 21. *Portrait of Alphonse Maureau* stable in its frame.

CONCLUSION

This paper asks as many questions as it answers. Given the consistency in support, grounds, and technique of the two pastels discussed here, it would be valuable to determine if other pastels by Manet share these characteristics. Research into the degradation patterns outlined above might lead to a stabilization procedure for the media. Finally, refinement or adaptation of the framing procedure would improve the care and longevity of pastels on canvas supports.

ACKNOWLEDGMENTS

The authors wish to thank the Art Institute of Chicago and the following individuals for valuable dialogue, guidance, and support: Gloria Groom, Kirk Vuillemot, Harriet Stratis, Antoinette Owen, Margaret Sears, Christopher Brooks Milan Bobysud, Kim Muir, Ken Sutherland, Antoinette Owen, Kristi Dahm, Mary Broadway, Maria Christina Rivera Ramos, Francesca Casadio, Catalina Vasquez-Kennedy, Katrina Newbury, and Helen Burnham.

NOTES

1. For an explanation of interpreting thread count results, consult https://www.ece.rice.edu/~dhj/TCAP/ITC.html.
2. Warp threads are the longer (or longitudinal) threads that are placed on the loom and held taught. The weft threads are inserted over and under the warp threads to produce a piece of cloth.

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FURTHER READING

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SOURCES OF MATERIALS

Perma/Cor B-Flute blue board
University Products

Tru Vue Optium acrylic glazing
Gemini

Volara foam rabbet tape
University Products, Hollinger Metal Edge

3M aluminum foil tape
Uline

Marvelseal 360 aluminized polyethylene and nylon barrier film
University Products, Talas

3M Double Coated Tape 415
University Products, Talas

Art Sorb polyethylene/polypropylene sheet impregnated with silica
University Products

Dibond aluminum composite sheet with a polyethylene core
Tri-Dee Distributors

Coroplast archival grade clear fluted polypropylene
Talas

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Branded by Fire: Treatment of *Primeros Libros*

The Cushing Memorial Library and Archives of Texas A&M University contains 20 examples of volumes designated as *primeros libros* and forms the basis of an international collaboration of nearly 30 institutions to build a digital humanities collection available for research (http://www.primeroslibros.org). *Primeros libros* are books first printed in the Americas from approximately 1539 to 1605 in colonial Mexico and Peru. The printing presses in New Spain functioned as a powerful instrument of the Spanish Crown and Catholic Church. Ascetic works, doctrines/catechisms, grammars, and dictionaries primarily fueled the printing press as well as the occasional medical, scientific, military or literary work.

These Texas A&M University volumes are previously untreated and several are in need of intense conservation treatment to bring them back as functional research tools while preserving their significance as unique artifacts. They are part of the Colonial Mexican Collection, which contains thousands of works either produced in Mexico or European imprints concerning Mexico during the Age of Exploration, Colonial, and early National periods, and is a significant collecting area for the library as well as resource for the scholarly community in this area. The collection offers a significant number of examples of Mexican colonial bindings, woodcuts, illustrations, illuminated and decorated manuscripts, types, publishers, marginalia, and other information.

This presentation reviewed the unique characteristics of *primeros libros*, such as the *marca de fuego* (burned in brand) that is usually present on the textblock edge of these books, while also relating them to their more common European cousins in areas such as printing and binding methods and materials used. Other *primeros libros* that had been previously treated before coming into the A&M collection were reviewed for durability of repairs in high-use research collections, aging characteristics of the repair materials, and appropriate aesthetic outcome of the overall treatment. Several book models were made to test methods for reconstruction of a *marca de fuego* and to test materials.

One primero libro, Benito Fernandez's 1568 work, Doctrina Chistiana en Lengua, was selected to serve as a case study for treatment to be carried out on other items within this collection.

The *Doctrina Christiana* was chosen as the case study because of the scarcity of the title and the severity of its condition. The item exhibited a mostly detached parchment wrapper with severe moisture damage and overall shrinkage, as well as severe pest damage and paper loss of the first signature, with staining and tidelines throughout the textblock. For binding structure strategies, several approaches were considered to address the diverse needs of the volume, from parchment repair for the binding to a completely new binding of the same structure, but ultimately it was decided to implement a reversible "medium solution" of an unattached sympathetic parchment wrapper, while reutilizing the original sewing supports and sewing thread. This treatment method stabilized the object materials, made it a functional research tool again, and maintained original materials in their original orientation for future research.

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Papers presented at the Book and Paper Group Session, AIC's 46th Annual Meeting, May 29-June 2, 2018, Houston, Texas

JOAN IRVING

"Not Always for Ornament:" Transparent Liquid Colors for Maps, Plans, and Prints

INTRODUCTION

Today, transparent effects for graphics are achieved with just a click of the mouse. To color a map or print with transparent color in the 18th century, in accordance with guidelines set forth in various English craft manuals, artists needed a solution of very finely ground pigment suspended in a clear aqueous medium. For this, a class of colorant was specifically formulated for coloring maps, plans, and prints, and they were the transparent liquid colors, commercially available or made by the colorist (cartographer, surveyor, artist). These transparent liquids were very different from the water-based media used for other types of objects, such as miniatures and even other types of popular prints, where body color and opacity were permissible. With greater specialization in the 18th century, with technical drawing in architecture, surveying, and engineering, and with the rising profession of the colormen, this new class of artists' materials was developed to meet specific needs. In 1755, Henry Wilson stated in his treatise on the manufacture of maps that colors must be made to be "so transparent as not to obliterate or deface the Lines, Trees, Houses, or whatsoever is necessary or ornamental to the Map" (263).

What are these liquid colors and how are they different from other watercolors? Who used them? Can you tell if a map or print was colored with the liquids? This paper will explore these questions against the backdrop of the history of watercolor and the rise of the professional colorman. Conservators can rely on a number of excellent resources on the history and development of watercolor; however, the commercially prepared liquid colors are little mentioned. In the 17th century and before, precursors to the liquid colors could be prepared as aqueous or oil-based solutions called tinctures, used particularly for washing or coloring maps (Purinton 2001). Pigments could also be purchased as powders in vials and mixed or "tempered" with gum arabic or purchased solidified in shells.

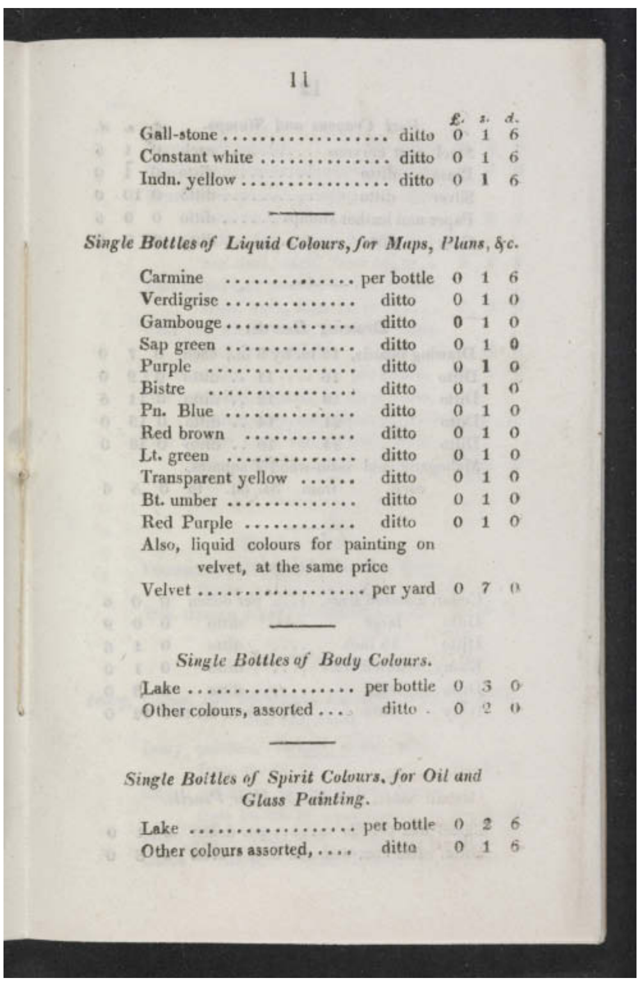
Papers presented at the Book and Paper Group Session, AIC's 46th Annual Meeting, May 29-June 2, 2018, Houston, Texas

Watercolor painting as an independent art form did not exist until the end of the 18th century, when it became a fashionable pastime in England—especially associated with scenic touring and capturing the landscape. Before that time, artists used watercolor as a subsidiary medium to heighten color in monochromatic drawings or to tint prints. By the last quarter of the 18th century, artists, gentlemen, and ladies could purchase solid watercolors in cakes more or less as we know them today.

HISTORY OF THE LIQUIDS

Interestingly, the liquid colors first arose in the building trades and created rising fortunes for the colormen, and sometimes colorwomen. That liquid colors may have some roots in the home trades makes considerable sense, since a particular formulation was needed to create broad, even washes of color for large swaths of wall or wallpaper. The Emertons of London initially traded more as color manufacturers than artists' colormen, promoting their wares to house builders and shipwrights. In this context, a very early commercial reference to the liquid colors appears in a trade card for Alexander Emerton. He established his business in London advertising in 1728 as a house painter and referred to "all Sorts of Water-Colours, prepared in Shells; and Liquid Colours, for Maps and Plans, &c" (National Portrait Gallery 2018). Another early reference also appears in a most unusual advertisement by a colorwoman, his wife Elizabeth Emerton, who took the reins of the family business following the death of Alexander in 1737. Elizabeth's trade card advertises "fine liquid colors for staining silks, linen, and paper" (Emerton 1741). Noteworthy, the Emertons also boasted of England's only horse mill for grinding fine pigments, which they touted as superior and less expensive than those ground by hand. The Emertons trade in house paints could well explain the trade card that appeared later in the century, where descendants seem to have made the upward social transition from color manufacturers to artists' colormen. Joseph Emerton's trade card prominently displays an artist at the easel painting the portrait of a lady sitter. However, his familial roots in industrial color remain evident, in the iconography of galley pots, wallpaper strainers' brushes—even the horse mill (Emerton 1744). The liquid colors eventually diverge from the building trades and also appear to diverge from general use by the public. William Reeves' trade card advertised "chemical colours for maps and plans" (Reeves 1782–1783). The term *chemical colors* suggests a technical rather than public vocabulary. Eighteenth-century experimentation led to the introduction of several chemical colors such as Prussian blue, Scheele's green, and others, which were the result of separation and combination techniques more common to the laboratory than the home studio.

As the 18th century drew to a close, the liquid colors were clearly a distinct commodity, arriving in American port cities in the early 1790s as "Reeves transparent liquid colors in bottles for illuminating maps and plans" (*New York Daily Gazette* 1793, 4). Whether in America or Britain, the liquids reigned supreme in the opening decades of the 19th century for the technical market (fig. 1). In "Treatise on the Construction of Maps," Alexander Jamieson (1814) directs his reader to "Mr. Newman, artist's colourman, 24 Soho square, has liquids in the following colors: gamboge, verdigris, carmine, purple, bistre, Prussian blue, light green, dark green…" (157). Jamieson mentions that Newman also sells cakes but cautions the draftsman in their use—advising to mix well and not add an excess of pigment because it is "liable to settle in particular places" (157). Though convenient cakes and tubes were widely available, it is significant that 19th-century manuals for surveyors and architects continue to provide instructions for grinding pigments and for steeping bits of bark and berries to create liquid colors because the particular properties of these colors were so useful for specialists. The palette remained remarkably unchanged until the introduction of aniline dyes. Transparent liquid colors persisted well into the 20th century, to be supplanted only by the most intangible of transparent media—CAD, computer assisted design.



11

		£.	s.	d.
Gall-stone	ditto	0	1	6
Constant white	ditto	0	1	6
Indn. yellow	ditto	0	1	6

Single Bottles of Liquid Colours, for Maps, Plans, &c.

Carmine	per bottle	0	1	6
Verdigrise	ditto	0	1	0
Gambouge	ditto	0	1	0
Sap green	ditto	0	1	0
Purple	ditto	0	1	0
Bistre	ditto	0	1	0
Pn. Blue	ditto	0	1	0
Red brown	ditto	0	1	0
Lt. green	ditto	0	1	0
Transparent yellow	ditto	0	1	0
Bt. umber	ditto	0	1	0
Red Purple	ditto	0	1	0
Also, liquid colours for painting on velvet, at the same price				
Velvet	per yard	0	7	0

Single Bottles of Body Colours.

Lake	per bottle	0	3	0
Other colours, assorted	ditto	0	2	0

Single Bottles of Spirit Colours, for Oil and Glass Painting.

Lake	per bottle	0	2	6
Other colours assorted,	ditto	0	1	6

Fig. 1. Liquid colors remain a commodity throughout the 19th century (Driver and Shaw 1824, 11).

MANUFACTURE AND USE

Other than the obvious fact that these are fluid media, what technical features distinguish the liquid colors and why did they have such lasting power, particularly for specialists? Clues about their technical qualities, especially transparency, are embedded in techniques of production. The trade cards don't reveal the secrets of their success, but the craft manuals of the 17th and 18th centuries provide some details. Craft-oriented manuals by English authors such as John Smith, William Salmon, and later Robert Dossie, offer guides for ladies and gentlemen in the arts—including the "washing" or coloring of maps and prints. These manuals encouraged the use of a variety of colorants, which we today would classify as organic and inorganic pigments. Many manuals praise the transparent effects of organic pigments such as madder or sap green while warning against some mineral pigments such as vermillion, which was said to "hide the mark of the graver" or obscure the printed design (fig. 2). These craft manuals for generalists and amateurs advised that the pigments for washing maps and prints could occasionally be the same as those used with oil, but only with thorough grinding and chemical additives. In other words, a good wash of inorganic vermillion, sometimes referred to as semitransparent, could be nearly as transparent as a wash of the organic pigment madder, but only with proper care and preparation.

Specialist manuals, however, told a different story. Edward Laurence, author of *The Young Surveyor's Guide* of 1716, unequivocally asserts that surveyors' colors are not the same as those used by painters in oil. "But for our purpose the transparent colours are principal…. Brazil and Logwood Water, Carmine, Indian-Cakes, Turnsoil, Ultramarine, Gamboge, Yellow-Berries, Saffron, Litmose, Sap-Green, French Verdigrease, Wood Soot, and Walnut Husks" (227). Here Laurence has listed primarily vegetable colors such

Fig. 2. (a) Opacity of vermillion (16x) versus (b) transparency of organic red (16x), which allows engraved details to be visible through the wash.

as Brazilwood and also a few inorganic exceptions of relatively small particle size—ultramarine and French verdigris. Consistent blues and greens were difficult to achieve with some of the plant-based sources such as litmus and turnsole for blue or sap green and buckthorn berries for green. Hence, the manuals commonly provided mineral-based alternatives for these colors, often ultramarine before the commercial availability of Prussian blue, and verdigris, which remained a standard green until aniline dyes became available. Laurence also advised the surveyor to be very careful about sourcing pigments and contracting with colorists, stating that "it is not convenient to repair to a painter to finish his work […] a painter is not to be found in every county, or is every painter furnished with colours fitting for such a purpose, they for the most part using more gross and ordinary colours" (216).

What was gross and ordinary was particle size and weight—key physical properties linked to transparency and opacity. Hiding power or opacity is the ability of a pigmented coating to obliterate the surface of the substrate. Naturally, the thickness of the coating and the concentration of the pigment play a role; however, the specific pigment and its particle size is important. Mineral pigments are generally more opaque because they are larger and heavier than organic pigments. Another key factor in opacity is refractive index, a pigment's ability to bend or scatter light in relation to the binder. Mineral pigments have a higher refractive index than organic pigments, again contributing to their relative opacity in water and gum arabic. Yet, in the generalist manuals by Dossie and others, the mineral pigments were not dismissed out of hand. Some of the minerals of smaller particle size could be mixed in a vehicle or aqueous solution with a suspension agent or additive that could reduce a tendency to agglomerate or clump and settle, creating an uneven, dappled wash. According to many, the preferred suspension agent or surfactant was alum while others recommended ox gall. Dossie specified "isinglass size prepared with sugar or honey, which makes the colours of this sort [semitransparent] work so freely, that they may be diffused almost as easily as the transparent kinds and with nearly good effect" (1758, 327).

These physical properties are what ultimately divided the users of the transparent liquid colors and the watercolor cakes. For professionals, the preference wasn't only for vegetable colorants but also for the vehicle—a liquid. Before the invention of the cakes in 1780, specialists and amateurs alike used the liquid colors for painting on velvet, flower painting, and for tinting prints, maps, and plans (Alston 1804).[1] For coloring prints, numerous craft manuals for amateurs and artists extolled the virtues of transparent effects or "leaving the lights" of the paper to appear through the wash, often for aesthetic rather than technical purposes. It was in poor taste to indiscriminately daub on very thick color, similarly covering the lights and shades, "like a penny print" (Jackson 1749, 49). Rather, colorists of prints were encouraged to let the light of the paper shine through and to be careful of colors that are too opaque, "sad," or deep. The liquids were considered ideal for these purposes.

After 1780, however, the new and exciting cakes appear to be the preference for most consumers, except for the professional or technical specialist. Though the manuals for generalists persisted in regurgitating the same recipes for making the liquids for a decade or so—as was customary with the popular craft manuals—the genteel reader of the "manual of elegant recreations" was advised to leave the liquids behind for the more convenient cakes: "The old treatises on water colours which contain directions for grinding them may be considered as obsolete colours being now manufactured...in cakes which are both brilliant and permanent" (Young Lady 1829, 355).

For professionals such as surveyors and architects, however, the issue of permanence was not a major concern and transparency was much more than an aesthetic issue. Legibility of the drawn or printed design and text, as seen through a transparent wash, was crucial to the function, which was informational. In addition, these professionals needed a large wash of consistent color, not one that might vary depending on the manufacture of the cake or techniques of dilution in a small saucer, as was the case with the cakes. This is not to say that cake or shell colors were never used by professionals. Surveyors may well have occasionally used solid cake or shell color for reasons of portability or for rendering border color or illuminating the cartouche, where more saturated color and precise lines were desirable. *The Practical Surveyor* of 1765 lists "Bottles and Shells of Water-Colours" in its list of necessary supplies for drawing and geometry (Hammond, 198), but it provides instructions only for preparing the liquids for washing or coloring plans (130). Much attention, therefore, is given in *The Practical Surveyor* and similar manuals to tools and techniques of grinding and processing pigments in preparation of a transparent liquid color.

A colorant owes its relative transparency not only to the chemical and physical properties of the pigment, but also to its processing. After extraction, mineral pigments such as ultramarine and red lead—and a few organic ones such as indigo—were ground. Artists' colormen commonly hand ground the mineral pigments into the first decades of the 19th century, however, the Emerton company boasted the superiority of horse grinding. Specifics for hand grinding unprocessed pigments are given in several of the surveyor's manuals. Some coarser pigments such as red lead and iron oxides were not well suited for a water-based medium and required further processing to create liquid solutions—if they were to be used at all as liquids. This laborious process was called, unfortunately, washing. "Washing" in this context does not mean coloring but means refining pigment by separating the coarser, larger particles from the smaller. This was accomplished by allowing the larger particles to settle in water or cling to the sides of the glass vessel, and collecting only the finest particles for use. In one manual, the reader is instructed to "put the colour in some clean Water into a Bason, often stirring it together; then let the Colour settle… and what at last sticks to the Sides will be the better colour" (Wilson 1755, 265).

No matter how well processed, ground by hand or by horse, or suspended in a variety of liquid vehicles, the opaque or even semitransparent pigments such as Prussian Blue or vermilion could not compete with the transparent pigments for effect or for ease of preparation. The transparent colors such as Brazilwood or gamboge were preferred because of their visual effects and because they required little preparation. These pigments were not ground, tempered, or washed but were simply diffused or steeped cold or hot, in a variety of liquids. These include water, stale beer, wine, or vinegar with the addition of various suspension agents (ox gall, gums, honey). Of gamboge, Salmon instructed: "dissolve it in fair spring water, and it will make a beautiful and transparent yellow: if you would have it stronger, dissolve some Alom therein" (Salmon 1672, 204–205). Alum was added not only to heighten color, but as a mordant and was thought to protect the color from fading. Color intensity was also adjusted by raising the pH with "sope lees," the dregs of the soap-making process, or lowering it with vinegar or citric acid. The liquors of these aqueous solutions were to be poured off "free of their settlings" and stored in glass bottles without further preparation. The "settlings" could also be strained through linen, brown paper, or both, which some manuals recommend.

HISTORIC RE-CREATIONS

To understand how the liquid colors handled, how they compared to cakes, and to answer the question of whether or not one can tell if a map or print was colored with the liquids versus cakes, test specimens were created in accordance with historic recipes. For these experimental reconstructions, it was understood from the beginning that organic pigments sourced from contemporary manufacturers would not be identical to those of the 17th and 18th centuries, but the goal was to make several liquids as close as possible, according to the recipes of the time. These selected colors, common for washing maps and prints, are Brazilwood, cochineal, gamboge, madder, and verdigris. Rather than use the formulations given by any one particular author, such as Boyle, Salmon, or Hoofnail, preference was given to the author who provided more quantitative details in their formulations such as drams, ounces, and quarts versus more informal instructions such as "boil it till it taste strong on the tongue" (Salmon 1672, 203). Pigments used in the preparation of the recreations were made from Kremer's line of historic pigments. The papers used for test washes are 18th-century English printing papers taken from a damaged book used for student experiments at Winterthur. The test pages were additionally sized with gelatin and alum as recommended in the manuals. Specific formulations for the liquid reconstructions appear in the Appendix.

Do washes of liquid colors look different than those from cake colors? Sometimes, depending on which cakes. To the naked eye, washes made with the liquids appear very even and dense, fully saturating the fibers. The liquids appear to have higher tinctorial strength than the cakes, making it challenging to create a pale wash with only one spare application of liquid medium. In order to compare the liquid washes to early watercolor cake washes of similar composition, that is, before organic synthetic dyes, watercolor manuals from the first decades of the 19th century were surveyed to select ones that included specimen washes of single colorants versus popular color mixes, such as "lake" and indigo. Two such pre-1830s manuals were found in Winterthur's library (Hassell 1825; Smith 1827).

In comparing washes made from the liquid laboratory reconstructions to watercolor cake washes of similar composition and color density, the 19th-century cake washes were found generally to have deposits of finely divided pigment visible in the specimens of medium to dark tonality, with a few exceptions, such as gamboge. Comparisons between organic liquids and inorganic cakes, such as Brazilwood liquid to red lead cake, were generally quite obvious, with the inorganic pigment having clear deposits of granular material. Interestingly, pigment particles were even visible in many of the organic lake watercolor cakes, which have a relatively small particle size. By contrast, the comparable organic liquids have minimal deposits of visible pigment. To hone in on these differences, potentially visible with simple optical microscopy available to the bench conservator, the red lakes were closely examined since they were often manufactured as liquids and as cakes. Comparisons between liquids of madder and cochineal-carmine lake were compared to numerous historic watercolor washes of madder, carmine, and "lake" (the latter often historically described as a mixture of cochineal-carmine, cochineal mixed with Brazilwood, or either of these with a small amount of vermilion). Among these red lakes, pigment particles were again visible in the cake washes of medium to dark tonality whereas the liquid washes had minimal visible pigment (fig. 3). However, the visible differences were negligible when comparing very pale washes of either historic cake or liquid, or when comparing liquids to some modern cakes, such as carmine, which is synthetic-dye based. It should also be noted that there would be differences in manufacture among the cakes and the liquids from varying sources. For instance, the historic manuals suggest that the liquids could be filtered through brown paper or linen, or levigated by simply allowing the solution to settle over time while pouring off the clear fluid. All of these techniques would impact the amount and size of particles visible in the final medium. The liquid recreations in this study were purified by levigation, with the exception of madder, which was strained as recommended in the manuals.

Another difference between the liquid recreations and the cakes is the presence of dark bits of detritus, possibly small pieces of root or bark, that do not appear highly colored as in pigment. These are not present in the cake washes from any of the manuals examined but were almost always visible in the liquid washes, even in the palest shades. One can imagine that such debris would have been difficult to control in the liquids and could be the product of manufacture or happenstance collection in open vessels. This debris proved useful when comparing the liquid reconstructions to two historical objects that were good prospects for "knowns" of liquid colors. A large 1775 pocket map (Scull) almost certainly had professional early color and was a good prospect for a liquid color due to its large size and its date—before the invention of watercolor cakes. A second object, a small 1762 atlas (Bonne), was also identified as a "known" for liquids by assessing application technique and by comparing to other volumes of the same atlas, which were similarly colored, suggesting a professional workshop. Under magnification there was little particulate pigment visible in the washes of organic yellow, organic pink, and verdigris in either object with only random, very scattered pigment solids occasionally discernable. However, small bits of dark debris, of varying size and shape, were also present—not as surface dirt—but bound in with the medium, much like the liquid laboratory recreations (fig. 4). The appearance of this debris may be another useful indicator of the presence of historic transparent liquids in hand-colored objects.

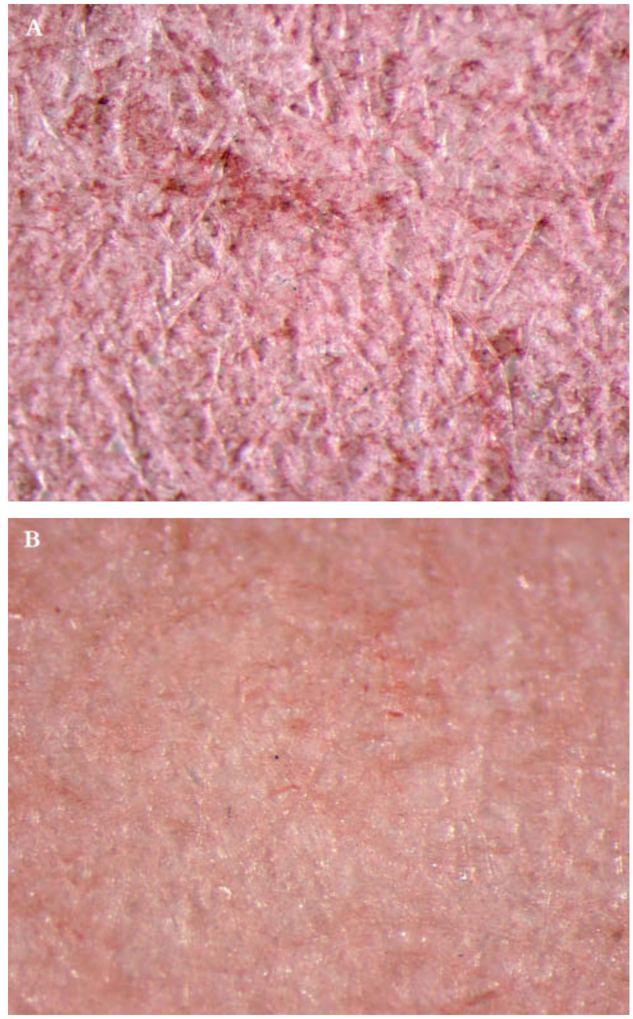


Fig. 3. (a) Agglomeration of pigment visible in madder (40x) specimen from Smith's Art of Drawing (1827) versus (b) little visible pigment in liquid madder (40x) reconstruction.

Another aspect of looking closely at the liquid colors is identification through analytical methods. Many conservators are very familiar with the various analytical techniques

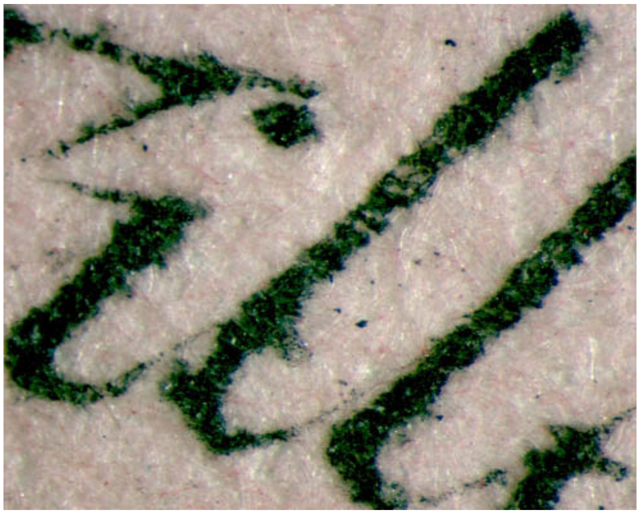


Fig. 4. Small bits of detritus bound in with liquid medium (40x) present in historical objects such as this 1762 French atlas colored with transparent liquids.

for identifying organic and inorganic pigments. What complicates analytical methods for the liquids is what makes the liquids so unique—homogenous washes of color deeply stained in the paper and therefore nearly impossible to sample. Extracting even minute fibers would mar a delicate, even wash. Preliminary work at Winterthur looks promising in terms of introducing a minimally invasive method of sampling for high-performance liquid chromatography (HPLC). Small 1-4 mm discs of agarose, 5 wt% and 10 wt%, were made using dermal punches. These were applied to watercolor washes to extract just enough pigment to achieve a successful HPLC separation—without visual effect on the sampled area in visible and ultraviolet light. This work is ongoing and results will be shared in the future, along with the use of nondestructive fiber optic reflectance spectroscopy (FORS), which has shown promise with organic materials.

CONCLUSION

For the conservator, the relevance of the liquid watercolors lies in connoisseurship and collections care. The liquids were preferred for transparent effects in some tinted prints, botanicals, and all maps, plans, and architectural drawings. Determining whether or not an object has early color has vexed conservators and curators alike; perhaps the presence of the liquids can, at least, provide some qualitative information. The appearance of the liquids on a print could suggest early color. Such an assessment must also take into consideration other qualities that conservators typically look to when analyzing color such as scientific analysis, palette, condition, application technique, and workshop practice, to name a few. The presence of the liquid colors, especially on an object that postdates the invention of watercolor cakes, also suggests a professional or technical hand. One suspects that even before the cakes, shell colors, the precursors of the cakes, would have been a more convenient and tidier option for the amateur than the messy liquids or tinctures in bottles.

While permanence may have been a concern for artists and amateurs, it was less prized than transparency by jobbing professionals and technicians. The fugitive nature of organic watercolors, made famous by Russell and Abney in 1888, was well known long before their time. As stated in the *Young Surveyor's Guide* of 1716, "N.B. Colours made from vegetables fade the soonest" (Laurence, 218). The small particle size and thinly applied washes that lend the beautiful transparency to the liquid color washes also make them most vulnerable to light, oxidation, acids, alkali, and, ultimately, fading. The latter we can observe empirically and has remained an area of continued scientific inquiry with microfading and with studies of photo-oxidation under anoxic conditions. Transparent beauty, though, is as seductive today as it was centuries ago, especially for the professional. On their website, Winsor & Newton advertise professional-grade watercolors as having "unrivalled transparency." Professionals today know what they knew in 1755, that "colouring… is not always for ornament only" (Wilson, 269).

AKNOWLEDGMENTS

Many thanks to Winterthur and the University of Delaware for supporting this research and the following for their contributions: Jocelyn Alcántara-García, Assistant Professor, Conservation Scientist, for high-performance liquid chromatography; Betty Fiske, for generously allowing me to share the history of the liquids with members and friends of Historic Odessa Foundation; John Krill, for sharing thoughts and research on the history of watercolors; Catherine Matsen, Scientist, Winterthur, and Rosie Grayburn, Associate Scientist, Winterthur, for x-ray fluorescence spectroscopy.

APPENDIX

Alum (alum water)

Definition: Alum (or Roche alum, rock alum, Roman alum) generally refers to aluminum potassium sulfate. It is a colorless, crystalline material used in the tawing of skins and as a mordant for many natural dyes.

Historic recipe: "To make alum water dissolve 4 ounces of alum in a pint of fair water boiling them till the alum is dissolv d or thus to 2 quarts of spring or well water put half a pound of Roch alum poudered dissolve it well by boiling filtre it through brown paper and keep it for use" (Barrow 1735, 1 recto Hh).

Laboratory reconstruction: 113 g of potash alum in 473 mL of Winterthur filtered tap water, boiled until solids dissolved.

Gum arabic (gum water)

Definition: a gum exuded from the stem of several species of Acacia tree, typically found in subtropical regions of the world.

Historic recipe: "Put a quart of pure spring water into a jar glass and hang in it ty d up in a fine woollen rag a sufficient quantity of pure white gum arabick bruised. Let it hang till the gum is dissolved put your fingers into the water and if you find them to stick together as if they were glued your water is too strong or full of the gum and therefore you must put more fair water to it and if you find it too weak you must put in more gum" (Barrow 1735).

Size

Definition: A material added to a porous substrate such as paper or textile to diminish absorbency. Common sizing agents for paper are starches, animal glues, gelatin, and cellulose ethers.

Historic recipe: "Take glew which steep all night in water then melt it over the fire to see that it be neither too strong nor too weak then let a little of it cool; if it be too stiff When it is cold put more water to it if too weak more glew using it lukewarm" (Salmon 1672, 202).

Laboratory reconstruction: .5% powdered gelatin dissolved in Winterthur filtered tap water, heated until all solids dissolved.

Brazilwood

Definition: Brazilwood is derived from various tropical trees of the senna genus native to South America, the East Indies, and parts of Asia. Brazilwood was an important wood and dye export from South America beginning in the 17th century.

Historic recipe: "To some ground Brazil put small [weak or stale] Beer and Vinegar of each a sufficient quantity let it boil gently a good while then put therein Alom in powder to heighten the Colour and some gum Arabick to bind it boil it till it taste stronge on the tongue and make a good red" (Salmon 1672, 203).

Laboratory reconstruction: 28 g of Brazilwood in 473 mL of liquid composed of equal parts stale IPA beer and white vinegar, boiled; 4 mL alum water and 4 mL gum water were added.

Cochineal-Carmine

Definition. Cochineal is derived from dried insect bodies of *Dactylopius coccus* Costa (formerly *Coccus cacti*) from Central and South America. The lake pigment carmine is formed when precipitated with alum.

Historic recipe: "Cochenele, Steeped as Brazil was boiled makes a fair transparent purple as thus take Cochenele and put it into the strongest Sope lees to steep and it will be a fair purple which you may lighten or deepen at pleasure" (Salmon 204). For proportion, Hoofnail cites a dram of solid cochineal powder in a pint of Thames water—or approximately 1.77 g in 473 mL (Hoofnail 1738, 27). There are numerous variations in vinegar, Rhenish wine, and "alkaly."

Laboratory reconstruction: 2 g of cochineal in 473 mL of liquid composed of equal parts stale IPA beer and white vinegar, not boiled; 4 mL alum water and 4 mL gum water were added. The solution was made alkaline with potassium hydroxide, to approximate "Sope lees" (or the dregs of soap making) to a pH of 14.

Gamboge

Definition: a yellow resinous plant gum produced by several species of the Garcinia tree. Gamboge was imported into Europe in the 17th century and possibly earlier.

Historic recipe: "Cambogia Dissolve it in fair spring water and it will make a beautiful and transparent yellow: if you would have it stronger, dissolve some Alom therein" (Salmon 1672, 204–205).

Laboratory reconstruction: 28 g of gamboge in 473 mL of Winterthur filtered tap water.

Madder

Definition: A natural red dye extracted from the roots of various species of the genus *Rubia*.

Historic recipe: "Take Madder four Drachms, ground Brazil one ounce, Rainwater a quart; boil away a third part: then add Alom half an ounce, boil it to a pint; then gum; Arabick one ounce, which boil till it is dissolved, cool it stirring it often, and strain it for use" (Salmon 1672, 202).

Laboratory reconstruction: 7 g of madder and 28 g Brazilwood ground in mortar and pestle, 946 mL of Winterthur filtered tap boiled and reduced in volume by one third, 14 g alum added and reduced to 473 mL; 28 g ground gum arabic added and heated until dissolved; solution cooled and strained through cheesecloth.

Verdigris

Definition: Verdigris or basic copper acetate is a bluish-green corrosion product formed when copper is put into acetic acid (vinegar). It is cheap and easy to obtain; the powder simply is scraped off copper and used as a pigment.

Historic recipe: "verdigrise boiled in vinegar makes a very good green but as it dries deep the wash must of course be very pale" (Jamieson 1814, 156). Hoofnail recommends adding a dram of gum water, or roughly 4 mL.

Laboratory reconstruction: 28 g of verdigris in 473 mL of white vinegar, with 4 mL of gum water or liquid gum arabic.

NOTE

1. The liquids colors are widely noted for painting on velvet and were advertised by Ackermann, Newman, Reeves, and others for this purpose. Manuals seem to suggest that the binder for liquids for painting on velvet was gum tragacanth, rather than gum arabic (Alston 1804, 69). Gum tragacanth was also used as a food thickener and may have yielded a more viscous solution, a more suitable consistency for painting on velvet rather than on a well-sized paper.

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SOURCES OF MATERIALS

Liquid gum arabic
Daniel Smith

Potash alum; pigments
Kremer Pigments

Gelatin (200 Bloom, Type B)
Polistini Conservation Material LLC

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Think Outside of the Box: Displaying Paper Objects Without Using Classic Methods

Toilet paper is one of our daily necessities. However, when it becomes a museum object that needs to be carefully treated and stored, it takes a lot of effort because of its light, thin, and soft properties. This essay targets preventive conservation of the toilet tissue object by utilizing friction and static electricity. Unlike other paper objects, toilet paper has unique properties; for example, it is thinner to be torn apart, lighter to be blown away, and more sensitive to moisture. For those reasons, we need to preserve and display this kind of object differently than we would more typical paper objects.

We focus on how to preserve and display this kind of object by choosing suitable materials and trying different methods of fixing museum objects. Due to its vulnerable structure and hygroscopic features, we avoid using any adhesive on the object directly. Instead, we try to use friction and static electricity. First, we made use of the storage methods traditionally used for textiles and fiber objects to fix the via friction. Through friction tests, we found the object could sit steadily on the textile. Then, we made a deep window with an inner tray for each toilet paper object. Last, we fixed the object with imperceptible strips to preserve sliding and falling. We also found static electricity could function to hold the toilet tissue object.

The object is a manuscript written by Lu Hsiu-lien on toilet paper with a ballpoint pen when she was imprisoned during the Kaohsiung Incident in 1979. This manuscript focuses on New Feminism and the political issue she has long been concerned with, which is quite important in the development of both society and politics in Taiwan. The manuscript used to be displayed on a poster by sticking it to copy paper with double-sided tape, which resulted in deterioration. As a result, it required treatment when it was housed in the National Museum of Taiwan Literature.

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Papers presented at the Book and Paper Group Session, AIC's 46th Annual Meeting, May 29-June 2, 2018, Houston, Texas

KIMBERLY KWAN

Small but Bulky: Rebinding a Portable 15th-Century Book of Hours

INTRODUCTION

Book conservation treatment rarely calls for the full rebinding of a book. Where possible, conservators preserve the material nature of a book by keeping its original components and performing minimal repairs. At times, more interventive treatments are necessary to prepare the book for safe handling. A 15th-century Flemish book of hours (HRC 10) from the Harry Ransom Center's Medieval and Early Modern Manuscripts Collection presents a case study where rebinding became essential, allowing an in-depth examination into how modifying traditional resewing and rebinding techniques can improve the opening of small, bulky text blocks.

TREATMENT DECISIONS AT THE HARRY RANSOM CENTER

The Harry Ransom Center at the University of Texas at Austin functions as both a museum and a research library, with an active exhibits program as well as a commitment to making its collections accessible to the public. As a public institution, the Harry Ransom Center's collection belongs to the residents of Texas and, while researchers are carefully supervised, access to collection materials is seldom restricted. Bound collections at the Harry Ransom Center are thus simultaneously historic artifacts as well as working objects that need to remain functional.

The primary goal of conservation is to stabilize the object in its current condition rather than returning it to a previous state. Where treatment is necessary, conservators often like to focus on preventive over interventive and, where it's necessary to keep treatment to a minimum, to preserve as much of the original object as possible. Occasionally, however, treatments for bound materials can become quite interventive for the object to remain safe during handling and access—if inadequate repairs are made for the sake of minimal intervention, more problems can arise in the future. As collection materials at the Harry Ransom Center are actively used in the Reading and Viewing Room and called for frequently in classroom settings (for instance, there were 414 class sessions encompassing over 8,000 students in 2017), interventive treatments are sometimes necessary for the continued access to collection materials.

HRC 10: A LEGACY TREATMENT

Multiple conservators have worked on the treatment of HRC 10 (ca. 1425-1475), a Flemish book of hours that originally belonged to the Miriam Lutcher Stark Library (fig. 1). The Stark collection was donated to the University of Texas beginning in 1925, and HRC 10 eventually made its way to the Harry Ransom Center, where it is now part of the Medieval and Early Modern Manuscript collection. The parchment text block consists of 237 leaves and measures approximately 9.5 cm (h) × 7 cm (w) × 4 cm (d)—it is small, fitting in the hand of a user, but rather bulky. Decoration includes 10 small miniatures and 12 full-page miniatures, with borders and initials throughout the manuscript painted and illuminated with gold.

When HRC 10 arrived at the Harry Ransom Center, the manuscript was in a 19th-century binding of full vegetable-tanned goatskin over paperboards with a hollow back. The text block had been sewn on recessed cords with the endpapers whip-stitched on, with a heavy amount of animal glue applied on the spine. The animal glue, which would have been applied hot, had gelatinized the parchment spine folds, further reducing the opening of a text block already restricted by its awkward dimensions and unaccommodating binding structure. A condition report of HRC 10 dating back to the 1990s describes the text block as very compressed, where "pressure must be used to open the book, during which the leaves flex a great deal from the gutter to the center of the leaf, causing stress to the media" (Primanis 1993, 2).

To view the manuscript, users had to grip the leaves tightly to force them open, which was especially damaging as there are no margins to the full-page illustrations (figs. 2 and 3). As a result, while the binding was in relatively good condition, the manuscript was disbound by conservators at the Harry Ransom Center sometime during this period.

Papers presented at the Book and Paper Group Session, AIC's 46th Annual Meeting, May 29-June 2, 2018, Houston, Texas

Fig. 1. HRC 10. Catholic Church. Book of Hours. Flanders: between 1425 and 1475. Courtesy of Olivia Primanis.

At a later point, residual animal glue on the text block spine folds was removed with water using cotton swabs, and Japanese paper mends were made where necessary. The text block was then resewn on double raised cords with an alum-tawed lining tacketed onto the spine, over which primary endbands were sewn (fig. 4). The sewing and endband supports were laced into wooden boards, with the intention of covering the manuscript in an alum-tawed skin with

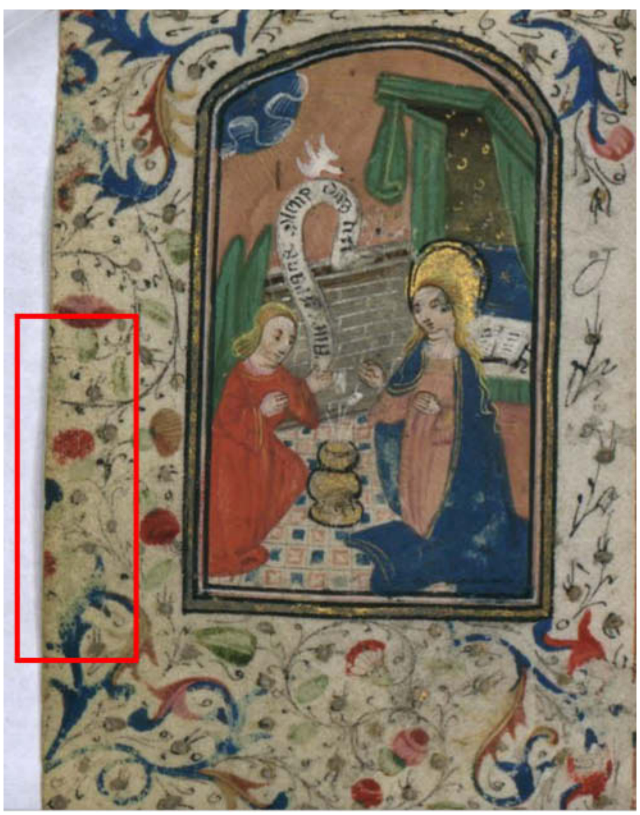

Fig. 2. Worn-away areas of the miniature from the lack of margins and handling with a strong grip.

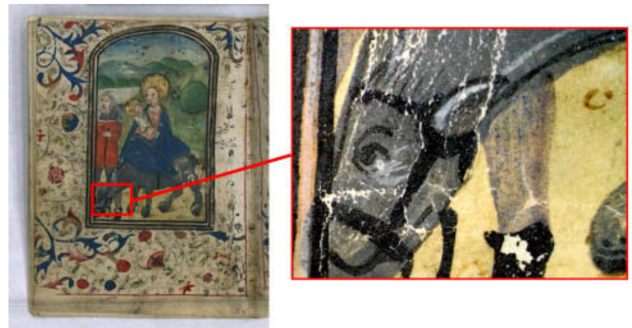

Fig. 3. Cracking media caused by flexing and handling of the leaves.

a baggy-back. When conservators rebind, some rebind in a period style or a structure that is aesthetically sympathetic because there is an idea that that is how the book was "meant to be." The binding structure just described may sound familiar to many book conservators—it may sometimes be the structure that is used when rebinding manuscripts of this period.

Nevertheless, while a lot of care had been taken in carrying out the treatment of HRC 10 to that point, the manuscript did not open as well as hoped after resewing (fig. 5).

For books where the leaves are wide enough and not too thick to drape naturally, it is not necessary for the text block to open to the gutter. In these instances, conservators prefer a reduced throw-up of the spine: "If a book throws up high the stresses and wear of opening are localized at the gutter instead of being spread out across the page. The paper will bend too much at the gutter and will be fatigued; worse, the tension of the sewing thread and supports will change as the book opens and closes, sawing the thread against the stations" (Conroy 1987, 2). Sewing supports and spine linings are used to restrict the movement of the spine so that the stress of the opening action is distributed across the leaf. On manuscripts like HRC 10, however, the text block is small and stubby, with narrow margins and stiff leaves that have no drape; high

Fig. 4. Resewing of HRC 10 on double raised cords with an alum-tawed lining. Tacketed onto the spine, over which primary endbands were sewn. Courtesy of Erica Schoirfer.

Fig. 5. Poor openability of HRC 10 after resewing on doubled raised cords.

throw-up is necessary for the book to open well. The use of double raised supports in the resewing increased the stiffness of the spine, reducing throw-up and restricting the opening of the book, meaning that the leaves still needed to flex in order for them to open (fig. 6). Treatment was left unfinished for awhile and, when the project was resumed, there was not a clear idea on how to proceed with the current structure.

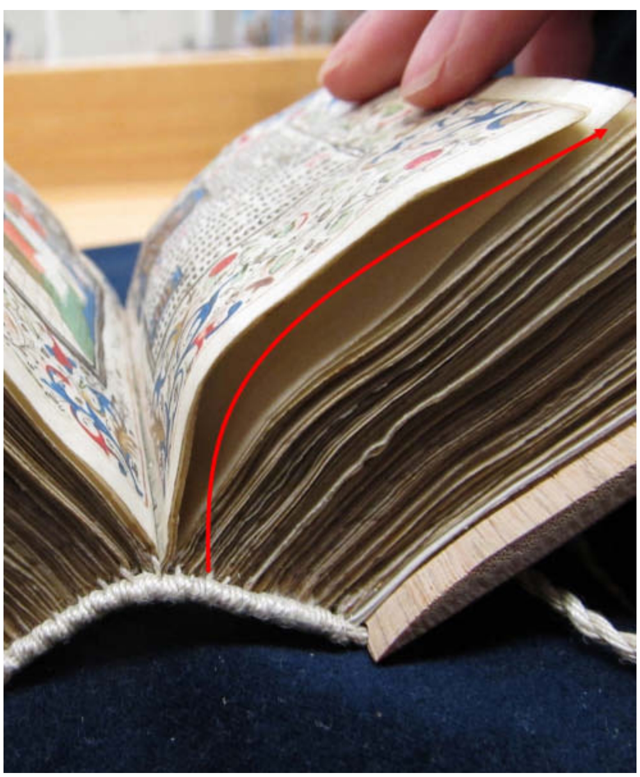

Fig. 6. Flexing of the leaf during opening, causing risk to media.

After reviewing condition reports and reconsidering the objective of treatment, the decision was made to remove the double raised supports from the text block. The sewing on double raised supports had appeared to be the right choice initially, as that is how a 15th-century manuscript would have been sewn. Sometimes, one becomes fixated on what the structure is supposed to be and alternative solutions are not considered even when it is clear the treatment is not working. Condition reports served as a reminder that the contemporary binding of HRC 10 no longer exists and is not necessary to recreate. As the media was in fragile condition and could be further damaged with flexing of the leaves, treatment proceeded by finding a structure for HRC 10 that could improve the opening and reduce flexing of the text block leaves during its use.

FLEMISH MANUSCRIPTS: ILLUMINATED LEAVES

A notable structural detail of HRC 10 is that its full-page miniatures were painted on individual leaves and adhered to the rest of the gathering with a hooked stub (fig. 7). This is typical of Flemish manuscripts—L. M. J. Delaissé describes how, "toward 1420 the specifically Dutch tradition in book production was already well established; unlike French Books of Hours, in which text and miniature are on the same leaf, in Dutch Books of Hours a miniature may be painted on a separate leaf, with one side remaining blank, which is then bound in at the appropriate place in the text" (Delaissé 1968, 19). The parchment used for the illuminated leaf tends to also be thicker than that used for the rest of the text block in Flemish illuminated manuscripts. This construction method affected

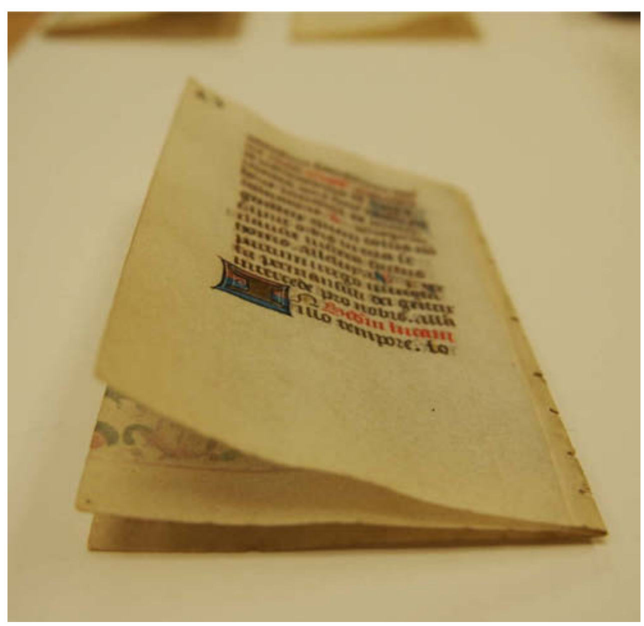

Fig. 7. An illustrated leaf is attached to this gathering by a hooked stub.

the opening: because the illuminated leaves are adhered to another leaf, the area of adhesion is stiffer, less flexible, and the illuminated leaves move with the leaves they are adhered to, reducing their ability to open flat.

A decision was made to detach the hooked stubs of the illuminated leaves from the gatherings they were adhered to, after which they would be resewn along with the rest of the text block. While this method of leaf attachment is significant in identifying the manuscript's Flemish origins, the choice to detach the stubs was made based on the treatment objective, which stresses the importance of increasing the opening characteristics of the text block to prevent the media from being flexed too much. Working under a microscope to observe any changes in the parchment, hooked stubs were gently humidified, using small pieces of damp blotter to soften the adhesive, after which leaves could be detached easily with a microspatula (fig. 8).

DETERMINING A SUITABLE STRUCTURE

As the sewing supports were so restrictive after HRC 10 had been resewn, the first consideration for improving openability was to try a structure with unsupported sewing. In discussions with colleagues from peer institutions, half were doubtful about the idea of resewing HRC 10 on an unsupported structure, preferring the control across the spine that raised supports would give during the opening. The other half suggested looking into variations of unsupported sewing structures, including sewing on a Japanese paper accordion with a link stitch or long stitch on airplane cotton. One conservator also suggested scraping or manipulating the spine fold before sewing to increase the parchment's flexibility. Through discussions with multiple conservators, it became clear that, even among experienced conservators, there is a wide range of opinions and uncertainty on what works or what might not. There is often more than one suitable solution, and it is also important to consider that what may work for one person and institution's culture may not work for another.

Models were made to test resewing the manuscript without any supports, using a link stitch, and to see if there were noticeable improvements in openability between different structures. The unsupported link stitch is a structure that offers a high throw-up, improving openability for stubby text blocks like HRC 10. A potential problem with unsupported sewing structures is that the stress of opening is placed entirely on the sewing thread, which can also cause knifing and chafing to sewing stations. These problems are less of a concern for HRC 10 as it is a small book, and its parchment text block would be less susceptible to stress at the sewing stations. Historic precedence for the use of unsupported sewing can also be found in Coptic and Ethiopian parchment manuscripts, as well as Western manuscripts such as the 8th-century St. Cuthbert Gospels.

Paper of similar thickness to the parchment in HRC 10 was selected for the models, with gatherings folded following the collation of HRC 10. Since paper is more flexible and accommodating than parchment, any openability issues seen with these models were expected to increase in a parchment version. The first model made was sewn all-along on raised double cords, so that a comparison could be made between it and the unsupported sewing structures. The leaves in this model did not open flat and, over time, the spine became very concave—possibly due to the tension of the sewing in combination with the size and thickness of the text block (fig. 9). In contrast, a model with unsupported link sewing opened flat (fig. 10). While this was the goal, the structure turned out to be too flexible. The gatherings could move up and down, and the spine could be easily twisted in one's hands and, with this movement, cause the leaves to rub against each other and abrade the media (fig. 11).

To reduce the flexibility of the spine, endbands with a back-bead were sewn over cords at the head and tail, with tie-downs at every gathering to reduce any vertical shifting. Having reduced that vertical movement, the next challenge was to reduce the horizontal shifting of the spine. In a conventional spine lining, bookbinders usually apply an adhesive to the spine and then apply a lining on top. A pounding brush is then used to ensure the lining has complete contact with the spine, molding to any slight undulations on the spine. This method of applying the spine lining is a typical procedure that does not tend to interfere with how the book opens. In this instance,

Fig. 8. Before treatment, after separation of hooked stubs from attached leaves, and bifolio under hooked stub after treatment.

Fig. 9. Opening characteristics of a model sewn on raised double cords.

where the text block has no drape and the margins are narrow, the lining restricted the opening. By adhering the first and last leaves of a gathering, these leaves did not open flat and the gatherings could not move independently of one another.

To avoid this effect in HRC 10, the adhesive was applied to a Japanese lining paper. The flat side of a Teflon folder was used to apply pressure on the lining over the spine, so that only the tops of the gathering folds are adhered to the lining (fig. 12). This method of lining attachment creates a gap in between sections, allowing the gatherings to pivot independently as the leaves are turned and for the leaves to lie flatter (fig. 13). The flexibility of the spine was also suitably reduced. There may be some concerns over how well the lining is adhered to the text block with this method—over the last year, the opening characteristics of this model were demonstrated almost on a biweekly basis during tours and classes, with deliberate attempts at twisting the text block in multiple directions to show the reduced flexibility after spine-lining, and the lining has remained firmly attached to the model text block. This is encouraging for the actual text block of HRC 10, where the text block will (hopefully) be handled less frequently and vigorously. As this model had suitable opening characteristics, HRC 10 was resewn following the model on an unsupported link stitch. It was then lined as described above using a heavyweight Japanese paper, over which primary end-bands with a back bead were sewn. Single-bifolio parchment endpapers with an airplane cotton hinge were added at the front and back of the text block.

Wooden boards were made for the covers, with the edges bevelled so that they would be aesthetically reminiscent of 15th-century bindings. Holes were drilled into the boards corresponding with the location of the sewing stations, and

Fig. 10. Opening characteristics of a model sewn with unsupported link stitch.

Fig. 11. The easily contorted spine of an unlined link stitch structure.

on the inside of the board, zigzag channels were drilled to accommodate the sewing thread, which had been left long at the beginning and end to be laced into the boards (fig. 14). The airplane cotton hinge was adhered to the inside of the board. The book was covered in an alum-tawed skin, leaving the spine unadhered for a natural hollow (fig. 15).

AFTER REBINDING: OBSERVATIONS AND CONCLUSIONS

After rebinding, there is a noticeable improvement in openability between the current structure of HRC 10 and when it was resewn on raised double supports. Due to the size of the manuscript, a collapsible custom cradle was made for HRC 10. Snake weights will still be needed to keep the pages down as the manuscript is being used, which can be tricky as there is no blank area of the text block to place the weights. The opening is still not ideal, and it must be accepted that for such problematic manuscripts where the text block is too small and thick, an ideal opening may not exist. Nevertheless, the aim of the treatment to increase openablity has been achieved.

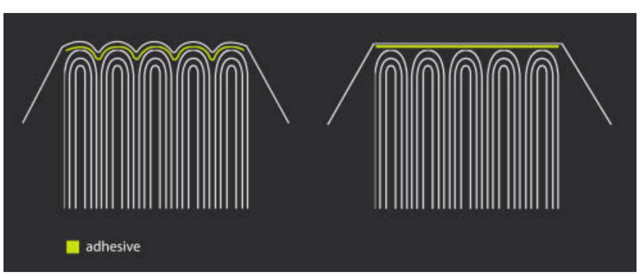

Fig. 12. Comparison of a conventional spine lining attachment (left) and a spine lining adhered only to the top of the spine folds (right).

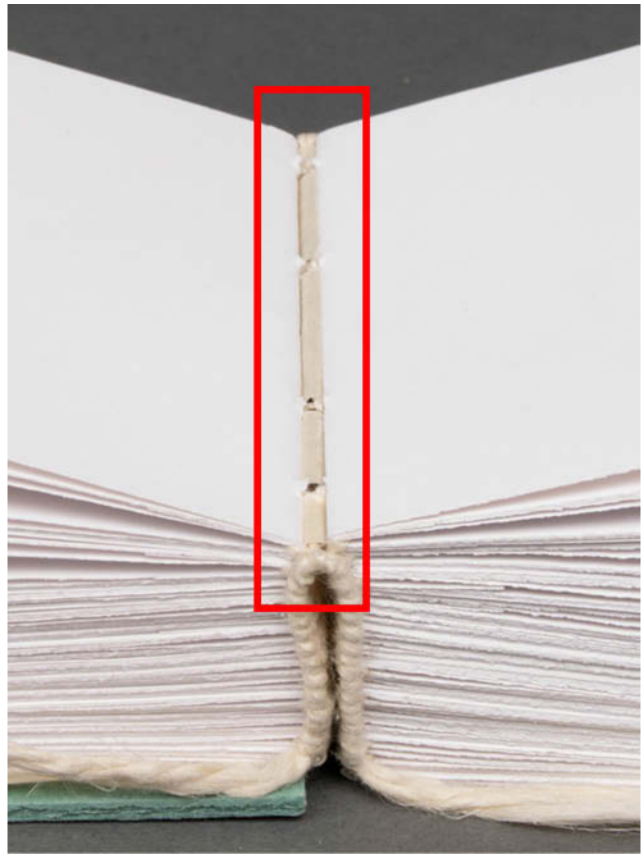

Fig. 13. Gap created by only adhering the spine lining to the spine-fold tips.

The high throw-up of the spine allows for a wider angle of opening and reduces the flexing across the leaves and, most importantly, the media (fig. 16). As interventive as the treatment was, it is satisfying to see how much HRC 10 is being used—the manuscript has been requested multiple times

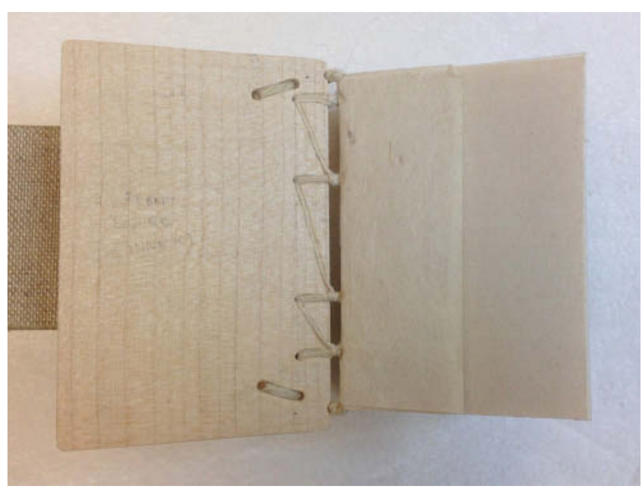

Fig. 14. The zigzag lacing-in pattern prevents the channels from creating a weak point in the board.

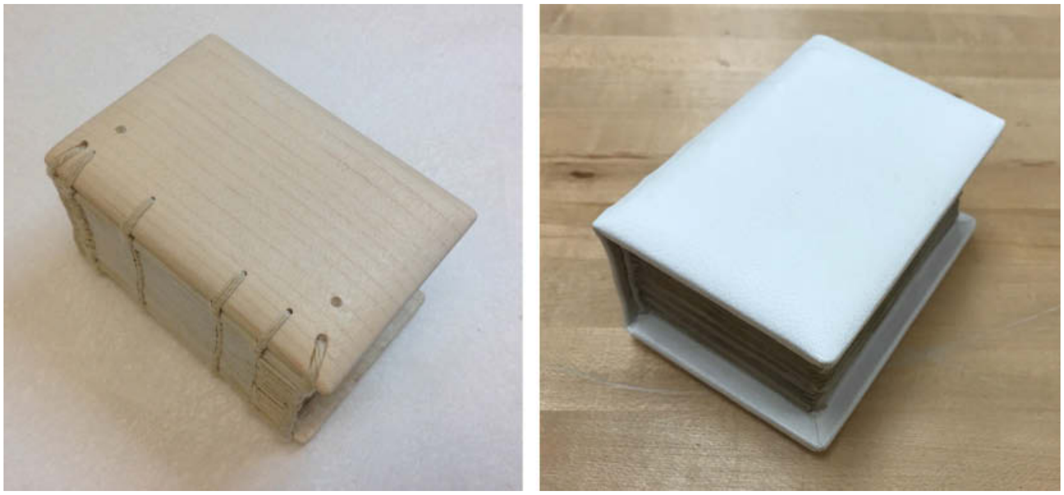

Fig. 15. HRC 10 before (left) and after (right) covering in alum-tawed skin.

since treatment was completed for classroom and research use and will be on loan to a Texas university for an exhibition (fig. 17).

A great deal of time and thought was put not only into the treatment of HRC 10, but also in how the manuscript would be stored and used. Whenever questions and considerations seem to be exhausted, however, new questions, points of views, and things to improve tend to come up through discussions with other conservators. In one instance, a question was raised regarding how the manuscript would be used—while a custom cradle had been made for HRC 10, there were questions whether books like HRC 10 were this size because they were meant to be held in the hands for an intimate experience. Conventional practice in reading rooms for special collections is that books must be opened on cradles with proper support, but it seems safer to simply hold the book in one's hands while reading than to have to weight each leaf down, take the weights off, and reweight each time the leaves were turned.

This question was posed at the 2017 Care and Conservation of Manuscripts Conference in Copenhagen when this paper was first presented. Commenters noted that the present-day use of HRC 10 is very different from its historical use, and that a researcher is probably going to need free hands to take notes and images of the manuscript. Often, the research isn't going to simply be reading and turning the leaves like a 15th-century user and so, in this scenario, it would perhaps be more helpful to put straps on the cradle instead of changing handling rules. The important reminder from this conversation is that even though an

Fig. 16. Opening characteristics of HRC 10 after rebinding.

Fig. 17. HRC 10, selected treatment materials, and models. Courtesy of Pete Smith.

object has remained in use for the last few hundred years, subtle changes in the way it is being used do matter and need to factor into treatment decisions.

Another consideration is the issue of rebinding—there are many small, bulky manuscripts with similar openability problems to HRC 10, which makes even digitizing for access impossible. In the case of HRC 10, it was fortunate that the manuscript was in a 19th-century binding and had already been disbound in the '90s, when such a decision might have been easier to make; as such, the openability of HRC 10 could be improved upon during treatment. However, many similar manuscripts are in original or early bindings, which makes things more complicated. Problematic books like these beg the question of what to do. Taking apart an intact early binding is an uncomfortable decision but choosing to do nothing and keep a book unusable is not a satisfying solution.

ACKNOWLEDGMENTS

I would like to thank the following individuals, who generously gave their expertise and support to this project: Olivia Primanis (Head of Book Lab), Erica Schoirfer (previous Book Lab intern), and my colleagues at the Harry Ransom Center; Maria Fredericks (Drue Heinz Book Conservator and Acting Director, Thaw Conservation Center), the Morgan Library & Museum; Yasmeen Khan (senior rare book conservator), Library of Congress; Renate Mesmer (J. Franklin Mowery Head of Conservation), Folger Shakespeare Library; Elizabet Nijhoff Asser, RNA Restauratie Nijhoff Asser; Andrea Pataki-Hundt (Head of Book and Paper Conservation Programme), Technische Hochschule Köln; and Vasaré Rastonis (previous Mellon Conservator for Special Collections), Columbia University Libraries.

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GILLIAN MARCUS

Caring for Electrophotographic Art: A Case Study of the Pati Hill Archives at Arcadia University

INTRODUCTION

Not long after Chester Carlson's Xerox 914 copy machine was first marketed to the business world in 1959, the photocopier found its place on the cutting edge of art production. Carlson's invention made life easier for office workers who had previously relied on slower and messier processes, such as the mimeograph system, for duplication. It also ushered in a new type of reproduction technology that was fast, cheap, and accessible (Xerox 1999). Almost as quickly as they were employed for more mundane tasks, photocopy machines were turning out electrophotographic (EP) prints destined for galleries and contemporary art museums.[1] The machine's simplicity and speed, as well as its ability to produce both abstract and hyperreal images, made it attractive to artists seeking to repurpose the technological conveniences of modern life as an extension of their artistic practice. When advances in technology made these machines smaller and more affordable to operate, copy shops staffed by "key operators" began opening up in cities and towns across the United States, making the grainy instant EP print accessible to almost anyone. Perhaps most significantly, the convenience of these machines allowed people who had not previously had access to traditional printmaking tools to quietly explore the possibilities of mass production.[2]

Artists with practices rooted in more traditional media, as well as members of the avant-garde Fluxus and International Mail movements, explored the newly available technology to produce what popularly came to be called Copy Art.[3] As with the initial embrace of any new technology, many artists experimented with electrophotography before moving on to other materials and modes of production, while a few became loyal to the medium. Pati Hill (1921–2014), an American writer and visual artist, found a home in the tactile process of making EP prints (Bailey 1980). Although she was not among the earliest adopters of the medium, Hill was one of the most prolific—producing an extensive body of EP work that spanned four decades, while also championing the work of younger artists experimenting with photocopy machines. In the spring of 2016, two years after her death, Arcadia University Art Gallery mounted a show of her early work, *Pati Hill: Photocopier, A Survey of Prints and Books (1974–1983)*. This event coincided with an announcement that the university would receive the entirety of Hill's archive, including thousands of black-and-white EP prints, through an initiative supported by Dorothy Lichtenstein.

Black-and-white EP prints are extremely common in archival document collections, where they are often considered secondary resources or copies of primary source material. However, there is a dearth of preservation and conservation literature providing a protocol for their care as art objects. Although the material composition of EP documents and fine art prints is often exactly the same, documents and art objects usually lead very different lives and, as a result, have different preservation needs. Preparing for this large acquisition provided the opportunity to examine the artist's methods and materials in order to begin establishing a set of guidelines for the care and preservation of black-and-white EP art. Although Hill experimented with digital electrophotography, color printing, and more traditional printmaking processes in the last decades of her career, for the majority of her practice she preferred to work with black toner on analog machines. This research focuses on the self-described "black pictures" of the artist's early career, ca. 1974–1983 (Torchia 2017).

PATI HILL: METHODS AND MATERIALS

By the early 1970s, Hill was already well-known for producing a significant body of written work; as a journalist and poet, she published one memoir, three novels, and one book of poems, as well as articles in *The Paris Review, Harper's Bazaar*, and *Seventeen*. After a break from writing and public life to raise a daughter, Hill began experimenting with the photocopiers that were available at copy shops near her Stonington, Connecticut home. The artist described her introduction to the photocopy machine as accidental; she was

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interested in keeping impressions of small objects she had saved over the years for sentimental reasons, but now wished to dispose of. Copying "bars of soap, zippers, fruit…and parts of old clothes—underwear and linen dresses" during regular visits to the copy shop led her to consider a more experimental approach to the machine's capacity for replication (Hill 1979, 156). She began feeding the copy shop machines with large amounts of black toner to increase the contrast of her prints, a practice that caused enough concern to key operators at her local copy shop that she was asked to leave. A sympathetic friend allowed her access to IBM offices in New York, enabling her to spend weekends using their copying devices as she pleased; she used this time to produce work for a show at the Kornblee Gallery in New York City. Hill's work was regularly featured at Kornblee Gallery, owned by art dealer Jill Kornblee, throughout the '70s; correspondence between the two women provided the basis for Hill's book, *Letters to Jill: A Catalogue and Some Notes on Copying* (1979). This text serves as both an artist statement and an insight into Hill's working methods.

In 1977, the designer Charles Eames, whom Hill met while traveling, provided her with an official introduction to IBM. Through this connection, Hill was able to secure an extended loan of the IBM Copier II to use at her home in Connecticut. Hill continued to focus her subject matter on the objects and detritus from everyday life, producing striking, simple images made from placing a single object on the copy platen. Her first series of prints, *Common Objects* (ca. 1975–1979) (fig. 1), was exhibited in the show *Common Alphabet* #1 (1978) at Franklin Furnace in New York City. This series focused on the objects of domesticity—eggs, hair curlers, socks, and cabbage, among other items—intended by Hill to serve "as a kind of de-Freudianized series of symbols that suggested language" (Hill 1979, 80). This interest in creating a visual language expanded upon her concurrent work *Proposal for a Universal Language of Symbols* (ca. 1975–79), in which she suggested the use of small runelike figures as a substitute for written speech (fig. 2).

Hill spent hours in the studio with the loaned IBM Copier II, reproducing commercial photographs, fruit, flowers, and even copying parts of a dead, frozen swan that she had dissected and placed on the copy platen (fig. 3)—all appearing to emerge from a tangible darkness. Alongside other artists working with the EP process, Hill earned a place in the state-of-the-medium show *Electroworks* (1979–80) at George Eastman House in Rochester, New York (and later Cooper Hewitt in New York City). Other group and solo shows followed, both in Europe and the United States. In the early 1990s, Hill's husband, the gallerist Paul Bianchini, opened two branches of Galerie Toner in Sens and Paris, France; these spaces were solely devoted to exhibiting art made using the photocopier (Torchia 2017).

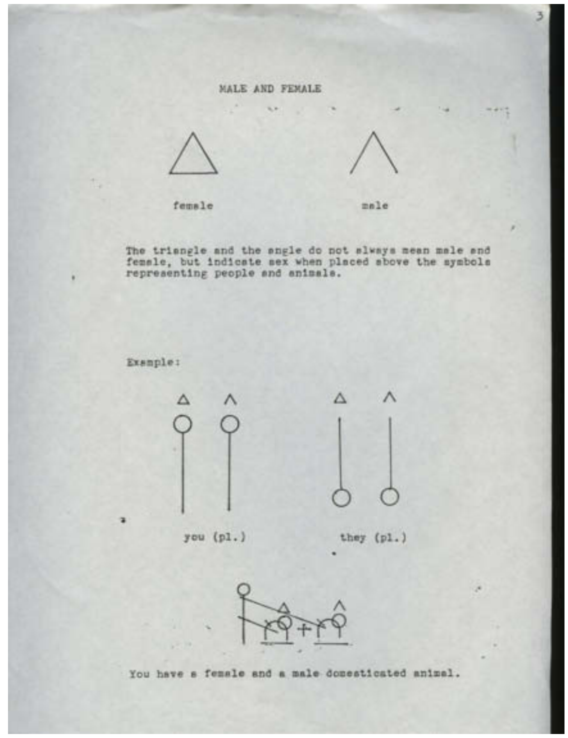


Fig. 1. Detail from *Proposal for a Universal Language of Symbols* (1975–79), black-and-white copier print, 28 cm × 21.6 cm. Courtesy of the Estate of Pati Hill and Arcadia University.

Fig. 2. Pati Hill, *Alphabet of Common Objects* (ca. 1975–79). Forty-five black-and-white copier prints, each 28 cm × 21.6 cm. Courtesy of the Estate of Pati Hill and Arcadia University.

DARK MATERIALS

The IBM Copier II became Hill's copier of choice, even after she was exposed to other models and manufacturers, and she favored this machine for its production of images, which were "grainier" and had "a greater range of tones and greater depth perception" in comparison to copies produced with other machines (Bailey 1980, 24). Introduced in 1972, the

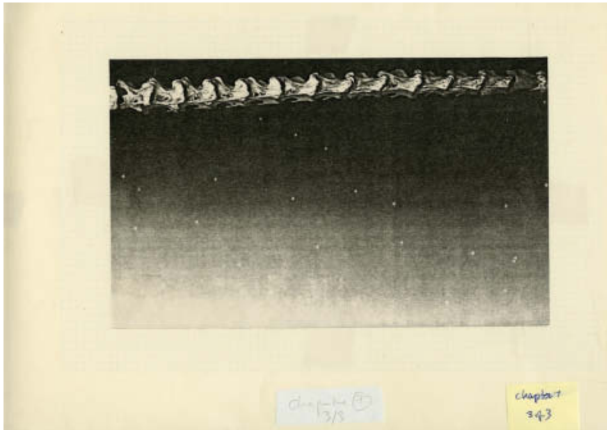


Fig. 3. Pati Hill, Detail of *Chapter 7 of A Swan: An Opera in Nine Chapters.* 1978. Electrophotographic print dry-mounted to mat board with artist's notes. One of a series of 32 captioned black-and-white copier prints, each 21 cm × 34 cm. Courtesy of the Estate of Pati Hill and Arcadia University.

Fig. 4. The artist at work in *Contact* Magazine, May 1980. Courtesy of the Estate of Pati Hill.

Copier II was large, heavy, and expensive to rent, but it also had a faster throughput rate than previous models, at roughly 6 seconds per copy. It was also one of the first copy machine models to be advertised as suitable for photocopying three-dimensional objects (IBM 1972). The Copier II was key to the development of Hill's working process and early aesthetic, as it allowed her to have full control over the amount of powdered toner fed into the machine and the resulting darkness and contrast of the final print. Hill favored the deep, textured blacks she was able to produce by spooning in more than the recommended amount of toner into the machine, the same practice that had seen her banned from her local copy shop for "the excessive use of dark materials" (Torchia 2017) (fig. 4).

Almost all of Hill's prints made on the Copier II feature a signature pattern of seemingly random spots of white—areas without toner—which Hill referred to as "stars." These were especially prominent in the wide swathes of darkness of Hill's prints, and in fact she preferred prints in which the tiny white spots were most striking (fig. 5a). "Since I want this picture to be showy," she wrote in a letter to Jill Kornblee, "I think I'll make it very dark and try for some stars—holes, they are really—so I open the powdered ink till and shovel in the black" (Hill 1979; McCray 2017, 24). These stars, known as "trash marks" in the photocopy trade, appear in the same location in a run of prints of the same object (figs. 5b and 5c). Although Hill's writing suggests that they were enhanced by her heavy use of toner, they are likely the result of a defect on the photoconductor drum or dust, toner, or paper debris in the machine or on the copy platen (Young 2018; Day and Davies 2005). Eventually, out of necessity, Hill went on to use other copiers. This included the Rank Xerox 2600, which was smaller and allowed for sharper detail, and the Xerox 3107. Still pining for the deep blacks of the overfed Copier II, she sprayed the Xerox prints afterward with fixative to saturate the images and intensify the darkness (Hill 1979, Bailey 1980). There is no record of the fixative the artist used, although her assistant recalled her "spraying paper with glue" (Chakour 2017).

DETERMINING PRINT ORDER THROUGH VISUAL EXAMINATION

Although Hill was extremely prolific—reportedly collecting the day's work by sifting through dozens of prints on the floor of her studio—she recognized each print as a unique object. Hill wrote in her journal that "the possibility of anyone making more than one identical—or even very similar—analog print is small…they are original separate prints" (Ferrari 2017, 108). This is illustrated in an anecdote shared by Fouzia Chakour, a neighbor of Hill's in Paris who worked as the artist's assistant in the early 1980s. She remembers Hill teaching her to recognize the "original" versus the "copy" through examining the toner density and clarity of each print:

> Pati let me figure out my own way of categorizing and then explained to me the different themes and how to distinguish between the originals and copies by examining the various shades of grey and density of the toner. She taught me to see how the grain of an original becomes slightly 'dilated' when copied a second time. I learned that each time you make a copy of a copy, the quality of the image deteriorates (Chakour 2017, 58).

The phenomenon Chakour refers to is known as degeneration, or generation loss, and occurs as an analog photocopy

Fig. 5a. "Stars" can be seen in this print as small white dots scattered throughout. Pati Hill, detail of *Chapter 9* from *A Swan: An Opera in Nine Chapters.* 1978. From an installation of 32 captioned black-and-white electrophotographic prints, 21 cm × 34 cm. Courtesy of the Estate of Pati Hill.

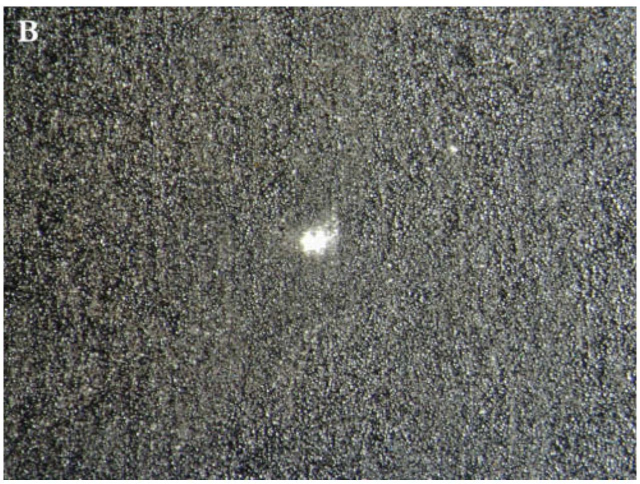


Fig. 5b. Stereo micrograph of a "star" at 60×. Courtesy of the author, Estate of Pati Hill.

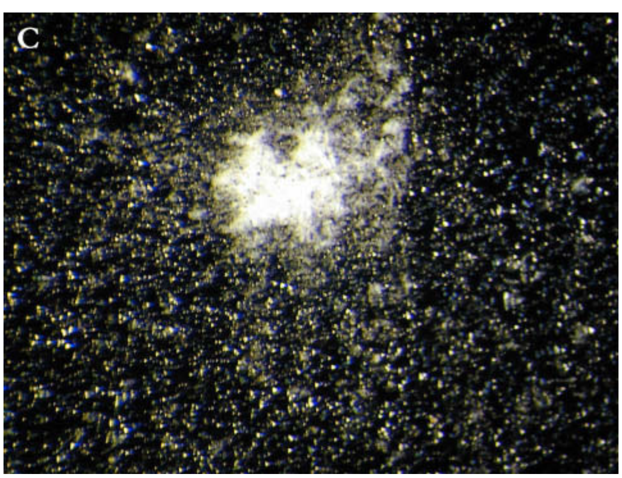


Fig. 5c. Stereo micrograph of a "star" at 310× under raking light, showing a complete absence of toner. Courtesy of the author, Estate of Pati Hill.

is reproduced multiple times. Each print became slightly "fuzzier," as defects were magnified with every subsequent print (Poissant 2002). In *Letters to Jill*, Hill also noted that the darkness decreased with each copy she made, as the toner stock depleted. In a medium that was celebrated for its ability to be used for the mass production of identical images, Hill took care to determine the sequence of production at the end of a day's work. Examining a detail from successive prints of the same configuration of objects under the microscope can clearly highlight visual differences caused by both image degeneration and the resulting changes in toner distribution patterns (fig. 6a). This is useful to identify the order that prints were made, and helps to identify whether an artwork is a "first print" of objects on the copy platen, or one of a series of copies of the first print (figs. 6b, 6c, and 6d).

The extent of generation loss visible in photo micrographs can be partly explained by a size discrepancy between the original object or image on the copy platen and the printed image. Most copy machines manufactured prior to 1980 were not able to produce images that were exactly true to size. Although the IBM Copier II was closer to exact size reproduction than

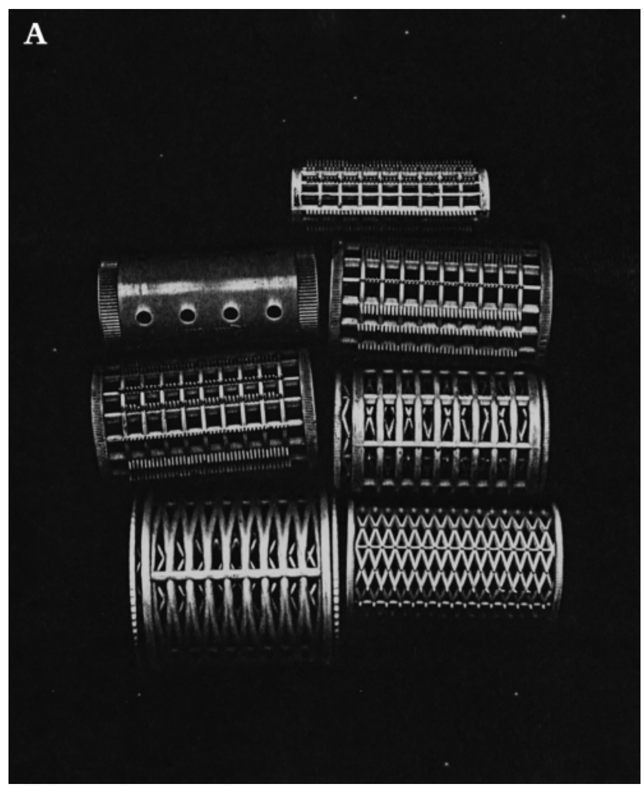
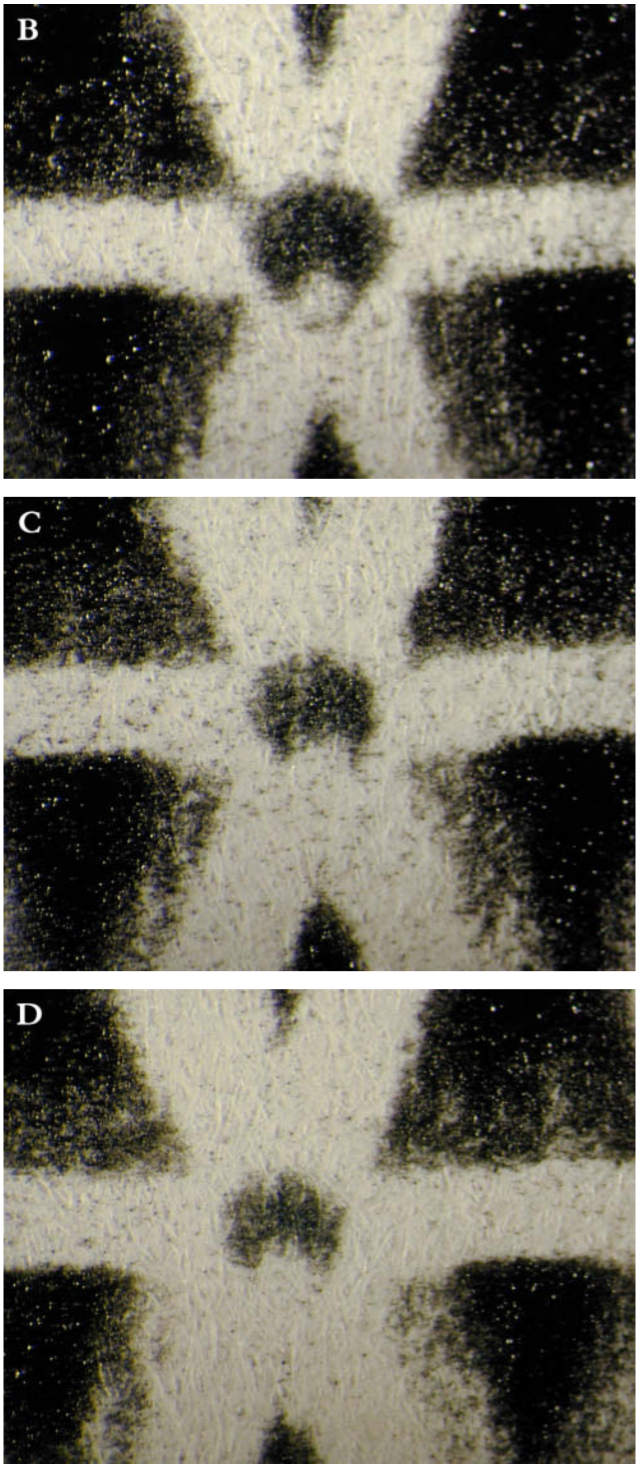


Fig. 6a. Pati Hill, black-and-white print of curlers from *Alphabet of Common Objects,* ca. 1975–1979. 28 cm × 21.6 cm. Multiple versions of this print exist, each with different configurations of curlers on the copy platen. Several prints, likely to be one first print and several copies of this print, were examined for signs of generation loss and changes in toner distribution (figs. 6b–6d). Courtesy of the Estate of Pati Hill and Arcadia University.



Figs. 6b–6d. Stereo micrographs (250×), detail of the print of curlers in figure 6a. Successive copies of the same image shows that toner distribution appears to become diffused and edges of details appear to lose sharpness with each print, characteristic of degeneration of the image. Courtesy of the author and the Estate of Pati Hill.

many other copiers, including Xerox models available at the time, there was still a slight discrepancy between the size of the object on the platen and the size of the image produced on paper. This was partly a result of the limitations of technology at the time, but was also an attempt by IBM engineers to reduce the potential for counterfeiting or fraud (Brewer 2015).

HOUSING AND ASSEMBLAGE

Hill appears to have done much of her own mounting and storage. Her very earliest work was of small objects, such as hairpins, keys, buttons, and other tiny odds and ends that had been cut out from their original sheet of copy paper. Some of these prints were as small as a postage stamp and were loose, unmounted, and housed in glassine envelopes at the time they arrived at Arcadia University. Many of these small prints had been adhered to larger sheets of paper in assemblages, using rubber cement as well as pressure-sensitive tape of various types (including masking tape, linen tape, cellotape, and other unidentified pressure-sensitive adhesives). As a result, many of these assemblages exhibited yellow or amber adhesive stains that appeared to have migrated from the verso to the recto; several of the small prints had become detached from the secondary support due to adhesive failure (fig. 7). The artist regularly mounted prints selected for exhibition directly to matboard using a dry-mounting press, a step that would have exposed the prints to a great deal of heat and pressure.

THE ELECTROPHOTOGRAPHIC PROCESS

Chester Carlson first patented his electrostatic printing process in 1939, using the term electrophotography—an amalgamation of "electrostatic" and "photography." However, the process was not made commercially available until 1950, when the Haloid Company (later renamed Xerox) manufactured the first commercial copy machines. The 1950 Haloid machine was difficult to use and was marketed mainly to copy letters, after the Battelle Memorial Institute, an American scientific research organization, had unsuccessfully attempted to market selenium-coated paper and plastic surfaces as photographic plates (Zachary and Rosenthal 1950). In 1959, the Xerox 914 became the first photocopy machine to be mass marketed to the public; before long, other companies picked up and expanded upon this technology and produced copiers of their own (Batterham 2008).

The multistep EP process is complex but can be broken down into a series of stages (fig. 8). In the first stage, an object or image is placed on the glass platen (the copying surface). Prior to 1987, analog copiers functioned by reflecting light from an illuminated image and projecting it onto the photoconductor drum (Hays 2003). (Post-1987, when photocopier manufacturers shifted to digital technology, the image was exposed on the photoconductor drum with a scanning laser or LED image bar.) Lighter areas of the image reflected more light, while darker areas reflected less light. An "electrical

Fig. 7. Pati Hill, untitled assemblage, ca. 1974–1979. Black-and-white electrophotographic prints adhered to translucent paper with pressure-sensitive adhesive, 28 cm × 42.5 cm. Courtesy of the Estate of Pati Hill and Arcadia University.

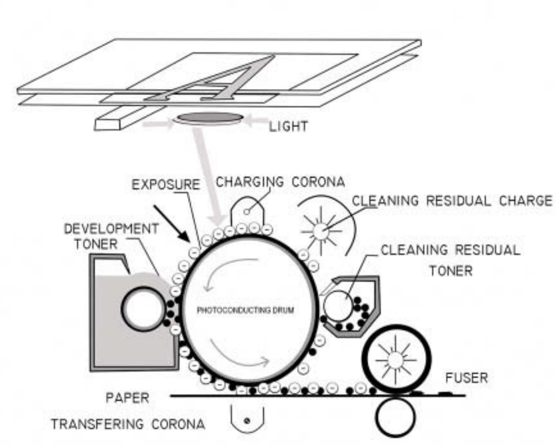


Fig. 8. Diagram of the analog electrophotographic process. Courtesy of www.photocopier.org.uk.

shadow” of the object was cast onto the photoconductor, a rotating conveyor belt or metal drum with a layer of a photoconductive material (usually selenium, germanium, or silicon). Functionally, this meant that areas exposed to light gained an electrical charge, while areas not exposed to light did not gain a charge. An ink drum carrying charged toner particles coated the photoconductor drum with toner, after which the sheet of paper was given a strong electric charge; as it passed near the toner-coated photoconductor drum it picked up the toner particles. This transferred the image from the photoconductor to the paper. In the final step, the toner-covered paper passed through hot rollers, which used heat and pressure to fuse the toner image onto the paper surface, after which excess toner was brushed from the photoconductor surface in preparation for the next print. The final product was the copy: an image formed from a layer of toner fused to a support through heat and pressure (Mizes et al. 2015).

MATERIALS

DRY TONER COMPOSITION

Dry toner powder is composed of a colorant (either dye or pigment), a polymeric resin, and other additives, often plasticizers or fumed silica. The polymeric component makes up 40–95% of the toner and, as it acts as a binder, the qualities of a particular polymer strongly influence the stability of the final print (Galliford 2001). Early copiers, including the IBM Copier II, used a two-component development system, in which carrier particles ferried the toner to the paper (Jürgens 2009). IBM patents show that toners manufactured contemporaneously to the IBM Copier II were composed of a polymeric resin, a modified polyester, plasticizer, and carbon black pigment, although it is not known if Hill used one or either types of toner for her work (Kukla and Munzel 1974).

COPY PAPER

The majority of paper manufactured for copy machines (often referred to as “plain paper” or “copy paper”) was not generally designed for permanence, particularly prior to the mid-1980s. Properties such as moisture content, resistance to electric charge during the copy process, and low cost drove material selection for producing copier paper stock (Batterham 2008). It can be very difficult to identify the manufacturer of a particular copier paper but, regardless of brand, most American papers produced prior to the mid-1980s contained processed wood pulp and had a high lignin content. Copier paper was, and continues to be, manufactured with dyes or optical brightening agents (OBAs), depending upon whether the paper is colored or (more commonly) white.

Prior to the mid-1980s, copy paper was internally sized with a fortified rosin or rosin-alum sizing during manufacture (Grattan 2000). Many European copy papers were manufactured with CaCO3 (calcium carbonate) as a filler, which had the added benefit of serving as an alkaline reserve; however, copy papers manufactured in the United States did not have an alkaline reserve and were fairly acidic. Paper production techniques shifted around the early-to-mid-1980s, when rosin sizing was replaced with alkylketene dimer sizing and alkenylsuccinic anhydride sizing (Hubbe 2004).

RISKS TO ELECTROPHOTOGRAPHIC PRINTS

VISIBLE LIGHT AND ULTRAVIOLET RADIATION

The carbon black pigment in black toner is fairly lightfast; however, the pigments and dyes in colored toner or colored paper are often very light sensitive. Colored copy paper, used by Hill used for several of her series—including *Men and Women in Sleeping Cars* (1979) and *Garments* (1976)—is also extremely vulnerable to fading from visible and ultraviolet (UV) light. Photolytic degradation can occur quickly in poor-quality paper, causing the paper support to become brittle and discolored. UV radiation accelerates degradation of styrene/n-butyl methacrylate resin, a component of some carbon black toners. Polyester-based toners are also susceptible to damage from high levels of UV radiation, although they are slightly more stable (Subt 1987). OBAs added during manufacture are particularly susceptible to photolytic degradation, which can result in an increasingly yellow appearance as the brightening agent is depleted (Mustalish 2013).

HIGH HUMIDITY AND MOISTURE

Although very low relative humidity can result in brittle EP prints, the primary concern most collections face is relative humidity that is very high or fluctuates between extremes. Rapid fluctuations in temperature and relative humidity can cause physical damage to the paper support and result in planar deformations. Toner areas of EP prints are prone to cracking or delamination when the paper is exposed to high humidity or moisture and then dried; as the paper substrate swells and contracts, the resulting tension can disrupt the mechanical bond between the paper and toner. High relative humidity can result in blocking of EP prints and promote mold growth, as well as affecting the lightfastness of OBAs in copy paper (Mustalish 2013).

MECHANICAL DAMAGE

Inconsistencies in photocopier maintenance and operation can result in variations in the temperature at which toner is fused to the paper surface, which may be problematic for toner adhesion as a print ages. Prints with improperly fused toner are especially vulnerable to friction (for example, from a crowded storage box), which can result in abrasion and the dislodging of toner particles from the surface of the paper (Subt 1987). The toner-paper bond can be further compromised if the toner components break down with age through exposure to UV radiation or heat. Folding or creasing an EP print may result in cracking or delamination of printed toner areas, as the mechanical bond between the toner and paper is broken (fig. 9). It is unknown whether Hill's heavy application of black toner has had an effect on the mechanical stability of her early prints; it is possible that a heavy toner load may impact toner-paper bonding by insulating against the fusing process, or by changing the material properties of the print into something more plastic-like (Burge 2018). However, this remains conjecture until further toner-adhesion testing can be undertaken on Hill's prints.

HEAT AND PRESSURE

High temperatures accelerate acid hydrolysis and can result in significant changes to the toner areas of a print. Polymers most commonly used in toner manufacture have a glass transition temperature (Tg) of 122°F to 158°F. For prints exposed to high heat, this can result in separation, distortion, and dislodging of toner particles. It can also lead to softening at room temperature (Galliford 2001). This can result in prints blocking together or to other objects in close contact, especially in combination with increased pressure.

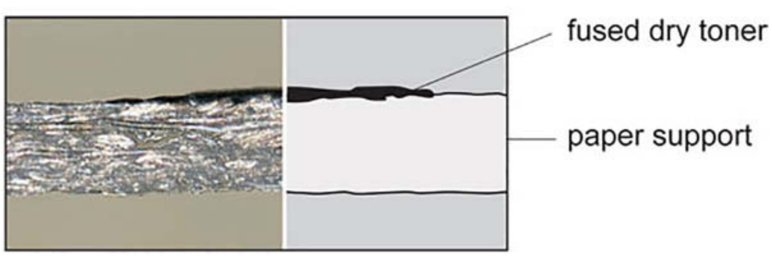


Fig. 9. Dry electrophotographic toner sits on the surface of the paper rather than penetrating. Courtesy of Image Permanence Institute and the Digital Print Preservation Portal, http://www.dp3project.org.

The closer the temperature in storage gets to the toner's Tg, the more likely blocking is to occur. Conversely, the lower the temperature, the less likely EP prints are to begin adhering to one another. A similar phenomenon can also occur if the copy adheres to the plastic or glass surface of an enclosure or frame (Jürgens 2009). Due to Hill's heavy application of toner, her prints have exhibited this phenomenon in storage.

PLASTICIZERS IN HOUSING MATERIALS

The use of polyvinyl chloride (PVC) storage sleeves or envelopes can result in plasticizer migration from the PVC into the toner, causing the toner to soften. This results in image transfer from the print to the PVC (Lowell and Nelb 2006). PVC storage materials should be replaced with polyester sleeves, which are chemically stable.

ORGANIC SOLVENTS

EP prints are sensitive to several organic solvents; in an early study of toner sensitivity, tests on IBM Copier II images showed that the toner layer dissolved upon application of ethyl acetate, toluene, trichloroethylene, and acetone (Porter 1980).

PAPER ACIDITY

Paper quality is one of the biggest factors affecting the longevity of EP prints. Poor-quality paper deteriorates over time, as acid hydrolysis of the cellulose weakens the paper. Even in the case of paper manufactured with an alkaline reserve, using acidic housing materials or poor-quality mat board for storage or display will result in acid migration; this can also contribute to the degradation of the acrylic components of the toner (Subt 1987).

DEGRADATION OF OPTICAL BRIGHTENING AGENTS

The majority of office copy papers manufactured in the mid-20th century and later were produced with OBAs (also known as fluorescent whitening agents or optical bleaches). These "colorless dyes" work by absorbing light at the near-UV range, while emitting light in the violet-blue range of the spectrum; this has the effect of making paper appear whiter. Examining Hill's prints under a longwave UV light source (365 nm) confirmed the presence of OBAs in at least some of the copy paper the artist used for her early work. Brighteners are often sensitive to heat, high pH, some pigments, bleaches, and polar solvents, depending upon formulation. The degradation of OBAs will often visibly change the appearance of paper and may make white paper appear to yellow over time; migration of these substances can also discolor areas of a print. Migration may not necessarily always be visible under UV light, depending upon the stage of degradation the OBAs have reached (Mustalish 2013).

GUIDELINES FOR STORAGE AND ENVIRONMENTAL CONDITIONS

OPTIMAL ENVIRONMENTAL CONDITIONS

Although cool storage (defined as 54°F or below) is ideal for long-term storage of EP prints, room temperature (approximately 68°F) is acceptable. In general, efforts should be made to maintain a stable environment within the following parameters: 40–68°F and 20-50% relative humidity (Burge 2014).

HOUSING AND EXHIBITION

ISO 18902 (*Imaging Materials – Processed Imaging Materials – Albums, Framing, and Storage Materials*) provides appropriate guidelines for the selection of housing materials for EP prints. This standard specifies chemical and physical requirements for all storage and display materials that are in direct or close contact with many traditional and digital hardcopy photographic materials, including EP and inkjet digital prints. All products used for storage should have passed the Photographic Activity Test (PAT). Envelopes and other housing materials constructed using adhesive should use non-rubber-based adhesive. Paper products used for storage should be alkaline (pH 7–9.5) and lignin-free (with a Kappa number of 7 or below, equivalent to a lignin concentration of no greater than 1%), with a 2% calcium carbonate reserve. Dyes or pigments used to color paper housing or labels must past the colorant bleed test. Plastic materials should be plasticizer-free, and should not be chlorinated, nitrate, or acetate plastic.

Of particular concern to EP prints is the possibility of damage through incorrect storage. Housing prints directly on top of one another may result in the verso of one print abrading the recto of the print below; a polyester sleeve or sheet will, in most cases, lower the risk of abrasion on a black-and-white EP print (Nishimura et al. 2009). Although stable EP prints may be stored in polyester sleeves to prevent abrasion, the electrostatic nature of polyester sleeves may make them inappropriate for friable or brittle surfaces. Glassine degrades quickly, and use of this material in storage can cause blocking and dislodging of toner particles that stick to the surface. Regardless of the housing materials used, care should be taken to avoid stacking too many prints on top of one another, and at a minimum they should be separated with acid-free, buffered, PAT tissue paper or interleaving paper. Poor quality matboard, interleaving paper, or other storage materials used for housing or exhibition may result in acid migration and the subsequent deterioration of both the paper support and toner. When framing a print, spacers should be utilized to ensure that the print does not stick to the glazing. Using UV-filtered glazing during framing is recommended when possible;

windows and non-LED light sources in exhibition and storage areas should be outfitted with UV-filtering sleeves.

CONSIDERATIONS FOR MATERIAL SENSITIVITY DURING CONSERVATION TREATMENT

The thermoplastic nature of toner's polymeric components should be kept in mind when planning conservation treatment of EP prints, especially when considering the introduction of heat or pressure. Treatments such as adhesive removal, backing removal, and flattening of the paper support using weight—for example, while drying—should be carried out with a minimum of heat and pressure. Use of heated spatulas or heat-set tissue during repairs should also be avoided. As toner is sensitive to some organic solvents such as ethyl acetate, toluene, trichloroethylene, and acetone, care should be taken to avoid the use of any of these solvents during adhesive removal, dry mount removal, or other conservation treatments near or on the toner areas.

Migration of OBAs in copy paper is an especially problematic issue where conservation treatment is concerned. Visual examination under UV light can indicate the presence of brighteners; however, OBAs may still be present without fluorescing if they are degraded or exist in very small concentrations. As a result, their presence may not be noted prior to treatment. Areas of paper with severe OBA migration may appear to have blue or yellow rings under natural light, although this too is dependent upon lighting and stage of degradation (Mustalish 2013).

Finally, exposure to moisture during aqueous treatments can result in cracking or delamination of the toner layer due to tension between the toner and paper as the paper swells and contracts. The introduction of moisture should be carefully controlled whenever possible (table 1).

Risk	Treatment	Sensitivity
High temperature	Adhesive/dry mount removal	Toner Optical brightening agents (OBAs)
Pressure and friction	Backing removal Flattening Surface cleaning	Toner
Organic solvents	Adhesive Removal Stain reduction	Toner OBAs
Aqueous treatments	Washing Humidification Backing removal	Toner OBAs Paper-toner adhesion
Bleaches (hypochlorite, chlorine, and peroxide)	Stain reduction	OBAs
High humidity	Humidification	Paper OBAs Paper-toner adhesion

Table 1. Conservation Treatment Risks to Black-and-White Electrophotographic Prints

CONCLUSION

It is hoped that the technical study of Pati Hill's working methods and materials will illuminate some of the unique preservation concerns of black-and-white EP art. Curators, conservators, and collections care staff should endeavor to reconsider the idea that EP prints are simply identical copies. As with any traditional printing process, each print is a unique object. Visual analysis suggests that generation loss, expressed through diffused toner density and distribution, can help identify the order of production. It can also help indicate whether a print is a direct copy of an object, or a copy of a copy. When acquiring EP art, detailed, descriptive records should be made not just of the artist's materials and methods, but also of the machine, process, and toner used, whenever possible. In the case of fine art EP prints, understanding the sensitivities of proprietary materials can help prevent significant visual changes from occurring. Similarly, thorough testing should be carried out when attempting conservation treatment of any EP print, even if similar prints have been encountered and successfully treated in the past.

ACKNOWLEDGMENTS

The presentation of this research was supported by the National Endowment for the Humanities, the Conservation Center for Art & Historic Artifacts, and Documentary Heritage & Preservation Services for New York. Special thanks to Barbara Lemmen (CCAHA) and Richard Torchia (Arcadia University Art Gallery) for many hours of guidance. And, of course, this research would not have been possible without intrepid copy pioneer Pati Hill, whose love of visual tricks turned eggs into sunsets and dust into outer space.

NOTES

1. Several terms are used in technical literature to describe the electrophotographic (EP) print, including photocopy, xerograph, Xerox, and electrostatic print.
2. One of the most notable examples of the photocopier facilitating access to printmaking is the artist Barbara T. Smith, who leased a Xerox machine after she was rejected by a lithography studio. (Mizota, S. 2013. Review: Barbara T. Smith's photocopies reveal an artist in transition. *Los Angeles Times*, March 01, 2013.)
3. The term Copy Art, or Xerox Art, is often used as a blanket term to describe art produced using an electrostatic printing process, either analog or digital. Although it is sometimes referred to as a "movement," work made using electrostatic processes encompasses a wide range of

aesthetic choices, materials, modes of production, and political and social origins.

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Multispectral Imaging and the Digitization of the Dead Sea Scrolls

INTRODUCTION

The Dead Sea Scrolls (DSS) are one of the greatest archaeological discoveries of the 20th century. Comprising around 1,300 manuscripts, including the earliest known copies of every book of the Hebrew Bible (except for the book of Esther), as well as nonbiblical and sectarian texts, this collection provides a glimpse at the era that saw the birth of Christianity and the formalization of Judaism. Since their discovery 70 years ago, the DSS have gone through several phases of treatment and documentation. At present, the dedicated conservation lab of the Israel Antiquities Authority (IAA) is not only overseeing the treatment of the scrolls, but for the last seven years has also been using a cutting-edge multispectral imaging system to digitize the entire collection with the goals of preserving the physical scrolls, preserving the content of the scrolls, and significantly increasing public access.

THE DISCOVERY OF THE DEAD SEA SCROLLS

The first scrolls were discovered in 1947 by a Bedouin looking for his lost goat in the caves along the western shore of the Dead Sea near the archaeological site of Khirbet Qumran. Three of the seven scrolls from this first cave were purchased by Eliezer Lipa Sukenik, a professor of archaeology at Hebrew University of Jerusalem, while the other four scrolls were purchased by the Syrian Orthodox Archbishop Athanasius Samuel. Mar Samuel smuggled his four scrolls into the United States and in 1954 placed an advertisement in the *Wall Street Journal* offering them for sale. They were bought, through an intermediary, by Yigal Yadin, Sukenik's son, who was a leading Israeli archaeologist. Together again, these seven scrolls are currently housed in the purpose-built Shrine of the Book at the Israel Museum where sections of these scrolls are always on display.

Starting in 1949, excavations in the region, led by Père Roland de Vaux, the director of the École Biblique et Archéologique Française of Jerusalem, discovered ten more caves with scrolls over a period of eight years. The excavated material was brought to the Rockefeller Museum in Jerusalem, where it was studied by an international team of biblical scholars. All together, these excavations yielded thousands of fragments comprising around 900 manuscripts spanning a period of time from the third century BCE to the first century CE.

In addition to the material found in the Qumran caves, the IAA's collection includes manuscripts from six other locations in the Judean Desert dating from the fourth century BCE to the seventh century CE. Around 80% of the collection is parchment while the remaining 20% is papyrus. The original scholars, working on the world's largest jigsaw puzzle, arranged the thousands of fragments of varying sizes into over 1,500 glass plates (fig. 1).

THE IAA AND CONSERVATION

In 1967, the Rockefeller Museum became the headquarters of the Israel Department of Antiquities, which was reformed into the IAA in 1989. The IAA is the government authority regulating all archaeological activities in Israel and serves as the national treasury of cultural heritage overseeing the conservation of and research into the excavated sites and material.

From the time of their discovery to the founding of the IAA, only eight volumes of the official DSS publication, *Discoveries in the Judean Desert* (DJD), had been published. The first director of the IAA greatly expedited publication, and, within 20 years, an additional 32 volumes were produced.

During this process, it was acknowledged that the scrolls themselves were in very poor condition as a consequence of their age and four decades of unintentional mishandling, including the extensive use of pressure sensitive tape, castor oil, British Museum leather dressing, and acrylic adhesives, and that without immediate intervention the world would soon have 40 volumes of publication but no original scrolls.

Therefore, in 1991, the IAA established a conservation lab dedicated solely to the DSS and a new work protocol using the most suitable and up-to-date methods was created with the assistance of an international committee of experts sponsored by the Getty Conservation Institute. The key parts of

Papers presented at the Book and Paper Group Session, AIC's 46th Annual Meeting, May 29-June 2, 2018, Houston, Texas

Fig. 1. The Scrollery at the Rockefeller Museum. Courtesy IAA. Credit: Najib Albina.

Fig. 2. Example of Japanese tissue splints and hinges. Courtesy IAA, LLDSSDL. Credit: Shai Haleyi.

this ongoing treatment have involved establishing suitable environmental conditions and rehousing the entire collection, removing previous treatments where possible, and supporting and strengthening the fragments.

DIGITIZATION AND THE DEAD SEA SCROLLS

From the very beginning, Najib Albina, the Rockefeller Museum house photographer, recognized the importance of photographing the scrolls and understood how infrared film could be used to make the invisible visible, especially since most of the scrolls are written in a carbon-based ink. In total, around 3,500 infrared photographs were taken in the 1950s to early 1960s, documenting the arrangement of the glass plates. These photographs were then used in the DJD and remained the primary photographs of the scrolls until the start of our digitization project.

From a conservation perspective, these photographs preserve the condition of the scrolls as they were found 70 years ago, prior to the 40 years of mishandling. Because of this, they are treated as important objects in their own right and kept in a dedicated climate-controlled storage room. As a preliminary stage of the digitization project, all of these negatives were scanned in 800 dpi.

The first step in the digitization process is to document the plate in its current condition. Each fragment is then stabilized where necessary, using small splints of remoistenable tissue made from Japanese tissue paper and 10% methyl cellulose adhesive. Methyl cellulose is also used to attach Japanese tissue paper hinges to each fragment, which are used to secure the fragments in their housing and limit movement. During digitization, these hinges provide a secure holding point for very small fragments when moving them to and from the camera (fig. 2).

A major decision was made at the beginning of the project to image fragments rather than plates, which was the first time that each fragment had been viewed as an individual physical entity. However, this meant that an entirely new cataloguing system had to be devised. Prior to this, there were two primary cataloguing methods. The first is the system used in the DJD where the fragments are recorded based primarily on their relationship to a specific manuscript rather than on their physical location in the collection; it is still the academic standard for referencing the scrolls. The second system was created by the conservators who numbered the fragments according to their placement in the plate in order to reference them in conservation documentation.

For the new cataloguing system, each plate is photographed in color with a standard camera, and then a software designed for this purpose creates a map of the plate with coordinates set at the center of each fragment. It then scans the plate and numbers the fragments according to their heightwise placement in the plate based on their topmost point rather than their center (fig. 3). This new numbering system as well as the system developed by the scholars will be used for the Leon Levy Dead Sea Scrolls Digital Library (LLDSSDL). Volunteers are correlating all three cataloguing systems in order to create a single unified searchable database. Although this continues to be a long and slow process, it has led to the rediscovery of "lost" fragments whose physical location had not been accurately recorded in previous catalogues (Ableman 2018).

THE MULTISPECTRAL IMAGING SYSTEM

The digitization is done with an LED-based MegaVision Multi Spectral Imaging System installed in 2011, after three pilot projects by Dr. Greg Bearman, an expert in spectral imaging, Dr. Bill Christens-Barry, a lighting expert, and Ken Boydeston of MegaVision. The system was tailored to the specific needs of this project and, during installation, each part was carefully measured and adjusted to ensure the correct angles and distances needed to achieve the best possible results (Shor et al. 2014).

The recto and verso of each fragment is photographed in 12 different wavelengths, seven in the visible light spectrum

Fig. 3. Example of a plate map for Plate 376. Courtesy IAA, LLDSSDL. Credit: Shai Halevi.

Visible Light Wavelengths	Near-Infrared Wavelengths
445nm – Royal Blue	IR706nm
475nm – Long Blue	IR728nm
499nm – Cyan	IR772nm
540nm – Green	IR858nm
595nm – Amber	IR924nm
638nm – Red	
656nm – Deep Red	

Fig. 4. Multispectral wavelengths.

and five in the near-infrared. The specific wavelengths are listed in figure 4, and the camera set up is shown in figure 5. The circles indicate the LED lights for all seven visible light wavelengths, the triangles indicate the LED lights for all five of the near-infrared wavelengths and the squares indicate raking lights, which repeat the longest and shortest wavelengths of light (royal blue and 924 nm).

First, the fragment is lit evenly from both sides for 12 exposures, one in each wavelength. This uniform lighting produces a flat image that best captures the text. Second, the fragment is lit from just one side, using the upper light, for six exposures: one in each visible light wavelength, excluding royal blue. Finally, two exposures are taken with the raking light. These last two steps are then repeated for the other side, giving a total of 28 exposures. The side lighting captures the physical, topographical features of the scrolls, which is why only one infrared wavelength is used. All of the visible light

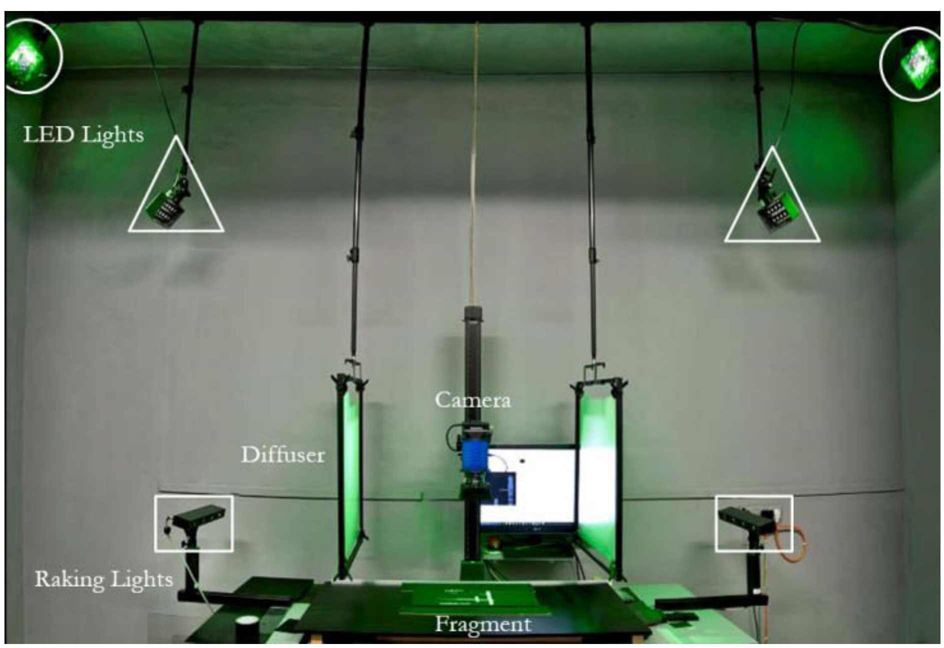

Fig. 5. MegaVision camera. Courtesy IAA. Credit: Shai Halevi.

wavelengths are then combined to create a full-color digital image. It takes four minutes to shoot the 28 exposures giving an average of ten minutes to complete the full 56 exposures needed to photograph the recto and verso of each fragment.

In order to ensure that the first photograph from 2011 will have identical parameters to the last photograph yet to be taken, the system is calibrated weekly and monthly. Every week, Shai Halevi, the project photographer, uses the standard 28 exposures to photograph a pure white flat field, pure black, and the standard color targets used in every photograph. Every month he uses 30 exposures (all 12 wavelengths from each side separately and together excluding the raking lights) to photograph the white flat field and five specially designed color targets. He then compares these images to the previous month or week to ensure that nothing has changed.

Black was chosen as the background for the photographs because it does not reflect light, which could affect the image and reduce the system's stability. Certain scholars would have preferred a blue background, which would have made it easier for them to isolate the fragments from their background, a necessary first step in several of the new computer-based analyses of the DSS they are attempting.

To further help maintain stability, the entire system is bolted to the floor to prevent movement, and the camera is never moved. Instead, the fragments are placed on a moveable black tile that allows larger fragments to be moved under the camera and then photographed in multiple sections without having to touch the fragments, thereby minimizing the handling of such fragile objects. The multiple images are then digitally stitched together to create a single complete image. In the last seven years, more than 25,000 fragments have been photographed, totaling almost 300 TB of data.

PROJECT OBJECTIVES

The objectives of this project are threefold: the physical preservation of the scrolls, the preservation of the content of the scrolls, and increased public access.

PHYSICAL PRESERVATION

Because the color images are objectively identical to the original scroll, they preserve its current condition and can serve as a surrogate should anything happen to the scroll in the future. In addition, these images are used to create photographic reproductions of the scrolls that can be provided for exhibitions where the conditions preclude the use of the original scrolls. These reproductions are printed on cardstock with blank versos to prevent any possible confusion with an original scroll.

This project was originally developed in conjunction with a scientific team from Pasadena California, the University of Eastern Piemonte Italy, and the Library of Congress, who developed a completely noninvasive and nondestructive monitoring system that combines the multispectral images with multivariate statistics (Marengo et al. 2011a, 2011b). In this system, a fragment is photographed five times, alternating with a white field. This combination allows the computer program to filter out background noise and then make a pixel by pixel comparison between the most recent images and past images of the same fragment. In the results, blue and red colored pixels represent pixels where change has occurred even before it is visible to the eye (Manfredi et al. 2015) (fig. 6).

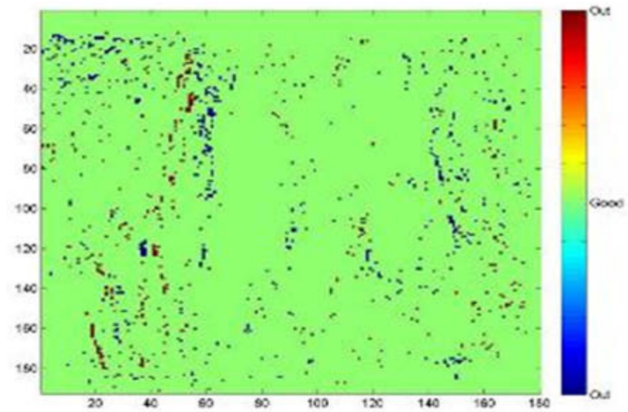

Fig. 6. Monitoring program sample results. Credit: Marcello Manfredi.

Every three months, six fragments with representative conservation concerns are photographed for this project. In its current format, the program is unwieldly and the results are not yet readily applicable to daily conservation practice. However, the collected data is being used to refine the program and create a more user-friendly monitoring system.

PRESERVATION OF CONTENT

The use of infrared as well as visible light wavelengths for this project is preserving the content of the scrolls by providing high-quality images of text that is no longer visible to the eye. A number of scholars have been able to use these images to

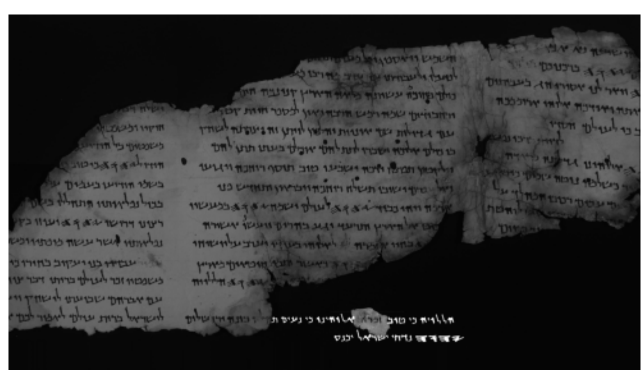

Fig. 7. Reconstruction of Psalm 147. Courtesy IAA, LLDSSDL, Shai Halevi, Orit Rosengarten, Oren Ableman.

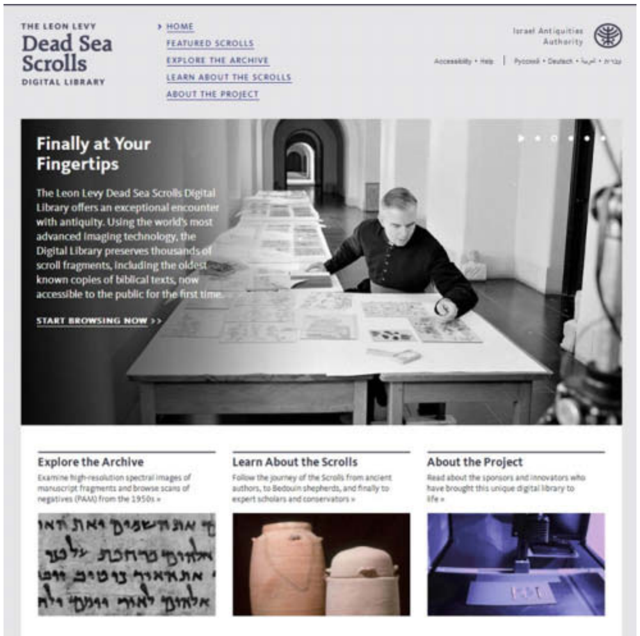

Fig. 8. Homepage of the Leon Levy Dead Sea Scrolls Digital Library. Courtesy IAA.

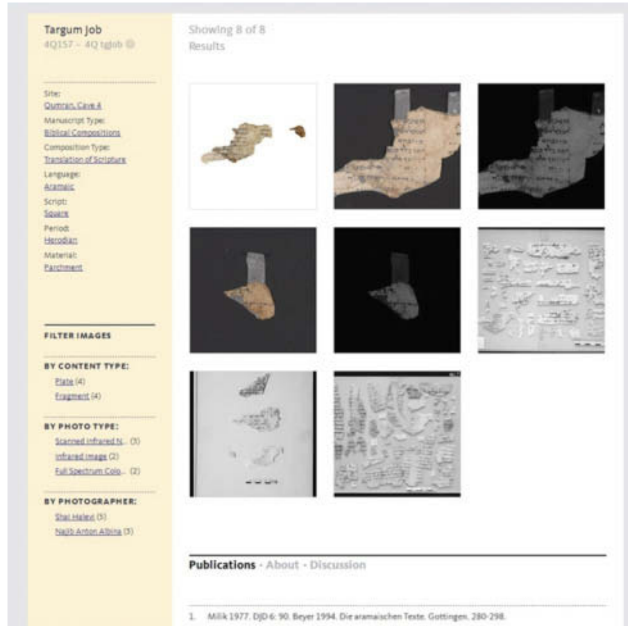

Fig. 9. Example of a LLDSSDL album page. Courtesy IAA.

provide new textual readings and discover previously indecipherable text.

Recently, Oren Ableman, the IAA's in-house DSS scholar, used the multispectral imaging system to identify letters, and in some cases words, on fragments that the original scholars had set aside as being too small and damaged to decipher. He identified one of these fragments as belonging to the Great Psalms Scroll from Qumran Cave 11, and was able to reconstruct a vanished line of text showing that, in this particular case, the first line of Psalm 147 is one word shorter than the version used today (Ableman, forthcoming) (fig. 7).

INCREASING PUBLIC ACCESS

The history of the DSS since their discovery has been troubled with complaints and accompanying conspiracy theories regarding the lack of access to the scrolls both from scholars and the general public. Even now, the price of a complete set of DJD volumes puts it out of reach of anyone other than

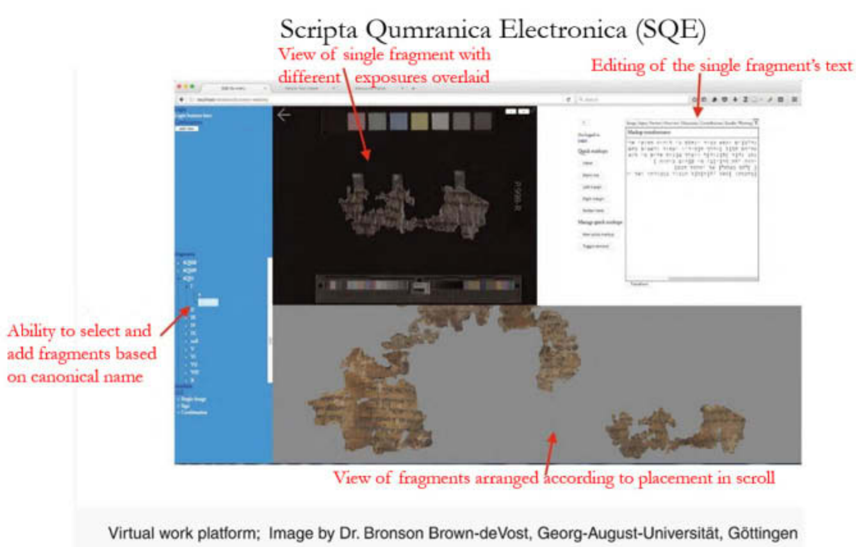

Fig. 10. Scripta Qumranica Electronica Virtual Work Platform. Credit: Dr. Bronson Brown-de Vost.

large institutional libraries. Therefore, a key component of this project has been the creation of a website (https://www.deadseascrolls.org.il) offering free-for-all access to the digital images of the scrolls (fig. 8). It launched in 2012, enabled by Google and funded by the Leon Levy Foundation and Arcadia Fund.

In the digital library, each manuscript has an album (fig. 9) with Najib Albina's original images, a color image of the complete plate, and two images of the recto of each fragment—the full color image and the infrared image at 924 nm—all uploaded with their metadata. The verso is uploaded if there is text. The other exposures are available for free to scholars on request. The website also includes a search engine, featured scrolls, and several interactive content pages. The current version has 34,000 images and is available in Hebrew, Arabic, English, German, and Russian. An updated version is currently being prepared and will include an additional 15,000 images, the translation of the content pages into Chinese, an upgrade of the metadata, and new additional content.

This project has been very successful in engaging public interest and involvement with the DSS, including educational activities and virtual exhibitions. In addition, the site has become an invaluable tool for DSS scholars who now how have free access to high-quality images.

There are a number of ongoing international collaborative research projects that seek to considerably increase the functionality of the website. One of these projects, named Scripta Qumranica Electronica (fig. 10), funded by the German-Israeli Project Coordination (DIP), is developing computer-based algorithms to not only connect transcriptions and translations of the text to the images, but also to create a virtual workspace where scholars will be able to manipulate the fragments, create new manuscript reconstructions, and publish digitally (Brown-de Vost 2016).

ACKNOWLEDGMENTS

Lena Libman, Tanya Bitler, Tanya Treiger, Shai Halevi, Oren Abelman, Beatriz Riestra, and Leon Levy Dead Sea Scrolls Digital Library.

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BROOK PRESTOWITZ AND YUKI KATAYAMA

Washi: Understanding Japanese Paper as a Material of Culture and Conservation

INTRODUCTION

Washi, Japanese paper, is used ubiquitously for treating books and paper objects on an almost daily basis because of its unique qualities. It is also a material of cultural significance with a rich history that can sometimes be overlooked in the treatment setting. The good aging characteristics of *washi*, particularly *kozo washi*, and the strength and thinness of these papers make it ideal for treating paper objects. However, traditional *washi*-making has experienced significant changes in the past few decades. Sadly, not all changes are for the better—the number of papermakers is dwindling and certain types of *washi* have become extinct due to closure of studios responding to various pressures. The accelerated changes in the industry, compounded by potential language barriers for conservators who are not fluent in Japanese, make it difficult for conservators to be certain of how these changes might be affecting *washi* used in treatment. Attending the Hiromi Paper Inc. *2017 Washi Tour* and the *Identification of East Asian Papers for Conservation Workshop* lead by Nancy Jacobi and Megumi Mizumura in 2016 at the American Institute for Conservation's 44th Annual Meeting inspired the author to share the insights gained through these experiences.

Seminal research on Japanese papermaking has been published in the conservation field covering the history of *washi*, and the conservation quality of handmade and machine-made *washi*. There are references that are the first to be consulted by conservators, such as Barrett's 1983 publication, *Japanese Papermaking: Traditional Tools and Techniques,* or *The Book and Paper Group Annual* articles, "A Study of the Quality of Japanese Papers Used in Conservation" by Beauman and Rempel in 1985, and "Machine Made Oriental Papers in Western Paper Conservation," by Nicholson and Page in 1988. At first, it may seem that there are limited resources on the subject; however, a broader search will reveal that a number of publications have been consistently published on the manufacturing and quality of *washi.* Many publications are in conference proceedings or European journals that may be more difficult for North American conservators to access. While much of the literature is quite dated, new and exciting research has been published in the last four years. Older publications, especially those discussing the traditional methods and history of *washi* are still relevant and valuable. However, the findings in resources related to *washi* permanence for use in conservation may not be reliable for the papers available today, although they do serve as records that may assist future researchers in how *washi* quality may have changed over time. Publications on *washi* can be separated into three categories:

***Washi* Manufacturing**—literature describing the papermaking procedures and its cultural context (Hunter 1943; Hughes 1978; Barrett 1983; Masuda 1985; Turner 1998; Mizumura, Kubo, and Moriki 2015; Colbourne and Hori 2015; Mizumura and Moriki 2017).

Examination and Identification–literature that establishes characteristics differentiating *washi* from other kinds of paper or other kinds of *washi* (Collings and Milner 1978; Nicholson and Page 1988; Koestler, Indictor, and Fiske 1992).

Quality Assessment–literature investigating the quality and aging characteristics of *washi* and the implication for conservation uses (Murphy and Rempel 1985; Inaba and Sugisita 1988; Uyeda et al. 1999; Inaba et al. 2002; El-Esseily and Inaba 2004; Calvini, Gorassini, and Chiggiato 2006).

Even with the more recently published articles on the subject, there is still limited information that would help conservators assess *washi* quality from a conservation standpoint without use of costly and sometimes inaccessible advanced technical analysis. The aim of this paper is to review traditional papermaking processes and the cultural importance of *washi*. Methods for examining *washi* will also be discussed to guide selection of high quality *washi* for treatment relying on touch, sound, and transmitted and raking light.

TRADITIONAL PAPERMAKING METHODS—A REVIEW

As would be expected, the traditional methods of making *washi* remain the same for papermakers dedicated to the

Papers presented at the Book and Paper Group Session, AIC's 46th Annual Meeting, May 29-June 2, 2018, Houston, Texas

tradition, albeit with a few modifications that will be discussed later. The process begins with cultivating and harvesting the raw materials. There are three main traditional paper fibers used in Japan: *kozo* (*Broussonetia kazinoki Sieb*), *mitsumata* (*Edgeworthia papyrifera Sieb. Et Zucc*), and *gampi* (*Wikstroemia sikokiana Fanche et Sav*). All of these fibers are bast fibers, meaning they are extracted from the inner layer of the bark.

Kozo and *mitsumata* can be domesticated while *gampi* must be harvested in the wild. *Kozo* is harvested every year, *mitsumata* every 3 years, and *gampi* every 5 to 7 years (Barrett 1983). Harvesting *kozo* and *mitsumata* occurs between November and January after the leaves have fallen (Hughes 1978; Barrett 1983; Mizumura, Kubo, and Moriki 2015). *Gampi* must be harvested in the spring between March and April because the fibers are ideal for papermaking at this time, and the bark is easily stripped from the branch by hand as it cannot be steamed (Hughes 1978). The stalks of the shrubs are carefully cut with enough of the stem left at the base of the plant to allow for new growth in the spring (fig. 1). Some people make their living by cultivating the raw materials for papermaking. It is also common for papermakers to cultivate and harvest their own raw materials. This paper will focus on the processing of *kozo,* as this is the main fiber in papers used for conservation.

Fig. 1. A harvested stump of *kozo* or *mitsumata* with stalks remaining to allow for new growth in the next season.

Just like grapes cultivated for wine, many factors in the cultivation of *kozo* related to the growing environment will influence the physical and chemical characteristics of the fibers. There are two main types of *kozo* fibers grown and used in Japan and recognized for their quality and unique properties: *nasu kozo* and *tosa kozo*. *Nasu kozo* is grown in more northern prefectures of northeastern Tochigi and southern Fukushima (fig. 2) (Masuda 1985). The climate is cooler and the growing season is shorter—yielding soft, tender, and shorter *kozo* fibers. *Tosa kozo* is grown in the south in Kochi prefecture, where the growing period is longer and produces longer, stronger fibers (fig. 2).

Kozo may be cultivated in other parts of the world with similar climates to Japan. Thai *kozo* is a recent introduction to the papermaking industry. It grows very fast and can be harvested twice in a growing season (Mizumura, Kubo, and Moriki 2015; Jacobi and Mizumura 2016). As a result, Thai *kozo* is much less expensive than Japanese *kozo,* creating competition for Japanese raw material suppliers that is too difficult to overcome (Jacobi and Mizumura 2016). The faster growing season also means that the Thai *kozo* fibers contain more oils and plant impurities that are very difficult to remove. These fibers require caustic soda, a more aggressive cooking agent, to remove the impurities. Even after cooking with stronger alkalis, the impurities can remain in the fibers and leach out, forming oily stains in the finished sheets (Jacobi and Mizumura 2016).

Fig. 2. *Nasu kozo* is grown in northeastern Tochigi and southern Fukushima Prefectures and *tosa kozo* is grown in Kochi Prefecture in the south.

China is another producer of *kozo* and it is believed to be of good quality (Mizumura, Kubo, and Moriki 2015).

The harvested *kozo* is immediately steamed and the bark peeled by hand from the wooden core in one piece. The bark has three layers (fig. 3): the *shirokawa* or white inner layer composed mainly of cellulose; the *nazekawa* or the middle green layer, which is composed mainly of hemicellulose; and the *kurokawa*, or the outer black bark (Hughes 1978; Barrett 1983; Masuda 1985; Mizumura, Kubo, and Moriki 2015). Different layers may be retained based on the type of paper to be made. The unwanted bark layers are scraped away after steaming (fig. 4). The desired part of the bark is then placed in the river to rinse out soluble impurities. The rinsed bark can be dried and stored until needed for papermaking.

If traditional methods are followed, the fibers will brighten slightly from natural light bleaching. There are three methods for light bleaching: in the river while rinsing, *kawa-zarashi*; on the ground in the sun, *tempi-zarashi*; or laid out in the snow and sun, *yuki-zarashi* (Hughes 1978). In some paper studios, chemical bleaching of fibers may be conducted as an additional step after cooking the fibers. Sodium hypochlorite (NaOCl) is the bleach that is most commonly used (Koestler, Indicator, and Fiske 1992; Mizumura, Kubo, and Moriki 2015). Less processing of the raw material occurs when chemical bleaching is involved in papermaking because all three layers of the bark can be cooked and then bleached to render everything the same color: bright white. Chemical bleaching produces poor quality *washi* that ages poorly because the fibers are less purified, chemically damaged, and have chlorine residues if chlorine-based bleaches are used (Uyeda et al. 1999; Koestler, Indictor, and Fiske 1992).

When papermaking is to begin, the dried bark is soaked anywhere from several hours to a couple of days (Hughes 1978; Barrett 1983). The steamed, scraped, and rinsed fibers are cooked with an alkaline agent for approximately two hours (fig. 5). The cooking time will vary depending on the strength of the cooking agent and the studio practices. Wood ash (potassium carbonate, K_2CO_3), also called potash, was the traditional alkali collected from burned wood or burned buckwheat husks (Barrett 1983). Slaked lime (calcium hydroxide, CaOH) has also been used. Two other alkalis that have been introduced to the *washi* industry are soda ash (sodium carbonate, $NaCO_3$) and caustic soda (sodium hydroxide, NaOH). These alkalis are stronger, reduce the cooking time, and are more soluble in water, allowing easier removal of residues when rinsing the cooked fibers. However, stronger alkalis will cause more chemical damage to the fibers and will also make the fibers whiter. After cooking, the bark is rinsed to remove any remaining alkali and soluble impurities. The fibers are carefully examined and any pieces of black bark, called *chiri,* are removed by hand in a process called *chiritori* (fig. 6).

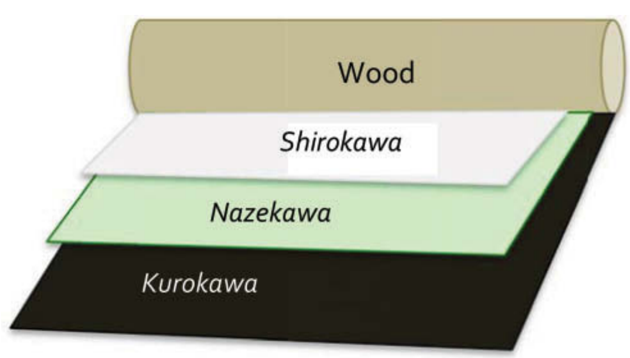

Fig. 3. Three layers of the *kozo* bark: the inner white layer called *shirokawa*, the middle green layer called *nazekawa*, and the outer black layer called *kurokawa*.

Fig. 4. Scraping unwanted layers of outer bark with a knife. Sekishu Kubota Studio, Shimane Prefecture. Credit: Jacinta Johnson.

The cooked bark is then beaten to separate the individual fibers. Traditionally, the fibers are beaten by hand with wooden mallets (fig. 7) or with a foot stamper. More automated methods are now being used to increase production rates, including mechanical beaters (fig. 8), *naginata* beaters—similar to a

Fig. 5. Mr. Fukunishi removing cooked bark from the cauldron. Fukunishi Studio, Nara Prefecture. Credit: Jacinta Johnson.

Fig. 6. Mrs. Kubota removing blemishes from cooked bark in the chiritori process. Sekishu Kubota Studio, Shimane Prefecture.

Hollander beater but with curved blades causing less physical damage to the fiber (Barrett 1983), and the Hollander beater. The modern mechanical beaters cause more physical damage to the fibers, producing shorter, weaker fibers.

The beaten fibers are mixed with water and a formation aid, called *neri*, in preparation for sheet formation. *Neri*, a plant mucilage extracted from *tororo-aoi* (*Hibiscus Manihot*), has a stringy, slippery consistency similar to mucus (fig. 9). The mucilage is key to Japanese papermaking as it helps to disperse fibers in the vat, slows sedimentation of fibers, and controls water drainage from the mold. *Neri* also helps with sheet separation after the post is pressed. It is not an adhesive or internal sizing agent. If additives are used, they may include *gofun*, calcined oyster shell powder, clays, and calcium hydroxide in the form of lime (figs. 10 and 11). Sizing agents are not commonly used in *washi* but some may include *dosa* (an animal glue and alum mix), *konyaku*, a plant starch from the *konyaku* (*Amorphophalus konjac K. Koch)* root, and rice starch. Sizing agents are often applied to the sheet instead of in the vat.

Fig. 7. Mrs. Fukunishi demonstrating how cooked fibers are beaten by hand. Fukunishi Studio, Nara Prefecture. Credit: Jacinta Johnson.

Fig. 8. A mechanical beater used in place of hand beating paper fibers. In some studios hand-beaten fibers are then further beaten using the mechanical beater. Fukunishi Studio, Nara Prefecture.

Once the pulp is mixed into the vat, the papermaker begins the Japanese sheet formation method called *nagashizuki.* Sheet formation involves repeated charging of the mold from the vat, complex shaking, and discharging excess pulp until the desired thickness is achieved. In Western papermaking, the mold is only dipped once, shaken gently and quickly, and allowed to drain. The Japanese papermaking studio setup is also quite different from a Western studio. The mold is called the *keta,* with the frame and the deckle hinged together. The screen is a separate part of the mold. It is called the *su* and is a flexible, laid screen made from stiff, organic materials like bamboo or kaya, a type of grass that will be discussed in more detail later. When referring to the Japanese mold and the screen together, it is called the *suketa*. This differs from the Western papermaking mold, which is a laid screen made from wires secured to the mold frame. The *suketa* is hooked onto wires attached to bamboo struts that extend over the vat above the papermaker's head. The struts help support the weight of the mold and flex with the movement of the screen during sheet formation. This system also allows for handles to be attached to the *keta* shoulder width apart and allows much larger *suketas* to be used.

Fig. 9. *Neri* dispersion agent extracted from the *torroro-aoi* root by crushing and soaking in water. *Neri* is scooped from the bucket and passed through a strainer before it is added to the vat.

Once a sheet is formed, the *su* is removed from the *keta,* lifted overhead, and couched on the post stationed on a table directly behind the papermaker. There are wooden guides

Fig. 10. Powdered oyster shells are sometimes added to papers as a filler.

Fig. 11. Kaolin is another type of filler that might be added to paper. Fukunishi Studio, Nara Prefecture. Credit: Jacinta Johnson.

that help align the *su* as the fresh sheet is couched. Instead of interleaving the sheets with felts, the fresh sheet is couched directly on top of the last couched sheet. A string, ribbon, or fishing line is often laid along the edge of the post closest to the papermaker to aid in sheet separation. The studio setup is very efficient and allows one person to do all the sheet formation steps and operate a much larger mold that would otherwise be too heavy to manage. In Western papermaking studios, this process requires at least two workers. Figure 12 shows Mr. Fukunishi making *udagami* and illustrates the tools and studio design unique to the *nagashizuki* method.

A completed post is pressed overnight in a screw press or hydraulic press. This is a slight alteration to the traditional lever press. The next day, the sheets are separated and applied

Fig. 12. Mr. Fukunishi making *udagami* with the *nagashizuki* method. The organization of the studio and the tools used in the step depicted here include the vat; the bamboo struts over the vat; the hinged frame and deckle called the *keta*; the removable, flexible screen called the *su*; the post behind the papermaker with the wooden guides; and fishing wire placed along the edge closest to the papermaker to assist in sheet separation. Fukunishi Studio, Nara Prefecture. Credit: Jacinta Johnson.

Fig. 13. Mrs. Hamada separates sheets of paper from the post. She is holding the brush used to apply the sheet to the drying surface, which is a rotating, heated stainless steel drum behind her. Hamada Washi, Kochi Prefecture. Credit: Jacinta Johnson.

to drying supports (fig. 13). Traditionally, these supports are made from wooden boards. The boards with the attached papers are then placed in the sun to dry. There are three types of wood commonly used: horse chestnut, ginko (fig. 14), and

Fig. 14. Examples of ginko drying boards. Fukunishi Studio, Nara Prefecture. Credit: Jacinta Johnson.

Fig. 15. Papermakers greatly value their drying boards as is evident by the repairs made with metal staples and *kozo* patches to secure splits and cracks. These boards used at the Fukunishi Studio in Nara Prefecture are 300-year-old pine heirloom drying boards. Fukunishi Studio, Nara Prefecture.

pine. Today, drying supports may include wooden boards placed in the open air to dry, wooden boards placed into heated chambers to accelerate drying and eliminating the change of poor drying weather, or heated stainless steel plates or drums that reduces drying times to a matter of minutes.

Wooden drying boards are very precious to papermakers because they have been passed down through generations. It is also difficult to get wooden planks of the same size and quality today. As a result, papermakers take good care of the boards, repairing splits and cracks as much as possible (fig. 15). These drying boards are the first things to be bought from another studio that is closing.

Once dried, sheets are removed from the boards (fig. 16), examined, and categorized by weight and quality. Weight is measured by hand in *monme*, reflecting the slight variances in handmade sheets. Any sheets that do not pass inspection are reprocessed into fibers. Figure 17 summarizes the steps in making *washi* and the reader may refer to Appendix A for a glossary of terms and Appendix B for a chart summarizing the effects of materials and methods on *washi* quality. The papermaking process is incredibly labor intensive. According to the Tosa Washi Museum in Kochi Prefecture, only 4% of the raw materials are represented in the final product.

CHARACTERISTICS AND HISTORY OF *WASHI* COMMONLY USED IN PAPER CONSERVATION

Conservators approach *washi* with treatment in mind. The types used for treatment have been carefully selected for their physical and chemical properties that align with the goals of the conservator. However, what is exciting and interesting is that there is a long history attached to *washi.* Each type of *washi* was carefully engineered for specific uses long before it was used for Western conservation. Understanding the history of the papers used in conservation can also help inform conservators of the characteristics each paper has that may be

Fig. 16. Mrs. Fukunishi removing dried *udagami* sheets from wooden drying boards. Fukunishi Studio, Nara Prefecture.

1.	Harvesting Raw Materials
2.	Bark Preparation
3.	Cooking Bark
4.	Rinsing, Chiritori
If nontraditional methods are followed, Chemical Bleaching	
5.	Beating Fibers
6.	Sheet Formation
7.	Pressing & Drying
8.	Inspection

Fig. 17. The procession of the steps involved in making *washi*.

helpful in treatment. It is important to note that, as of 2014, three types of *washi* were registered as UNESCO Intangible Cultural Heritage of Humanity: *sekishu-banshi*, *hosokawa-shi*, and *hon-minoshi*. *Sekishu-banshi* and *hon-minoshi* will be discussed in more detail below. *Hosokawa-shi* is made in Saitama Prefecture (fig. 18)—this paper celebrates a long history and was and is prized for its quality. Below is a summary of the history of four types of *washi* most commonly used in conservation: *tengujo*, *sekishu-banshi*, *usumino*, and *udagami*.

TENGUJO

The first mention of *tengujo* can be traced back to the 15th century (Masuda 1985). Traditionally, *tengujo* was used as filter paper, for cleaning lenses, and wrapping precious objects. Later, it was in high demand for uses related to typewriters and mimeographs (Hughes 1978). *Tengujo* as we know it today is made in Ino-cho in Kochi Prefecture (fig. 18) using only the *shirokawa* (white) layer of *tosa kozo* (Masuda

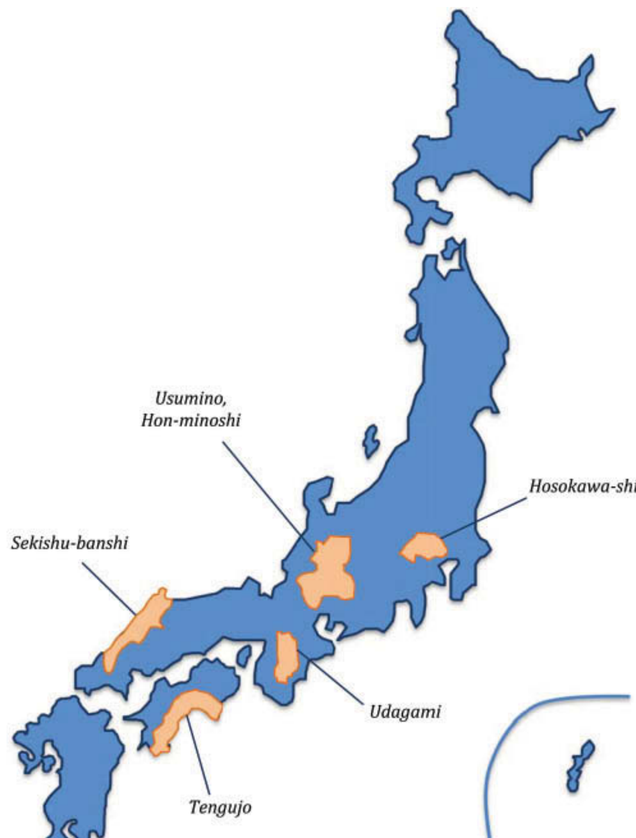

Fig. 18. Map showing the location of four types of papers commonly used in conservation. *Tengucho* is made on Shikoku Island in the south in Kochi Prefecture. *Sekishu-banshi* is made in Shimane Prefecture on the west coast off of the Sea of Japan. *Usumino* is made in the Mino area (bottom half) of today's Gifu Prefecture. *Udagami* is made in Yoshino in the middle of Nara Prefecture. In addition to *sekishu-banshi*, the other two UNESCO papers are also shown: *han-minoshi* made in Gifu Prefecture, and *hosokawa-shi* made in Saitima Prefecture.

1985). Kochi papermakers incorporate a second fiber-rinsing step conducted after the beating step. The fibers are placed in a basket called *koburi* (fig. 19) while rinsing to further remove hemicellulose and other plant impurities (Barrett 1983; Masuda 1985). The additional rinsing step is unique to Kochi Prefecture and produces paper that is softer, with more "give." According to Hidaka Washi Co., Ltd. (2017), Kochi *tengujo* is the thinnest handmade paper in the world with a thickness of 0.03 μm, and the thinnest machine-made paper with a thickness of 0.02 μm.

SEKISHU-BANSHI

Sekishu-banshi is made in Shimane prefecture (fig. 18) and is one of the oldest types of 100% *kozo* papers with records mentioning it in the 8th century (Masuda 1985). *Sekishu* was known for its strength and was used for account books, windows and sliding doors, and *karibari* boards (Hughes 1978). *Banshi* or *hanshi* means "half sheet" and refers to the size 9.8 × 13.8 in. (24.9 × 35 cm) and is only used in reference to 100% *kozo* papers of this particular size (Hughes 1978). Today there are two other sheet dimensions for *sekishu-banshi*: 19.6 × 27.5 in. (49.7 × 69.8 cm) and 23.98 × 35.7 in. (60.9 × 90.6 cm) (Masuda 1985). *Sekishu* is made with the *nazekawa* (green) and *shirokawa* (white) layers of locally grown *kozo* bark (fig. 20). The green layer is composed mostly of hemicellulose, which helps fibers bond together. The incorporation of the green layer in *sekishu-banshi* produces a stronger paper with a distinct rattle and slightly warmer color than other *kozo washi*. This paper is traditionally made with a kaya screen, although bamboo screens are also used.

It is important to note that there are two types of *sekishu* available to conservators today: *sekishu-mare* and *sekishu-tsuru*. These names are an indication of paper quality. *Sekishu-mare* has been made strictly following the traditional methods. *Sekishu-tsuru* has been made with the incorporation of more modern techniques to decrease production times and includes the use of caustic soda, machine beating, and heated steel drying plates. The difference in production methods is also reflected in the retail price for each type of *sekishu*.

Fig. 19. A *koburi* basket on display at the *Tosa Wahi Musuem* in Kochi Prefecture. The basket is used for the additional rinsing of fibers after they are beaten. This step is unique to papermaking in Kochi.

Fig. 20. Papermakers retain the green *nazekawa* layer of the *kozo* bark when making *sekishu-banshi*. This layer is composed mainly of hemicellulose and imparts unique characteristics of the paper. Sekishu Kubota Studio, Shimane Prefecture. Credit: Jacinta Johnson.

USUMINO

Usumino is made in the Mino area of Gifu Prefecture (fig. 18) and is also one of the oldest papermaking areas. There are references to Mino *washi* dating from the 8th century (Masuda 1985). This type of *washi* is recognized for its extremely fine quality. This is because of the quality of *kozo* used, its excellent fiber distribution, and even sheet formation. Only the *shirokawa* (inner white) layer of *nasu kozo* is used to make *usumino* (Masuda 1985). Papermakers in the Gifu Prefecture use mallets that are unique to this area for beating fibers. The mallets have grooves cut in a starburst pattern on the beating face of the mallets (Hughes 1978). Historically, heavier weight *washi* made in the Mino area was used for the windows of the guest room called the *shoin* because its fine quality allowed an even, diffused light into the room, uninterrupted by slubs (Hughes 1978; Masuda 1985). This type of paper is called *shoin-shi*. *Usumino* is selected by scroll mounters for the first lining of artworks made for hanging scrolls because the artworks are on fairly thin, translucent supports (Masuda 1985). The flawlessness of *usumino* does not disrupt the appearance of the artwork.

UDAGAMI

While *udagami* is not ubiquitously used for treating Western paper objects, it is used for scroll mounting. *Udagami* is made in Yoshino in Nara Prefecture (fig. 18). Paper made in this area of Japan is referenced as early as the 15th century and was recognized for its thinness and quality (Masuda 1985). *Udagami* is used as the final lining in scroll mounting because of its stiffness, resistance to insects and heat, and minimal reactiveness to moisture.

The *shirokawa* (white) layer of locally grown *kozo* is used to make *udagami*. Kaolin filler is added to the pulp before the formation aid and is what imparts the unique characteristics to this type of *washi*. The amount of clay added to the vat is determined by the thickness of the paper to be made. A different formation aid called *nori-utsugi* is used in Yoshino instead of *neri* and is a mucilage extracted from the bark of a locally grown shrub (*Hydrangea paniculata Sieb.)*. Another distinctive characteristic of *udagami* is that it is made on a long and narrow mold approximately 12.5 × 57.2 in. long, fitted with a kaya screen (fig. 12). This size is a more recent introduction to the making of *udagami* (Masuda 1985).

EXAMINATION OF *WASHI*

Knowing what kind of *washi* is being used in treatment is important for ethical practice and for maintaining respect for cultural heritage. There are challenges to understanding *washi*. It may be difficult to follow the many variations on spellings of *washi* names or deciphering specific names of papers versus more general names of categories of papers. Additionally, language barriers for those who are not fluent in Japanese or immersed in the *washi* culture can lead to misunderstandings. To further complicate matters, names that once stood for quality *washi* no longer can be used as a guide when ordering conservation quality papers (Jacobi and Mizumura 2016). Finally, manufacturers' details can be difficult to obtain, making it harder to ensure that quality papers are selected. Thankfully, *washi* suppliers are aware of this and provide as much information as they can for the papers that they offer.

There are certain features of *washi* that will indicate manufacturing methods and fiber furnish. These characteristics will inform the conservator of the quality of papers selected and their behavior during and after treatment, such as strength, reactivity to moisture, and long-term stability. These features are also unique markers related to the historical and cultural importance of this material. Knowing what these characteristics and markers are will help conservators select quality papers for specific treatment uses as well as help respect the beautiful cultural heritage of *washi*. This will allow more detailed information about materials to be incorporated into treatment records for future reference. In this section, the following markers and characteristics that influence *washi* quality will be discussed: fiber furnish, cooking and bleaching agents, fiber processing and distribution, screen impressions left in the papers, machine-made or handmade papers, and drying methods.

FIBER FURNISH

Identifying the fiber furnish of *washi* will help discern traits like flexibility, reactivity to moisture, and predict how the paper will age as each fiber type has different quantities of lignin and hemicellulose. Also, a specific type of *washi* may be desirable in treatment with a specific type of fiber furnish. For example, a fill might be necessary in a more modern work of art that has been made on a paper with *kozo* and sulfite wood pulp fiber mixture. This section will focus on observations made using visuals, sound, and touch, and will not discuss technical analytical methods.

The three traditional fibers for *washi* are *gampi*, *mitsumata*, and *kozo*. However, papers made with *kozo* are the most common in conservation, making logical deduction easier in this challenge. Today, some *washi* marketed as traditional papers have pulp mixtures of one of the three traditional fibers with hemp and/or sulfite wood pulp. *Gampi* has the shortest and weakest fibers and is the most reactive to moisture. A sheet of *gampi* has a warmer color with a high luster, very smooth surface, and exhibits a significant degree of translucency at lighter weights. Another distinctive characteristic of *gampi washi* is a very loud rattle when shaken.

Mitsumata looks similar to *kozo* and it can be difficult to differentiate between the two. The fibers are shorter than *kozo* and the paper is slightly weaker and more opaque than *kozo* papers when viewed through transmitted light. *Mitsumata* is more lustrous and softer than *kozo* papers, which is why it is historically described as a feminine fiber.

Kozo fibers are the longest and strongest of the traditional fibers and the *shirokawa* (white) layer has the least amount of lignin and hemicellulose content in comparison with the other two bast fibers. *Kozo* paper has more of a rattle when shaken than *mitsumata* papers and has some luster. *Kozo* papers are also slightly more translucent than *mitsumata*. Thai *kozo* can be harder to differentiate when comparing two types of *kozo* papers. However, the fibers are shorter and are less supple and lustrous than Japanese *kozo*. Papers made with Thai *kozo* are often whiter because they have been cooked with stronger alkalis and are regularly chemically bleached as well.

Kozo and sulfite wood pulp fiber or *kozo* and hemp fiber mixes produce duller papers that are more opaque in transmitted light. These papers are not as resilient when flexed and do not have as crisp of a rattle when shaken compared to pure *kozo* papers. Additionally, the rough side is fuzzier and feels courser because of the short wood fibers. Like Thai *kozo* papers, *kozo* and wood pulp mixes are cooked with caustic soda and chemically bleached.

COOKING AGENTS AND CHEMICAL BLEACHING

Differentiating between types of cooking agents when examining papers without any context can be challenging.

However, some qualities can help guide the conservator in the right direction. Papers made strictly following traditional methods will have warmer yellow-cream tones, with good flexibility, and will feel "healthier." Stronger cooking agents, particularly caustic soda, produce lighter colored, less supple, and weaker papers. Bleached fibers will have similar characteristics as papers cooked with caustic soda but they will also be unnaturally bright white. Papers made with fibers cooked with strong alkali agents and/or chemically bleached will be stiff and coarse to the touch and will be weaker. Both types of papers will not age well because these processes have chemically damaged the fibers. It is important to note that when chemical bleaching is used in the manufacturing of *washi*, there is no need to carefully process the bark by removing the different layers, which is done when making good quality paper. Instead, all components of the bark are processed and a very poor quality paper is produced. To make things more complicated, some bleached papers are redyed to make them look like the warmer, traditionally made *washi*.

FIBER PROCESSING AND DISTRIBUTION

If fibers are not beaten thoroughly, slubs (clumps of fibers) will be present in the *washi* and are more visible in transmitted light. More slubs may indicate less care taken in processing fiber; however, the presence of a few slubs can be a good indication that the paper is handmade. Three examples of papers with varying degrees of fiber processing viewed in transmitted light are shown in Figure 21.

Even distribution of fibers in a sheet may also be determined using transmitted light. Less transparent areas in a sheet indicate a denser area of fibers. Significant variances in transparency, or a mottled appearance in transmitted light, is a sign of uneven, poorly distributed fibers. This happens during sheet formation or when an incorrect amount of dispersion agent (*neri* or *nori-utsugi*) is added to the pulp (Barrett 1983). Figure 21 also shows a range in fiber distribution quality in different quality sheets.

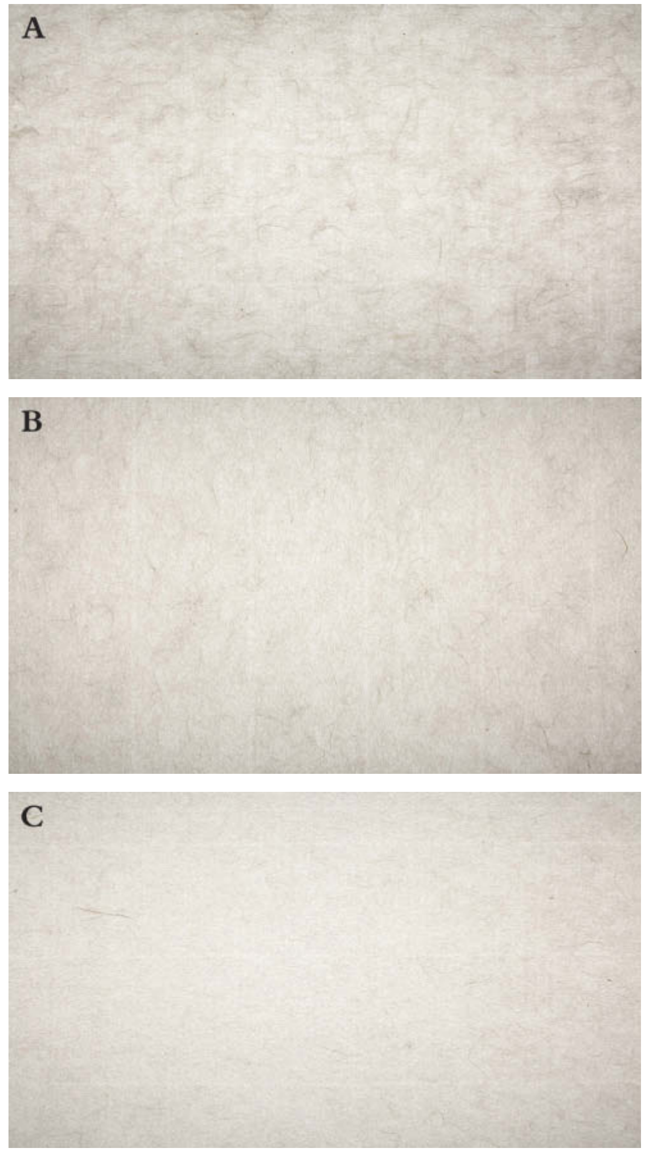

Fig. 21. Three different papers in transmitted light arranged from poor quality to excellent quality (a–c). The first image depicts poorly processed fibers and poor fiber distribution in the sheet. The last image depicts good fiber processing and excellent fiber distribution. Credit: Matthew Hamilton.

SCREEN IMPRESSIONS

If there are chain and laid lines impressed in the *washi*, there are two kinds of *su* (screens) that may have been used. As mentioned earlier, the *su* is a flexible mat made with bamboo or kaya as the laid supports and silk woven around the laid supports to form the chain lines. It is possible to differentiate between the two types of screens by looking at the chain and laid line relief patterns in the paper. The unique pattern of each type of screen is related to the construction of that screen.

Bamboo screens are constructed by cutting bamboo splints to the desired diameter. Then half the diameter of the splints is cut away at either end. The splints are lap joined to create one continuous laid line support across the width of the screen (fig. 22a). The joins are aligned at the same point for each laid support in the screen. The laid supports are secured by stitching silk chain lines at even intervals. A double chain line will be woven where the lap joins are in order to secure this weak point in the screen structure (fig. 22b). When looking at paper in transmitted light, those made with a bamboo screens will have narrower distances between chain lines, sets of narrow double chain lines at intervals, and the laid lines are much finer (fig. 22c). According to papermakers, *washi* made

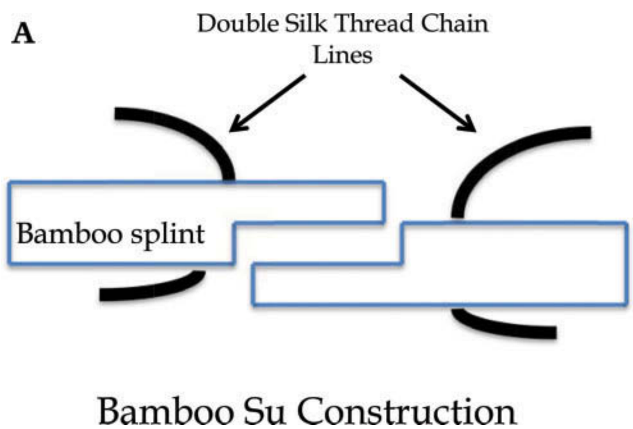

Fig. 22a. Construction of a bamboo screen.

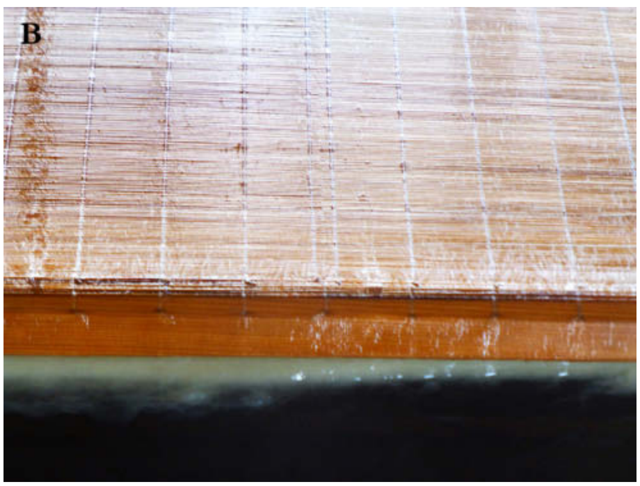

Fig. 22b. Bamboo screen.

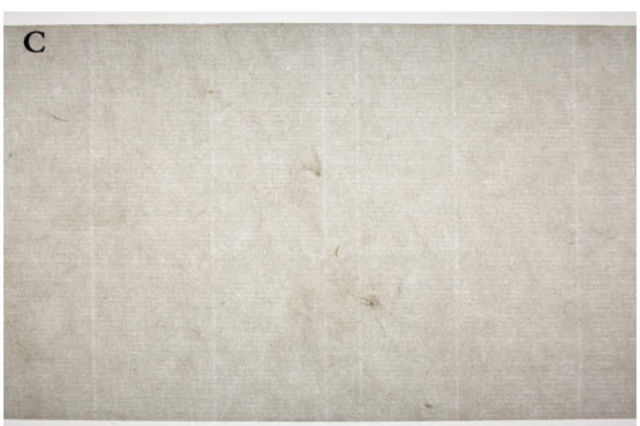

Fig. 22c. Detail of a paper made with a bamboo screen in transmitted light. The narrower chain lines, double chain lines, and finer laid lines are visible. Credit: Matthew Hamilton.

on a bamboo *su* are crisper. This may be because the laid supports are closer together and more uniform in diameter, affecting the way the fibers lay on the screen during sheet formation.

Kaya screens are made using the hollow kaya (*Miscanthus sinensis*) grass. The harvested grass is sorted by diameter. The grass is aligned end to end and joined by placing a thin bamboo splint inside the hollow grass to secure the butt join (fig. 23a). The single chain lines are sewn to secure the kaya laid supports regardless of where the joins are placed (fig. 23b). The kaya *su* has wider distances between chain lines than bamboo screens. The diameters of the kaya supports are also slightly larger, more pronounced, and more irregular when viewing the chain and laid patterns with transmitted light (fig 23c). Also, the papers made from kaya *su* are softer. The patterns of chain and laid lines will help indicate the type of *washi* in question as specific types of *washi* are traditionally made with a bamboo or kaya screen. For example, *sekishu-banshi* and *udagami* are traditionally made with a kaya screen.

The lack of chain and laid lines may indicate that the *washi* was made with a silk *sha* placed over the *su*. A *sha* is a silk cloth made with the leno, or gauze weave, an open but strong weaving technique. The *sha* is often placed onto a *su* when making thinner papers to catch the fibers. This masks the chain and laid lines of the *su* and will make a paper with a wove screen pattern. The lack of chain and laid lines may also indicate that the *washi* is machine-made.

MACHINE-MADE OR HANDMADE

When determining if a paper is handmade or machine-made, size is often the most helpful indicator. Machine-made *washi* can come in any length and the width is larger than the width of most handmade *washi* molds. The presence of deckled edges may also help determine if it is machine-made or handmade. Machine-made paper will have two deckled edges with the exception of *tengujo*. Handmade paper can have three (when the sheet is cut in half) or four deckled edges unless all edges have been trimmed, as is often the case with *tengujo*. Finally, grain direction of a paper is also helpful in identifying a machine-made paper. The grain direction of machine-made *washi* is stronger in the machine direction. Handmade *washi* grain direction will be slightly less distinctive, with the grain being stronger in the chain line direction because this is the dominant direction of movement during *nagashizuki* sheet formation.

DRYING METHODS

The drying method used in making *washi* can be determined by examining the surface texture of both sides of the sheet. Handmade *washi* will have a rough side, the side of the paper that the brush was passed over when attaching it to the drying board. Brush marks on the rough side are often visible in raking light (fig. 24). The smooth side of *washi* has been in contact with the drying support. If it is very smooth, the paper was dried on a heated metal plate. If it is moderately smooth, the paper has

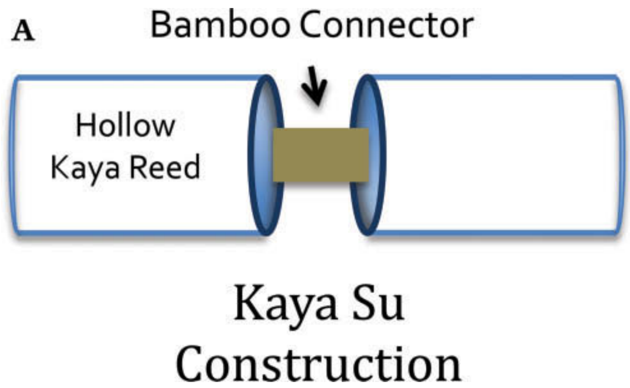

Fig. 23a. Construction of a kaya screen showing the double chain line.

Fig. 23b. Detail of a kaya screen showing the random placement of laid support joins.

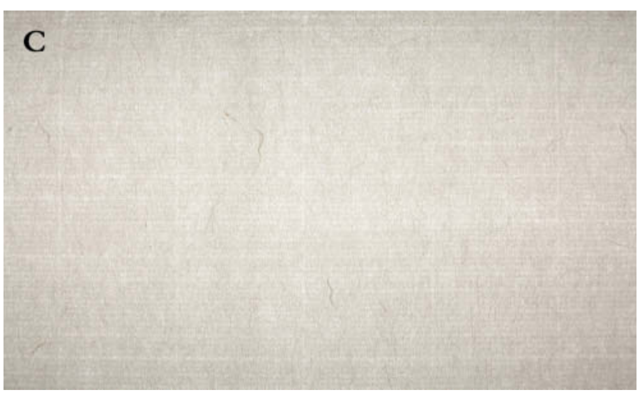

Fig. 23c. Detail of a paper made with a kaya screen in transmitted light. The wider chain lines and inconsistent, pronounced laid lines are visible. Credit: Matthew Hamilton.

been dried on a wooden board. Looking for these traits in a paper will help determine how severely it will react to moisture: papers dried on wooden boards will expand and contract less than papers dried on heated metal plates (Nicholson and Page 1988). This is because the heated metal plates dry the papers very quickly. Papers dried this way have more moisture removed from the fibers, causing shrinking and creating a lot of stress in the paper, making it highly reactive to moisture.


Fig. 24. The brush marks visible in racking light on the rough side of a sheet of *washi*. The marks are imbedded on the paper as it is brushed onto the drying support.

Identifying these characteristics of *washi* will give a sense of how the *washi* will react during treatment. Even fiber processing and distribution will mean that the *washi* will behave uniformly across the sheet. It is also an indication of quality and care in making the *washi*. Drying methods will greatly influence the dimensional changes of the paper when introduced to moisture and may inform the conservator's use of that paper in treatment (for example, prewetting papers dried on heated steel plate prior to lining). Identifying machine-made versus handmade may help select higher quality papers necessary for certain tasks or treatments. While there are good quality machine-made papers for use in conservation, a good quality handmade *washi* following traditional methods with Japanese cultivated *kozo* will be of higher quality because less physical and chemical damaging of the fibers has occurred, and the locally grown *kozo* is of better quality than Thai *kozo*.

THE FUTURE OF *WASHI*

Handmade *washi* is on the decline as it becomes more and more difficult to get the raw materials needed to make quality papers. The traditional process is very labor intensive with little profit, pushing younger generations toward more appealing careers. Consequently, many species of *washi* are vanishing as papermakers end their careers. In 2013, the Japanese government recorded only 170 papermakers still working (Megumi and Moriki 2017). A similar decline is observed in the tool-making trade associated with the paper-making trade—making it more difficult for papermakers to get the tools they need (figs. 25 and 26). While the situation seems dire, there is some hope. Many of the papermakers

Fig. 25. Mr. Ichibei Iwano, National Living Treasure and maker of *hosho washi*. Echizen, Fukui Prefecture. Credit: Jacinta Johnson.

Fig. 26. Mr. Yamamoto, the last *su* maker. Kochi Prefecture. Credit: Jacinta Johnson.

Fig. 27. So Kubota making sekishu. *Sekishu* Kubota Studio, Shimane Prefecture. Credit: Jacinta Johnson.

Fig. 28. Osamu Hamada, papermaker. Hamada Washi Studio, Kochi Prefecture.

visited on the Hiromi Paper Inc. *2017 Washi Tour* had a younger generation family member who was interested in learning the trade (figs. 27 and 28).

CONCLUSION

Washi holds a very important role in book and paper conservation because of its unique qualities and good aging characteristics. However, the *washi* industry has undergone many changes that have been largely unaccounted for in conservation literature. In response to differences in quality of some *washi* caused by these changes in the industry, conservators can assess a paper's quality by understanding how traditional papers are made and look for certain characteristics and marks formerly discussed that can help indicate paper quality. This practice will also help to keep the cultural importance of *washi* in mind.

Much more work is needed to update what the profession understands about *washi*. The composition and aging properties of *washi* used in conservation should be reexamined. Efforts to create a relevant reference would be invaluable, with standardized descriptive terminology used to communicate *washi* characteristics, and ensuring that what is understood is based on reliable translations of the Japanese language and *washi* culture. Finally, with the awareness of the fragility of the *washi* industry, conservators should investigate how to help sustain this industry it relies so heavily upon.

ACKNOWLEDGMENTS

I would like to thank my co-author, Hiromi Paper Inc., for organizing the invaluable and informative *2017 Washi Tour*. Many thanks to Jacinta Johnson for her willingness to share her beautiful images to help illustrate the concepts covered in this article. I would like to also acknowledge Nancy Jacobi and Megumi Mizumura for the wonderful workshop they led at the 2016 AIC-CAC joint meeting, *Identification of East Asian Papers for Conservation,* as it helped me to delve deeper into understanding *washi*. Thank you to my mentor, Betty Fiske, for instilling an appreciation for Japanese conservation techniques and for helping me to build my foundation in understanding *washi*. I would like to extend a final, special acknowledgment to all the papermakers who are dedicated to carrying on the trade of making traditional *washi* and to whom book and paper conservators are indebted to for their quality product.

APPENDIX A

GLOSSARY

Banshi or hanshi: A term that means "half sheet" and refers to a paper size that was popular in the middle ages: 9.8 × 13.8 in. (24.8 × 35.0 cm) used in reference to 100% *kozo* papers of this particular size.

Dosa: A mixture of animal glue and alum sometimes used as an external sizing agent.

Kaya: A hollow grass, *Miscanthus sinensis*, used to make screen supports. Kaya screens are often used for making certain types of papers like *udagami* and *sekishu-banshi*.

Keta: The deckle and mold frame of the Japanese paper mold that is hinged together.

Koburi: The special type of basket used to rinse fibers used for the additional rinsing step unique to papermaking in Kochi Prefecture.

Kurokawa: The outer black layer of the *kozo* bark.

Nagashizuki: The Japanese sheet formation technique.

Nazekawa: The middle green layer of bark composed mainly of hemicellulose.

Neri: A plant mucilage extracted from *tororo-aoi* (*Hibiscus Manihot*) that has a stringy, slippery consistency similar to mucus. The mucilage is added to pulp as a fiber dispersion agent.

Nori-utsgi: A different formation aid used in Yoshino instead of *neri*. It is also a mucilage extracted from the *Hydrangea paniculata Sieb.* shrub.

Sha: A silk cloth made using the leno, or gauze weave, an open but strong weaving technique. The *sha* is placed over the *su* in a paper mold to create wove patterned paper and is often used when making very thin papers.

Shirokawa: The inner white layer of bark where the quality bast fibers are located in *kozo* bark.

Su: The flexible, removable laid support that forms the screen in the paper mold. It is made from organic materials such as bamboo or kaya instead of metal wire.

Suketa: The name of the Japanese paper mold used when referring to both the screen and the hinged deckle and mold frame.

APPENDIX B: Methods of manufacturing *washi* and how it affects paper quality

Quality	Kozo Source	Cooking Agents	Bleaching	Beating Methods	Drying Methods
Excellent Quality	Japanese *Kozo* i.e., *Nasu* or *Tosa Kozo*	Wood Ash/Pot Ash, Potassium Carbonate, K_2CO_3	Natural Bleaching, Light	Hand Beating with Wooden Mallets	Wooden Boards, Outdoors
↓		Slaked Lime, Calcium Carbonate, $Ca(OH)_2$		Foot-Powered Stamper Mechanical Beater	Wooden Boards, Heated Chambers
	Thai Kozo	Soda Ash, Sodium Carbonate, $NaCO_3$		*Naginata* Beater	
Poor Quality	Thai Kozo/Fiber Mix (Hemp, Sulphite Wood Pulp)	Caustic Soda, Sodium Hydroxide, NaOH	Chemical Bleaching, Sodium Hypochlorite, NaClO	Hollander Beater	Heated Stainless Steel Plate or Drum

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The Unintended Effects of Some Book Treatments on Original or Early Binding Structures and Materials

The treatment of bound materials in special collections has become more conservative over the past half century. Today, book conservators choose treatments that safeguard physical information intrinsic to early bindings. The treatments focus on mending and stabilizing book structures, which lessen the need for invasive treatments such as rebinding or rebacking covers. However, in repairing rather than replacing older structures and materials, the book conservator is often challenged by the binding's deteriorated condition, which can range from slight to considerable. At the Ransom Center, we have found that the repair of one binding structure can stress and, in some cases, break adjacent deteriorated binding components. This presentation will discuss problems that typical repairs can cause, such as a new break in the sewing structure or stiffness in the spine, which changes how a book opens and how the pages turn. Techniques used by Ransom Center conservators to minimize stress to older components to preserve early structures and materials will be described using case studies.

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Papers presented at the Book and Paper Group Session, AIC's 46th Annual Meeting, May 29-June 2, 2018, Houston, Texas

Chancery Master Exhibits—Piecing It Back Together

The focus of this paper is the conservation of a 17th-century map damaged by water and iron gall ink. Triggered by a document request at The National Archives (TNA) for the Victoria County History project, archivist Amanda Bevan discovered the bad condition of a 17th-century map, which is of great historical interest. The map is part of a group of objects (C 110 64-67) dating from the mid-15th to the 18th century, which had been material evidence in a court case. In his will, Samuel Travers dedicated the proceeds from the sale of his land to the establishment of a foundation for poor naval lieutenants. Travers's will became the subject of much dispute and litigation, and the trust relating to the Naval Knights was not validated until July 26, 1793, almost 70 years after his death. The map appears to have been worked with to the extent of its material failing, which led to the production of an 18th-century copy. The transfer process of the ink drawings involved pricking through the paper onto the new support. The map also shows staining from water damage, which would have contributed to the breakdown and removal of the adhesive holding the lining to the paper and exacerbated the iron gall ink damage. The iron gall ink degradation the pricking and the water damage all contributed to the paper delaminating in fragments like a jigsaw. New treatment approaches for iron gall ink damage included the use of gels and a heat mat.

This conservation project reflects recent developments in paper and book conservation at The National Archives' Collection Care Department. It included the identification of materials and the development of tailored conservation treatments with the help of the conservation scientists. It required historical research provided by the archivists and non-TNA historians. As a result, the map is being used as a case study for in-house training and for various outreach events. In the newly created position of the Senior Conservation Manager for Single Object Treatments, I have been focusing on high-profile documents and conservation challenges and directing the development and adaptation of new treatment methods. The present conservation project lent itself to contribute to TNA's conservation skill development program and to improve the organization's conservation methodology for single objects.

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CHRISTINA TAYLOR, GEORGINA RAYNER, KATHERINE EREMIN, AND CHRISTOPHER WALLACE

Stone Paper: Examination of Géricault's *Lion Devouring a Horse* Lithographic Printing Matrix

As lithography gained popularity during the beginning of the 19th century, Alois Senefelder, the inventor of lithography, marketed stone paper as a cheaper, more accessible alternative to the cumbersome limestones most commonly used for printing. Between 1820 and 1821, Théodore Géricault, one of the early proponents of lithography, experimented with the use of stone paper. The *Lion Devouring a Horse* stone paper matrix is in the collection of the Harvard Art Museums and was the focus of this study. Stone paper is a lithographic printing matrix made of a heavyweight paper prepared with a special coating. Like other lithographic processes, the image is drawn on the prepared surface with a greasy material and the surface is then processed and printed from. The stone paper matrix for *Lion Devouring a Horse* sustained numerous losses to the coating, and during printing the losses in the image area transferred to the prints as voids. Through examination and comparison between the stone paper matrix and various impressions of the print, it is evident that some prints exhibit more voids than others. This variation is an indication that the coating deteriorated as the impressions were being printed and these voids helped build a chronology of this coating deterioration. Earlier impressions of prints are typically considered to have stronger impression quality but based on the developed chronology, earlier impressions of *Lion Devouring a Horse* do not necessarily relate to stronger impressions.

Senefelder described stone paper coatings as compositions of clay, chalk, and metallic oxides. X-ray fluorescence analysis of the stone paper coating revealed only the presence of lead. Small samples were taken for analysis by Fourier transform infrared spectroscopy, gas chromatography-mass spectrometry, scanning electron microscopy with energy dispersive analysis, and matrix assisted laser desorption/ionization. Analysis confirmed that the material was dominated by lead white (basic lead carbonate) combined with a drying oil binder, casein, and gum. Lead soaps are thought to be present within the medium.

The results of these careful comparisons, the instrumental analysis, and tests carried out on modern examples of stone paper illustrate the practical challenges Géricault faced when printing from stone papers and the reason for their limited commercial success.

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Papers presented at the Book and Paper Group Session, AIC's 46th Annual Meeting, May 29-June 2, 2018, Houston, Texas

Screenprint on Plastic (Some Assembly Required): A Case Study of Joe Tilson's *The Software Chart* 1968

By the beginning of the 1960s, contemporary printmaking in the Americas and Europe was already in the midst of a renaissance. Artists and printers actively began to collaborate to produce artworks that challenged traditional concepts of printmaking. The boundaries of size, materials, content, and production were virtually obliterated and resulted in some of the most unique, affordable, and accessible art produced at the time. *The Software Chart*, 1968, by British artist Joe Tilson, is a screenprint on plastic printed by the Kelpra Studio, leaders of the era in the production of artists' screen printing in London, England. The five-color screenprinted image, appropriated from print media and referencing a major international event, is printed on plastic (noted as Astrafoil) and backed with a reflective surfaced plastic (noted as Lumaline). The print and backing were adhered to each other with double-sided masking tape, mounted to card, and framed in a shallow metal frame. Printed and produced in an edition of 150, most known versions of this print assembly exhibit severe pressure-related distortions and off-gassing (vinegar odor). The print was not considered to be in exhibitable condition and came to the conservation department for review. This presentation described in detail the print history and concept, components, condition issues, material analysis, treatment stages, degree of treatment success, and the many issues relating to possible reconstruction, final presentation, and long term prognosis.

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Papers presented at the Book and Paper Group Session, AIC's 46th Annual Meeting, May 29-June 2, 2018, Houston, Texas

ROGER S. WILLIAMS

Optically Cleared Repair Tissues for the Treatment of Translucent Papers

INTRODUCTION

There are many types of translucent papers, each with its own set of conservation issues stemming from various manufacturing processes. The characteristic that makes them stand apart from other papers—transparency—can itself be at risk when there is a need for applying mending or lining tissues. This project explores the physical aspects of paper transparency and investigates the concept of optical clearing (transparentizing) of repair tissues, with the goal of achieving appropriate repairs on translucent papers without dramatically increasing the opacity of treated areas. The term "optical clearing" is borrowed from the fields of biology and medical research. It refers to the process of rendering biological tissues transparent through the application of clearing agents, which minimize the scattering of light and allow greater visibility for microscopy and imaging. This is similar to some historical processes of transparentizing paper, in which oils, waxes, and rosins were added to fill light-scattering interstices, allowing more light to travel unimpeded through the paper web. This concept is applied to conservation repair tissues, with the goal of determining a coating to serve dual functions: optical clearing agents and reactivatable adhesive.

OBJECTS TO BE TREATED

In 2016, two late-19th-/early-20th-century print portfolios bearing transparent overlays came down to the conservation lab at Northwestern University Library:

1. *Atlas Photographique de la Lune* (1896–1910) by Maurice Loewy & Pierre Henri Puiseux. A collection of 73 photogravure heliographs of the moon's surface. Each plate possesses a translucent tissue overlay with printed keys indicating the geographic characteristics depicted in the plates (fig. 1).
2. Frank Lloyd Wright's *Ausgeführte Bauten und Entwürfe* (1910–11), commonly known as the *Wasmuth Portfolio.* This two-volume work showcased Wright's architectural work to date with 100 lithograph plates, 27 of which are on translucent tissues tipped to the heavier plate with which they are associated (fig. 2).

There was significant damage to the tissues on both of these objects, with prominent tears and breaks that required mending. The translucent papers feature prominently in these two objects, and they rely both aesthetically and functionally upon the tissues' transparency: viewers are meant to see what is printed on the tissue and on the adjoining plate simultaneously. These items served as the impetus for this research project.

PAPER OPACITY

LIGHT AND PAPER

Light interacts with matter in two basic ways: scattering and absorption. Scattering involves a change in lightwave direction. *Elastic scattering* is what is typically called "reflection"; it involves the light bouncing from the material surface. *Inelastic scattering* is what is commonly called "refraction"; it is the bending of the light's path as it passes from one material to the next. This tendency to bend light is expressed as the material's refractive index (RI, or n). A bend in the path of light occurs when it passes from one material into another with a different RI; the greater the difference in RI, the larger the angle of divergence (Tilley 2011).

The interaction of light with paper is complicated by paper's disordered physical structure. Paper, at its simplest, is made of a web of cellulose fibers, which are themselves constructed of networks of macro- and microfibrils. Paper is far from a "pure" substance; it is anisotropic, stochastic, and heterogeneous.

Pure cellulose itself is a translucent material, absorbing only in the UV (Hubbe, Pawlak, and Koukoulas 2008). It has an RI between 1.46 and 1.56, depending on its origin (Saarela, et al. 2008). But between the cellulose fibers in paper are pockets of air, which has an RI of 1.0; 50% or more of the volume of a typical sheet of paper is occupied by air (Hubbe, Pawlak and Koukoulas 2008). When a wave of light attempts to pass through paper, it has to transition back and

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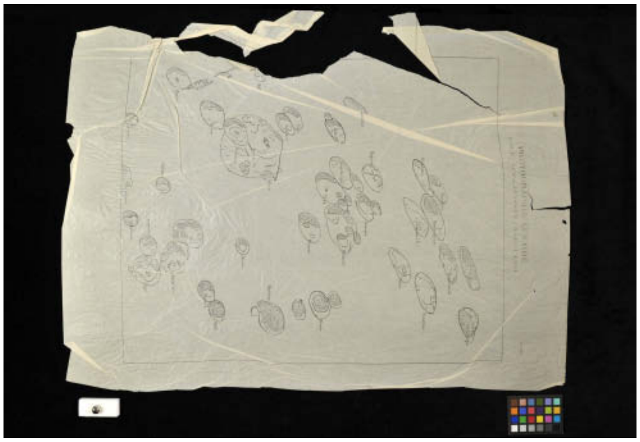


Fig. 1. A damaged translucent overlay from *Atlas Photographique de la Lune*.

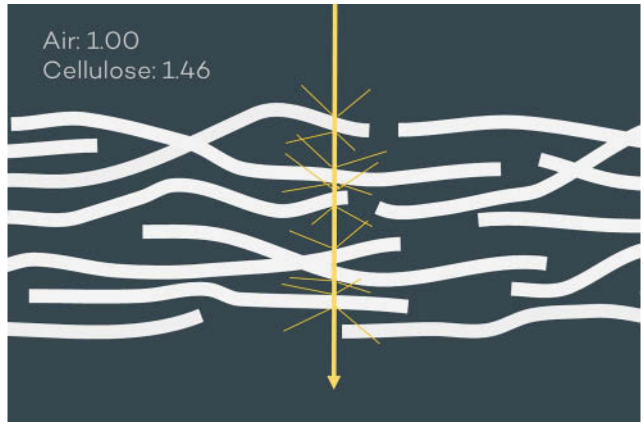


Fig. 3. A beam of light encounters many scattering surfaces as it attempts to transmit through a disordered medium like paper.

forth between air and cellulose a large number of times. (This is complicated even more by nonuniformities within the fibers, which present more transitions.) Each transition presents the potential for scattering. When confronted with dozens of layers of fibers, there is little chance for each wave of light to make its way through a sheet of paper (fig. 3). A beam of light that hits paper gradually diminishes in intensity as it penetrates the layers in a process called "attenuation" (Tilley 2011).

HISTORICAL PRODUCTION OF TRANSLUCENT PAPERS

In the vast majority of its use, opacity is a desirable quality in paper. Printers need to be able to place text on both sides of a leaf without it showing through to the other side. But for use as tracing paper or overlay, papermakers have found means of making paper more transparent. "Translucent paper" is used here as an umbrella term for any paper that has had its opacity reduced through in-production means. Detailed explanations of these processes, as well as means of categorization and identification, are available in several other articles (Bachmann 1983; Homburger and Korbel 1999; Laroque 2000). The four primary historical methods of transparentizing are as follows:

Fig. 2. A damaged translucent plate from the *Wasmuth Portfolio*.

1. Impregnating: Following formation of the sheet, the paper is coated with oil, resin, or wax that fills the light-scattering interstices between the fibers. This was the earliest method widely used (Bachmann 1983).
2. Acid treatment: An acid bath (typically sulfuric acid) causes a colloidal cellulose layer to coat the fiber web and fill the light-scattering interstices. This was a mid-19th-century development (Homburger and Korbel 1999).
3. Overbeating: The pulp is beaten for a longer period than normal. The fibers in the formed sheet are more fibrillated (interconnected), and, with this higher Relative Bonded Area (RBA), there are fewer light-scattering interstices present. This method came about in the late 19th century (Homburger and Korbel 1999).
4. Calendering (or supercalendering): This is done in combination with other processes; it encourages greater interconnectivity of the fibers and tends to give the paper a glossy surface (Laroque 2000).

The overarching theme of these methods is the formation of a more cohesive, interconnected sheet. In a sense, the goal is to bring the sheet from the typical "web" structure of paper towards more of a homogeneous "film" to avoid the scattering of light.

TREATMENT OF TRANSLUCENT PAPERS

As a result of these production methods, translucent papers possess several unique sensitivities, which can vary wildly by category. Some are highly hygroscopic and sensitive to polar solvents and may expand and warp dramatically in their presence (Van der Reyden, Hofmann, and Baker 1993). Others may resist the absorption of water due to their film-like quality or due to the presence of impregnating agents (Page 1997). Impregnating agents can also be disturbed by solvents, making those papers susceptible to loss of transparency (Van der Reyden, Hofmann, and Baker 1993).

An extensive literature review of the treatment of translucent papers was published in 2000 by Claude Laroque in *Studies in Conservation* Volume 45 (International Institute for Conservation of Historic and Artistic Works). This project will not present its own literature review of translucent paper treatment to avoid repetition. Needless to say, a very wide range of treatments have been explored in the past, from standard "wet" linings with wheat starch paste to reactivated precoated tissues (reactivated with either solvent or heat). The adhesives and carriers used by conservators have ranged from the more traditional (starch pastes, proteinaceous glues; Japanese tissues) to the modern (polyvinyl acetates, acrylic-based adhesives; nonwoven nylon). Maintenance of transparency is an aspect of treatment that has mostly been treated in qualitative terms. This is likely due to availability of equipment and a reliable testing method. One previous article included quantified opacity measurements of modern tracing papers, and characterized changes in opacity in response to various solvents (Van der Reyden, Hofmann, and Baker 1993). But increases in opacity due to the application of repair tissues have not been the focus of these studies.

Adding material to translucent papers, as in mending or lining, will inevitably increase the opacity of the treated area. This issue has previously been approached through the use of extremely lightweight Japanese tissues. The great length and strength of kozo fibers allows for a sheet with very low mass with relatively high durability. The low mass of the paper means there is less material for light to penetrate in transmitting through the paper. This follows basic logic: the lower the mass of the repair tissue, the smaller the increase in opacity.

Recent developments in the production of nanocellulose have led to the introduction of nanocellulose papers into the conservation field, which have been proposed for the treatment of translucent papers. The nanofibrils or nanocrystals that compose these papers are of such small size (10–20 nm in diameter, 2 μm in length) that interstices between the fibers are reduced enough to avoid the scattering of light (Dufresne 2012; Hu et al. 2013). Papers made from a combination of Japanese fibers and nanocellulose are also available, as in Bacterial Cellulose (BC) paper made by Gangolf Ulbricht.

OPTICAL CLEARING

This project seeks to establish another means of achieving low opacity in repair tissues, and borrows the concept of *optical clearing* from the fields of biology and medical research. Optical

Fig. 4. A clearing agent provides a bridge of easier transition between the fibers of a disordered medium.

clearing (also called refractive index matching) refers to the process of rendering biological tissues translucent through the application of *clearing agents*, which minimize the scattering of light and allow greater visibility for microscopy and imaging (Tunchin 2007). Much like paper, biological tissues are disordered media made up of networks of polymeric fibers. The ideal clearing agent has an RI similar to that of the fibers; the agent replaces the air between the fibers and serves as a "bridge" of easier transition for the light (fig. 4). The closer the refractive indices of the fiber and clearing agent, the less chance for scattering (Saarela et al., 2008). The historical transparentizing method of impregnation is itself an optical clearing process.

Though the term may be unfamiliar, optical clearing is something that conservators encounter on a regular basis. The tendency of repair tissues to become transparent when wet with paste is an optical clearing process, with water serving as the primary clearing agent. This project seeks to explore the possibility of a more permanently and efficiently cleared state. The ideal coating would serve dual functions: reactivatable adhesive and optical clearing agent.

TESTING

OPACITY MEASUREMENT

Opacity readings for this study were taken using an X-Rite i1Basic Pro 2 spectrophotometer, in conjunction with Color Translator & Analyzer (CT&A) software by BabelColor. The system uses a Contrast Ratio Opacity (OP) measurement, as defined by ISO 2471. Measurements are taken via two consecutive readings: first, with the sample placed over a white (highly reflective) backing; second, with the sample placed over a black (highly absorbent) backing. The spectrophotometer measures the brightness of each, and performs the following function:

$$\text{Opacity (Y)} = \frac{Y\ (black)}{Y\ (white)} \times 100.$$

This function provides the opacity measurement, expressed as percentage opacity (e.g., a fully opaque material would have an opacity of 100%).

A white/black backing was fashioned in-house for the opacity measurements in this project. Teflon film, which provides 99% reflection across the visible spectrum, was used for the white backing. A black cavity, as described by ISO 2471, was made for the black backing; this was constructed out of thick mat board, painted black, with a hole the size of the spectrophotometer lens cut into it, adhered to a piece of board coated with Avian Black-S Coating by Avian Technologies, LLC (fig. 5). This provides a near 0% reflection across the visible spectrum.

A Note on Percentage Opacity vs. Percentage Change

Some figures in this project are expressed as percentage opacity, and others as percentage change in opacity. These can be confusing. A repair tissue with a starting opacity of 20% can be optically cleared to an opacity of 2%; this means a reduction of 18% opacity, which is a decrease of 90% of its original opacity (or a "percentage change" of –90%).

Fig. 5. The white/black backing fashioned for the Contrast Ratio Opacity measurements.

Similarly, a substrate with a starting opacity of 50% can be increased to 55% following the application of a mend; this is a 5% opacity increase, and a percentage change of +10%. When it comes to affecting the visual appearance of a substrate, it is percentage change in opacity that really matters. A substrate with a starting opacity of 20% is far more affected by a 5% increase than a substrate with a starting opacity of 75%; the first would have a percentage change of +25%, the second a change of +8.3%.

TEST 1: OPTICAL CLEARING WITH CONSERVATION ADHESIVES AND COATINGS

The first test conducted was designed to measure the optical clearing efficacy of a variety of adhesives and coatings commonly used and trusted in book and paper conservation. The test also sought to determine what conservation repair papers are most effectively cleared.

Methodology

Seven tissues were included in this test. Five relatively lightweight Japanese repair tissues were selected that exhibit an array of qualities: a lightweight white kozo paper (Tengujo 5g); a colored kozo paper (Somegami 5g); a medium-weight white kozo paper (Uso Mino 12g); a lightweight gampi paper (Usuyo 11g); and a medium-weight gampi paper (C-Gampi 16g). Also included were two papers that incorporate nanocellulose materials. A film made purely of nanofibrillated cellulose was acquired from Innovatech (henceforth referred to as MFC, short for microfibrillated cellulose). The seventh paper tested was BC Tissue by Gangolf Ulbricht, a paper made from a combination of bacterial nanocellulose and kozo/mitsumata fibers. This paper is specifically marketed for the treatment of transparent papers (Seger and Kochendörfer 2015).

Samples were cut at 3 cm^2 and divided into groups: three samples of each tissue for every adhesive to be tested. All samples were measured for opacity using the contrast-ratio method. The samples were then coated with their corresponding adhesives,[1] allowed to dry, and then measured for opacity a second time (figs. 6 and 7).

Results

The two most successful optical clearing agents tested were Plextol B500 (fig. 8) and Avanse MV-100, the two adhesives described for preparing heat-set tissue by conservators at the National Archives and Records Administration (NARA) in their article on that subject (Varga, Herrmann, and Ludwig 2015). Plextol caused an average percentage change of –65%. The very lowest reading in all the samples occurred in the BC Tissue coated in Plextol at a mere 1.5% opacity (fig. 9).

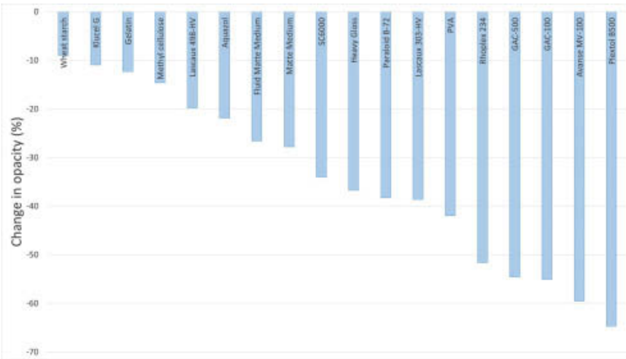


Fig. 6. The results from Test 1, condensed in terms of average percentage change in opacity by coating, in order of least effective to most effective.

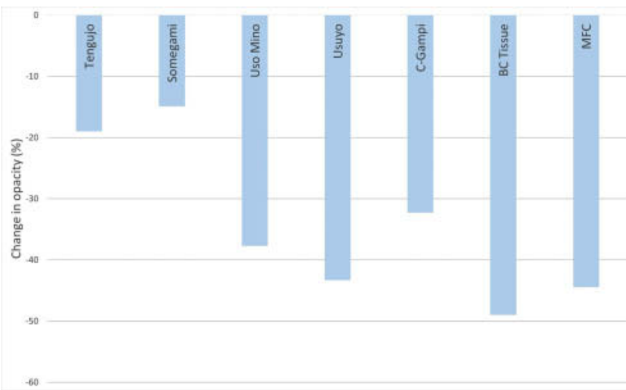


Fig. 7. The results from Test 1, condensed in terms of average percentage change by paper type.

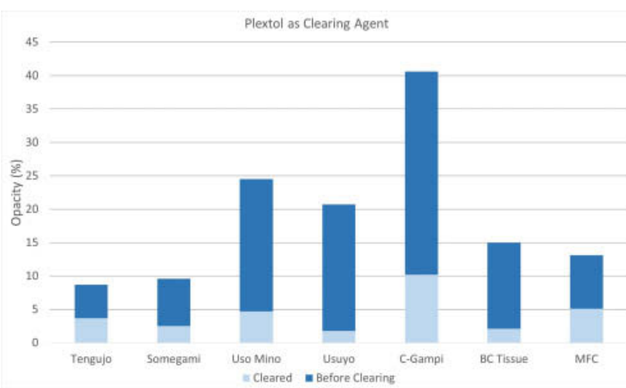


Fig. 8. The results of the most effective clearing agent, Plextol B500. The darker segments of the bars are the papers' original opacities, and the lighter segments are the optically cleared opacities.

The two papers that incorporate nanocellulose exhibited the greatest flexibility in opacity. Where the solution-based adhesives (e.g., methyl cellulose) caused little change in the traditional papers, they successfully cleared the nanocellulose papers. BC Tissue performed the best overall, with an average drop of nearly 50% across all adhesives. The largest individual decrease in opacity occurred in the Usuyo gampi paper coated with Plextol, which dropped by over 90% of its original opacity (fig. 10).

Plextol and Avanse were followed by GAC-500, GAC-100, and Rhoplex AC-234, all of which are acrylic dispersions. Acrylic-based adhesives proved to be the most effective in lowering the opacity of repair tissues. Acrylic dispersions have fantastic film-formation properties, meaning their drying process results in very cohesive, even films, free of voids and irregularities (Chorng-Shyan 2008; Lovell and El-Asser 1997).

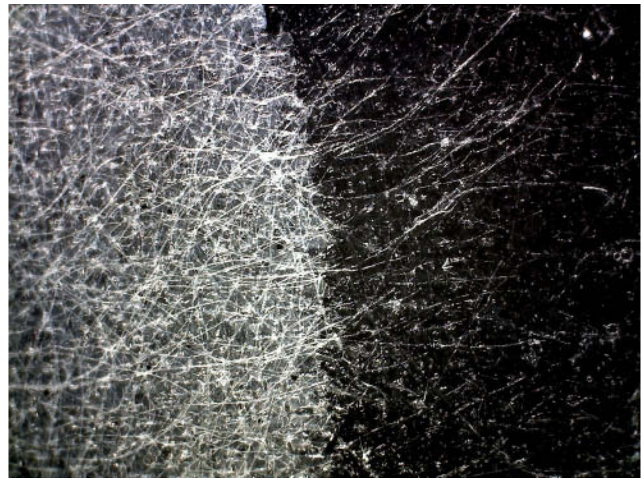


Fig. 9. A sample of BC Tissue over a black background (140× magnification). The left side is uncoated, and the right side has been optically cleared with Plextol B500.

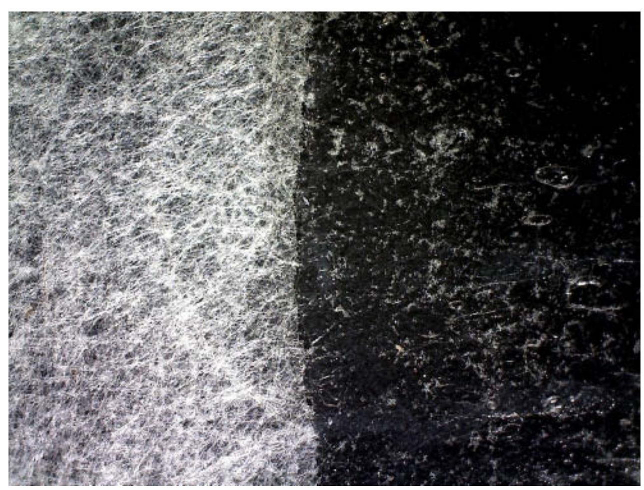


Fig. 10. A sample of Usuyo gampi over a black background (140× magnification). The left side is uncoated, and the right side has been optically cleared with Plextol B500.

This is ideal for the optical clearing process, where the goal is to disperse all air from the paper web. The RIs of all acrylic components fall within a very close range of the cellulose RI,[2] so an effective match is achieved for smoother transitions between fibers. Acrylic polymer chains are highly irregular, with bulky branches and side groups. Because they cannot be packed into crystalline formations, they form isotropic and 100% amorphous films, making them ideal for light transmission, with no crystalline areas to cause scattering (Seymour and Carraher 1984; Chorng-Shyan 2008).

Of the traditional repair papers, the gampi tissues showed a much greater flexibility in opacity. For example, whereas Tengujo had a starting opacity (average 9%) significantly lower than the Usuyo (average 20%), the Usuyo opacity consistently dropped below that of Tengujo after coating. Gampi tissues exhibit a higher RBA—their fibers are more interconnected with smaller interstices, and the fibers are much smaller than the highly visible kozo fibers.

The opacity of the nanocellulose papers proved to be more flexible than the traditional papers and reacted differently to some of the coatings. Where the nonacrylic adhesives did little to reduce opacity in the Japanese tissues, there was success in clearing the BC tissue with Aquazol (–61.6%). Similarly, the MFC was successfully cleared with gelatin (–49.13%) and Aquazol (–63.4%).

It was assumed that the MFC would clear the most successfully and achieve the lowest opacities, but this was not the case across all adhesives. Whereas the MFC achieved the lowest readings in the solution-based adhesives (wheat starch paste, methylcellulose, Aquazol, Klucel G), it cleared less with dispersion-based adhesives (Jade 403, acrylics). This may be due to the size of the particles in polymer emulsions, which may be too large to effectively penetrate the microscopic interstices between the MFC's microfibrils.

Only one of the adhesives dramatically *increased* sample opacities: Rhoplex AC-73 (average +62.1%). This is certainly due to the minimum film-formation temperature (MFT) of this acrylic dispersion, which is 37°C (98.6°F). All coatings were applied at room temperature (72°F), and the AC-73 subsequently dried to a brittle, opaque crust. When applied to the Usuyo gampi tissue over a hot plate set to 80°C, the Rhoplex AC-73 did successfully lower the opacity of several samples to a degree visually comparable to some of the other acrylic dispersions.

Lascaux 498-HV, which is perhaps the most commonly used acrylic adhesive in book and paper conservation, did not perform well in comparison to other acrylic dispersions, resulting in an average 20% decrease in opacity across all papers. It was outperformed even by the matte mediums, which contain light-scattering agents. Following the success of the heated Rhoplex AC-73 application, a similar test was performed with Lascaux 498-HV. With its MFT at 5°C (41°F), a film-formation temperature higher than room conditions may help with the adhesive's clearing efficacy. A small amount of diluted 498-HV was heated to 80°C and applied to samples of the Usuyo gampi tissue, which were also kept warm over a hot plate. The clearing was improved from a mere –10% at room temperature to –55%.

TEST 2: DILUTION AND OPACITY

It is standard practice to apply precoating adhesives to repair tissues in highly diluted states. This is done to obtain a coating that is as thin as possible upon drying while still achieving appropriate adhesive ability. A coating that is too thick can cause unwanted aesthetic effects (gloss) as well as tackiness and excessive adhesive penetration into the treated substrate. In Test 1, all adhesives were applied in relatively thick states to avoid variables and to observe the greatest potential for clearing. All of the acrylic adhesives, for example, were applied entirely undiluted.

The Avanse/Plextol recipe laid out by Varga, Herrmann, and Ludwig calls for a 4:1:1 mixture, with four parts water diluting one part Avanse MV-100 and one part Plextol B500. At the time, their study found this to provide the ideal coating to avoid tack and sheen while still achieving adequate adhesion (Varga, Herrmann, and Ludwig 2015) on most papers.

Methodology

A simple test was devised to observe the effects of dilution on the optical clearing capabilities of the top-performing clearing agents, Avanse MV-100 and Plextol B500. Six ratios of the Avanse/Plextol mixture were made: a 1:1 undiluted mixture, followed by five increasingly diluted mixtures (1:1:1, 2:1:1, 3:1:1, 4:1:1 and 5:1:1). Each ratio was applied to five samples of the Usuyo gampi tissue (this tissue showed the greatest percentage change in opacity for both Avanse and Plextol). The adhesive mixtures were applied by brush to both sides of one half of each 3 cm × 3 cm^2 sample. These were allowed to dry on a silicone baking sheet for 2 hours at room conditions (72°F, 40%RH). Two opacity measurements were then taken on each sample using the Contrast Ratio Opacity method. One reading was taken in the center of the coated area, and one reading was taken from the edge of the coated area; this was done to capture the variation in coating that occurred across the surface of the samples—the more dilute mixtures dried to uneven coatings.

Results

As expected, there was an obvious trend in the results, with a direct relationship between coating thickness and optical clearing efficacy (fig. 11). However, the decrease in clearing capability was less dramatic than expected within the first few levels of dilution; even at the 3:1:1 mixture, the Avanse/Plextol recipe was able to clear the Usuyo by 75% of its original

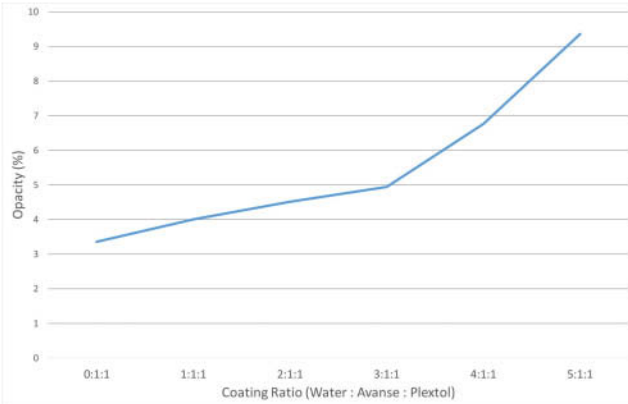


Fig. 11. The results from Test 2, showing a direct relationship between coating thickness and optical clearing efficacy.

opacity. Beyond this level of dilution, though, there is a definite upswing in opacity. When diluted beyond a certain degree, the dispersed polymer particles are interrupted by too much water and are unable to coalesce. Instead of a continuous film, a speckled pattern is formed within the cellulose web (fig. 12).

TEST 3: GLOSS AND OPACITY

There is a direct relationship between the efficacy of clearing agents and the resulting gloss of the cleared tissue. All of the most successful clearing agents in Test 1 also caused a significantly glossy surface. Acrylic dispersions form coherent films with very smooth surface topography; this extreme smoothness encourages both transmission and specular reflection of light (Tilley 2011).

Some acrylic media are designed to produce a relatively matte finish with the addition of a light-scattering substance (often a silica dust). Two matte mediums made by Golden Artist Colors were included in Test 1: Matte Medium and Fluid Matte Medium. These proved to be moderately effective clearing agents (both performed better than Lascaux 498-HV, for example).

Methodology

A test was devised to establish the relationship between gloss and transparency across varying mixtures of acrylic adhesive and acrylic matte medium. The test followed a similar procedure to the dilution/opacity test (Test 2): eight mixtures of matte/adhesive medium were made with an increasing ratio of matte acrylic medium to glossy acrylic adhesive (0:1, 1:4, 1:2, 1:1, 3:2, 2:1, 4:1, 1:0). Each mixture was applied by brush to both sides of five 3 cm × 3 cm$^{(2)}$ samples of the Usuyo gampi tissue. These were allowed to dry on a silicone baking sheet for two hours at room conditions (72°F, 40%RH). Two opacity measurements were then taken on each sample using the Contrast Ratio Opacity method. One reading was taken in the center of the coated area, and one reading was taken from the edge of the coated area (fig. 13).

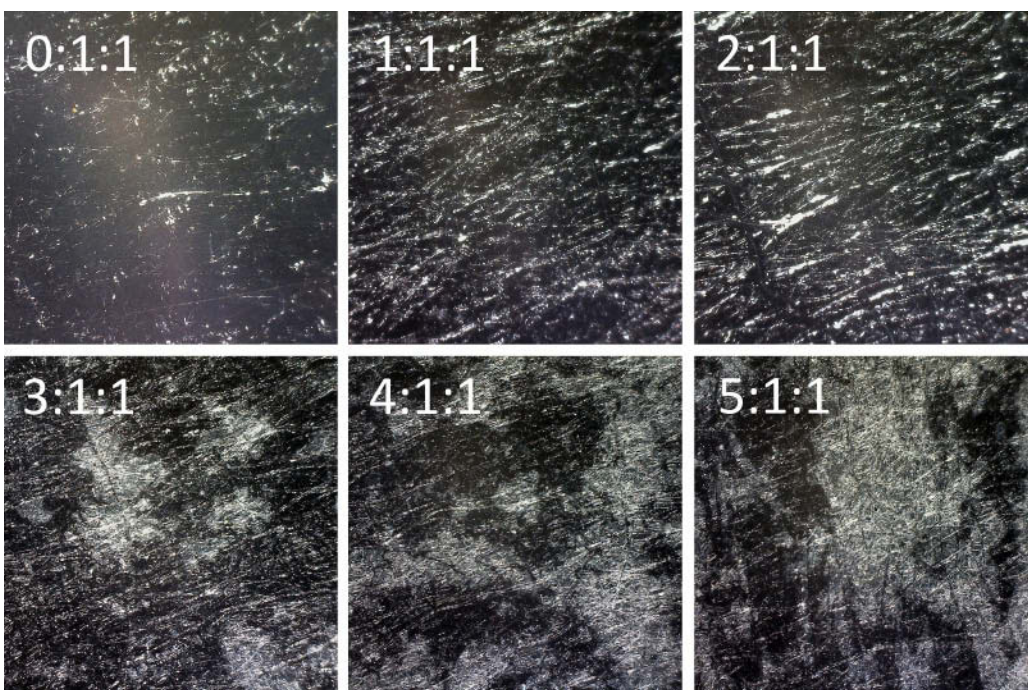


Fig. 12. Samples from Test 2 (140× magnification). A speckled pattern of uncoated fibers forms on the diluted samples.

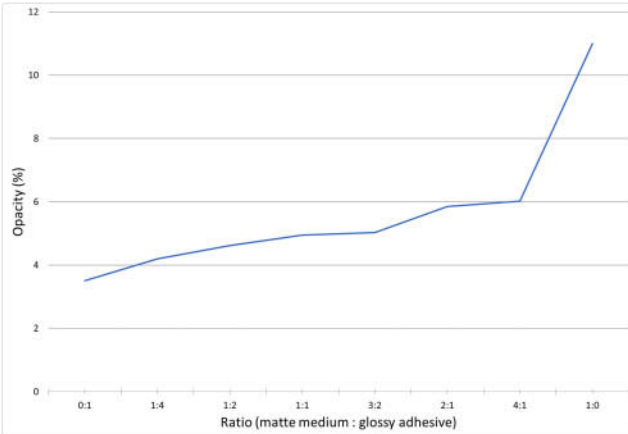


Fig. 13. The results from Test 3, showing a direct relationship between coating gloss and optical clearing efficacy.

Following the readings, the samples were photographed in raking light to capture a qualitative assessment of their glossiness (fig. 14).

Results

The resulting upward trend in opacity was less pronounced than expected—even the 4:1 mixture, with four times as much matte medium than glossy adhesive, remained at a relatively low opacity (6%, compared to the Usuyo tissue's original 20% opacity). The opacity nearly doubled between the 4:1 (6%) and 1:0 (11%) samples.

TEST 4: LIGHT-AGING AND OPACITY

The tendency of acrylic media to yellow over time, especially when stored in dark environments, is well documented (Whitmore and Colaluca 1995; Whitmore, Colaluca, and Morris 2002; Jablonksi, et al. 2003). Increases in turbidity have also been documented in acrylics. This may be caused either by the formation of crystallized particles within the acrylic film or by the migration of surfactants to the film's surface (Whitmore, Colaluca, and Farrell 1996; Hayes, Golden, and Smith 2006). Though many of the acrylic adhesives used in this study have been extensively tested and proven to have acceptable aging characteristics, it was determined necessary to observe the longevity of the clearing effects of these materials in relation to yellowing and turbidity.

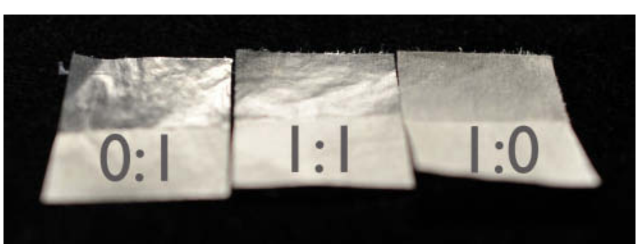


Fig. 14. Three samples from Test 3, showing the increase in gloss as the ratio of matte medium increases.

Methodology

Thirty samples of 3 cm^2 were cut from the Usuyo gampi paper. Fifteen samples were assigned to each of the two adhesives/coatings selected for aging: Plextol B-500 and Avanse MV-100. The samples were coated and divided into three groups: five of each adhesive to be dark-aged, five of each to be aged in sunlight, and five of each to be aged under fluorescent light. All samples were measured for opacity using BabelColor CT&A and for color profiling using X-Rite i1Profiler. Fifteen of the samples were also measured in their uncoated areas to obtain color-change information for the Usuyo tissue itself.

Three aging supports were cut from archival board and labeled. A sheet of silicone-coated polyester film, cut to the same size, was adhered to the board on the two vertical edges with double-sided tape. V-shaped slits were cut into the polyester film to serve as holding notches, so that each sample could be held in place without being adhered or covered. Opacity and color measurements (L*a*b*) were taken of all samples prior to aging. One aging support was placed in an archival box and stored in a cabinet (dark aging), one was placed under a fluorescent light in 24/7 operation (fluorescent aging), and one was placed in a southeast facing glass window (daylight aging). Each aging support was accompanied by a blue wool standard (BWS). Color profiling measurements were taken of each BWS prior to aging.

Each sample was measured for opacity (BabelColor CT&A) and color profile (X-Rite i1Profiler) every 30 days. Exposed (uncoated) areas of the Usuyo tissue were also measured for color profile to factor in any changes occurring within the paper itself. To obtain color-change information, the profiling information for each month's readings were compared to that of the 0-day readings using the i1Profiler data analysis software, which generates a L*a*b* delta E* ($\Delta E^\star$) figure for each sample. (It is typically said that a distinguishable change in color begins at $\Delta E^\star$ 1.0, though a 2.0 indicates readily noticeable color change).

Results

In terms of color change, the Avanse MV-100 performed very well; none of the color changes in any of the three exposures reached $\Delta E^\star$ 1.0 (fig. 15). Plextol B500 exhibited a small amount of color change; the samples exposed to daylight reached $\Delta E^\star$ 2.0 at 120 days and then stabilized (fig. 16). These changes occurred as a *decrease* in yellow tones. This change was exhibited even more strongly in the light-exposed Usuyo; both the fluorescent and daylight samples surpassed

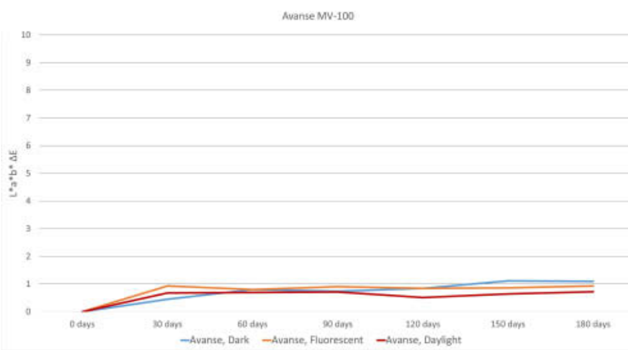


Fig. 15. Color change observed in the Avanse samples, in terms of $\Delta E\star$.

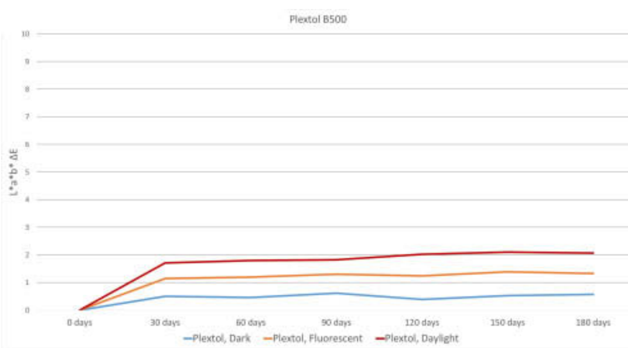


Fig. 16. Color change observed in the Plextol samples, in terms of $\Delta E\star$.

$\Delta E\star$ 2.0 after 60 days, indicating light-bleaching. It is possible, then, that any color change observed in the coated samples was occurring in the paper itself, rather than in the coating.

In terms of opacity, Avanse exhibited more change, with a slight increase in opacity observed in the light-exposed samples. The daylight-exposed samples increased from an average of 2.26% to 6.04% over 180 days (fig. 17). This change was noticeable to the naked eye; there was a clear turbidity increase in the light-aged Avanse samples (fig. 18). This haziness could be caused by the migration of emulsifiers to the film's surface, or by oxidation and scission of the polymer chains, causing the formation of micropores (Jablonski et al. 2003; Hayes, Golden, and Smith 2006). It should be noted, however, that this decreased opacity is still far lower than the 20% average for the uncleared Usuyo. The dark-aged samples exhibited a negligible amount of change.

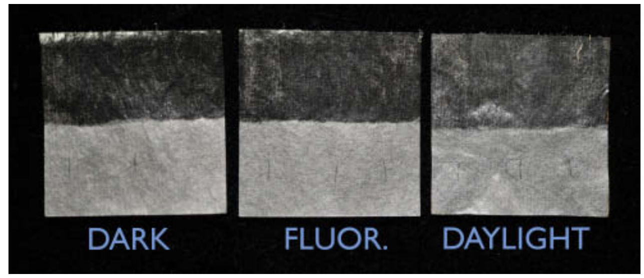


Fig. 18. Avanse samples, seen after 120 days of aging.

The Plextol samples proved far more stable in terms of opacity (fig. 19). Though there was a very small increase in average opacity in the daylight-aged samples (1.48% to 2.51%), all of the readings taken were within the normal range of a newly coated sample.

TEST 5: APPLICATION METHOD AND OPACITY

As demonstrated by Test 1, conservation adhesives can be used to dramatically decrease the opacity of repair tissues. The last test series was designed to illustrate the effectiveness of optical clearing in the context of application to translucent substrates. The goal was to compare the effect of using optically cleared tissues to some other common repair application methods.

Methodology

Two modern transparent papers were selected: an interleaving tissue with a matte surface and a glassine with a glossy surface. These were cut to 10″ × 10″ and divided with pencil

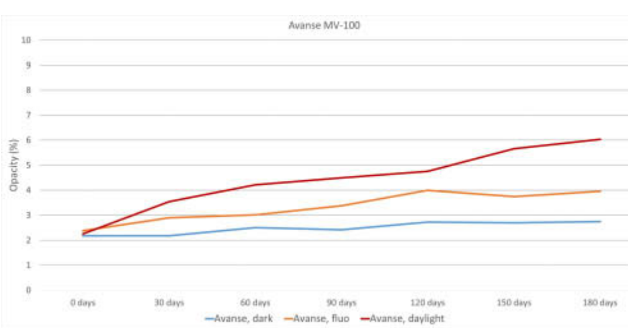


Fig. 17. Opacity change observed in the Avanse samples.

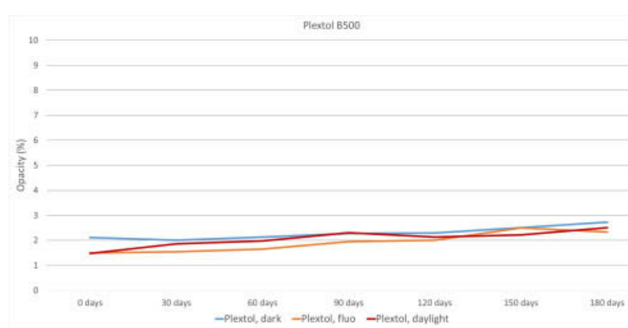


Fig. 19. Opacity change observed in the Plextol samples.

into 25 boxes—five columns of five boxes each. Five treatment methods were selected for testing:

1. Wet application with wheat starch paste, using the 10% recipe of standard use in the Northwestern laboratory, dried under weight with blotter and Hollytex.
2. Tissue precoated with a 50/50 wheat starch paste/methyl cellulose mixture, reactivated with gellan gum and dried under weight with blotter and Hollytex.
3. Tissue pre-coated with Klucel G (1%), reactivated with a 50/50 ethanol/acetone spray over a suction table (as described by Susan Page in her 1997 BPG *Annual* article).
4. Tissue pre-coated with a 4:1:1 mixture of water/Plextol B500/Avanse MV-100 (as described by Varga, Herrmann and Ludwig in their 2015 BPG *Annual* article), reactivated with a tacking iron.
5. Tissue precoated and optically cleared with a 1:1:1 mixture of water/Plextol B500/Avanse MV-100, reactivated with a tacking iron.

Prior to treatment application, opacity readings were taken of the transparent papers in the areas to be treated. The interleaving tissue and glassine had average opacities of 28% and 30.6%, respectively.

All five of the treatments were executed using BC tissue by Gangolf Ulbricht, as this tissue achieved the lowest opacity readings in the optical clearing test. All treatments were applied with samples of BC tissue cut to 1” × 1”. Following treatment, two opacity measurements were taken of each treated area: one in the center and one at the sample edge (fig. 20).

Results

There were consistent differences in the final opacities of the treated areas, which could be clearly seen with the naked eye (fig. 21). The tissues precoated with Klucel G and applied over the suction table resulted in the greatest increase in opacity, adding over 8% opacity to both the interleaving tissue and glassine (percentage change of +29% and +28%, respectively). The optically cleared tissue resulted in the smallest increase in opacity, adding 2.3% to the glassine and a mere 0.6% to the interleaving tissue (percentage change of +7.6% and +2%, respectively). An abbreviated sample was made to demonstrate the dramatic effects of optical clearing. Two small rectangles of Usuyo gampi tissue were applied to a piece of glassine. The first was adhered with wet wheat starch paste

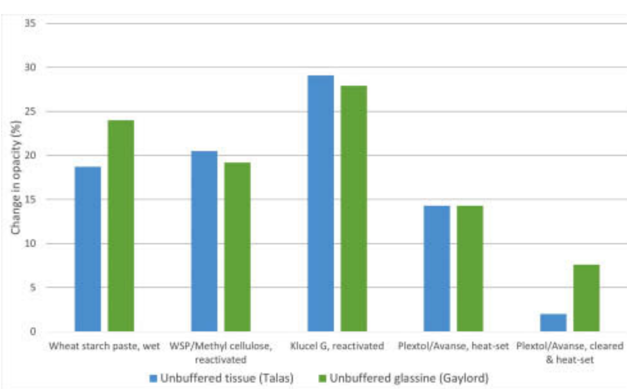
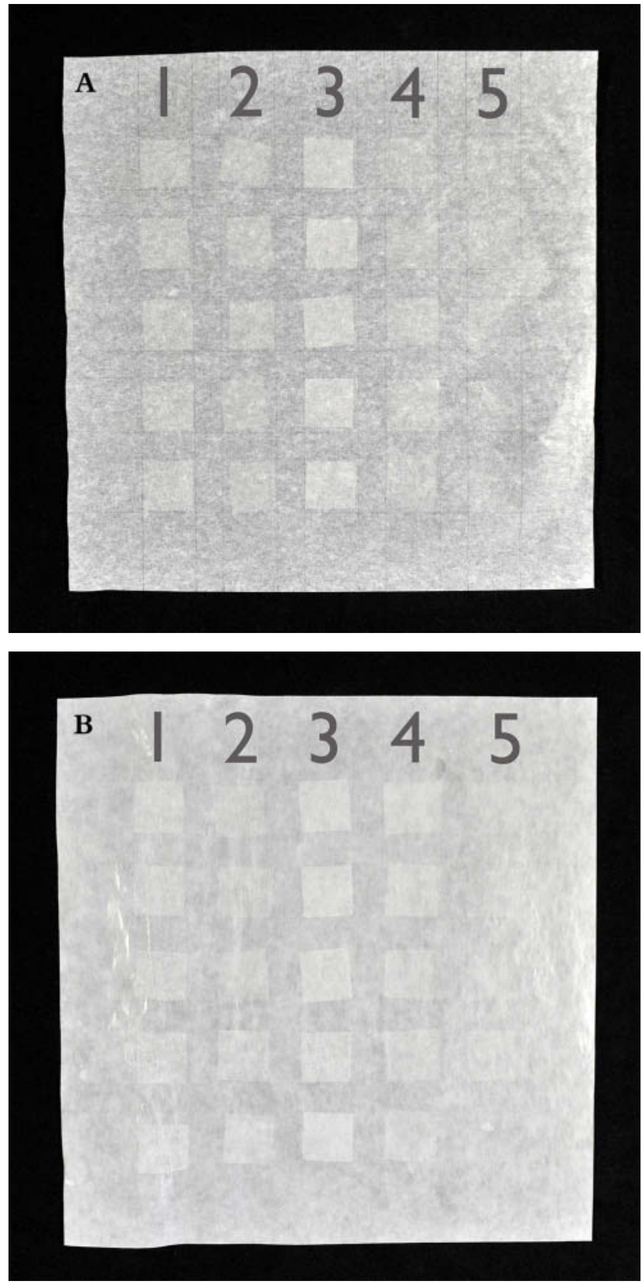


Fig. 20. Results from Test 5, viewed in terms of percentage change in opacity.



Figs. 21a and 21b. The BC Tissue samples from Test 5, applied to their respective substrates with a variety of methods. There are obvious differences in the resulting opacities. The rightmost columns (#5) are the optically cleared samples.

(10%) and dried under weight. The second was optically cleared with Plextol B500 and adhered with a tacking iron. The mend applied with wheat starch paste caused an increase in opacity of 18%, while the optically cleared mend caused an increase of only 2.5% (fig. 22).

PRACTICAL APPLICATION

MAKING AND APPLYING OPTICALLY CLEARED TISSUE

It is fortunate that the two adhesives proving to be the most successful clearing agents in Test 1—Plextol B500 and Avanse MV-100—are also the two acrylic adhesives described for heat-set tissue by conservators at NARA, published in a 2015 article in the *Book and Paper Group Annual*. At the time, their research found the Plextol/Avanse recipe to function well in terms of adhesion, visual cohesion, off-gassing, reversibility, and aging (Varga, Herrmann, and Ludwig 2015).

Their recommended instructions for making the pre-coated tissue involve placing the repair tissue (a lens tissue or kozo paper) over a silicone-coated polyester film, and using a screen to squeegee the adhesive mixture (4:1:1 water/Plextol/Avanse) onto the tissue. The coated tissue is then allowed to dry adhesive side up on the polyester film.

A different process was used to make the optically cleared tissues in this project. A less dilute mixture of the adhesives is used, as the dilution test (Test 2) showed that a highly dilute mixture loses its clearing efficacy. A 2:1:1 mixture was found to be ideal for this project. The lens/kozo tissue is replaced with Gangolf Ulbricht's BC Tissue for its superior clearing ability and relative handling strength.

Typically, the goal in making precoated tissues is to apply the adhesive only to the surface of one side of the repair tissue

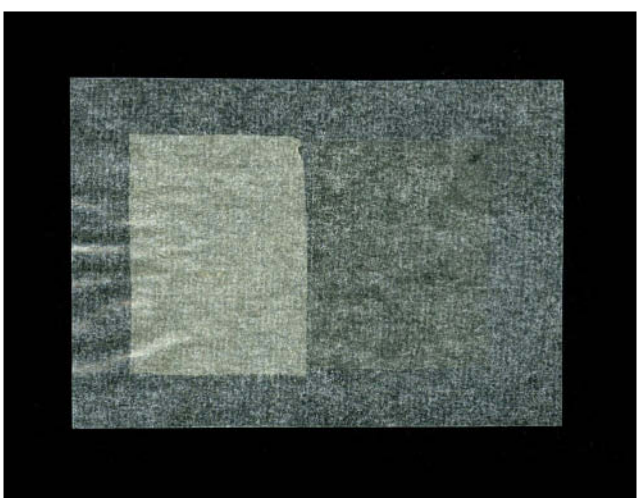


Fig. 22. The abbreviated method application test. On the left side, the Usuyo gampi tissue was applied with wet wheat starch paste. On the right side, the Usuyo gampi tissue was optically cleared with Plextol and applied with heat.

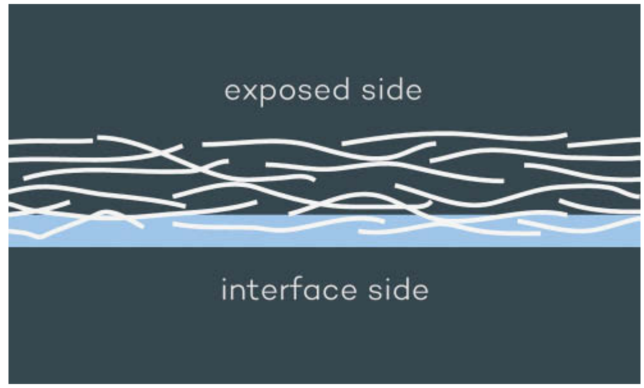


Fig. 23. The cross-section of a typical precoated tissue, with the adhesive restricted to the interface side.

(fig. 23). This avoids having any exposed adhesive following application. For optically cleared tissue, however, the adhesive needs to penetrate the paper web in order to diminish light-scattering interstices. The ideal optically cleared tissue would have the adhesive coating one side of the tissue (the repair-interface side), penetrating the remainder of the tissue, but not coating the opposite side of the tissue (the outward-facing side). The ideal coating would be very thin, but nonetheless forming a cohesive film within the cellulose web (fig. 24). To achieve these qualities, the following "mini-*hikkake*" method was used for this project, mimicking the traditional Japanese technique for applying paper linings with a drop-stick:

1. The tissue is cut into small, easily handled strips (roughly 15cm × 6cm).
2. The tissue is placed onto silicone-coated polyester, which is itself placed over a dark surface. The dark surface allows greater working visibility.
3. A bamboo skewer is placed under one short end of the tissue strip. This will function as the mini-*hikkake* (or drop-stick).
4. Using a flat brush, the adhesive mixture is brushed onto the tissue, starting at the *hikkake* and moving outward.

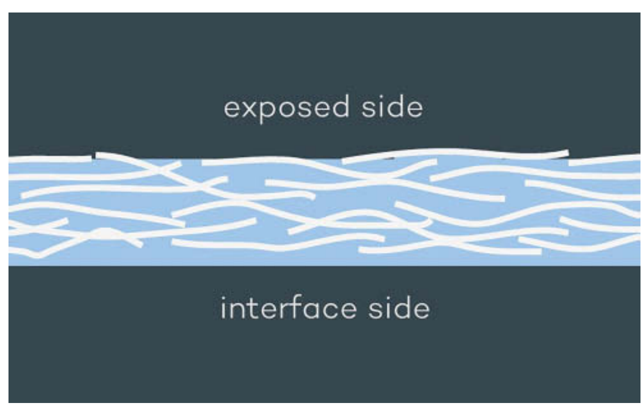


Fig. 24. The cross-section of an optically cleared tissue, with the adhesive fully penetrating the fiber web.

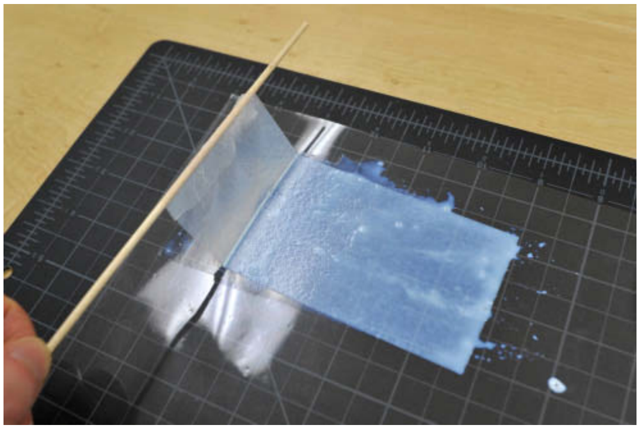


Fig. 25. Using the "mini-hikkake" to flip the coated tissue.

The small size of the tissue strip allows adhesive application without prior humidification, which can disturb the acrylic film-formation.

5. Using the mini-*hikkake*, the tissue is lifted, flipped, and placed adhesive-side down onto the silicone-coated polyester (fig. 25).
6. A dry brush is used to smooth wrinkles and disperse air bubbles.
7. *Optional:* When partially dry (roughly 3 minutes after flipping), a Teflon folder is used to burnish the tissue to redistribute and flatten the adhesive, or to remove excess adhesive if necessary.

With this coating method, the adhesive side of the tissue dries against the polyester film. The opposite side (the outward-facing side) has no directly applied adhesive, and dries to a more matte surface.

The coated tissue can remain on the silicone-coated polyester until usage. The tissue is strong, easily adhered, and easily handled, so very thin strips (2–3 mm) function well (fig. 26). A tacking iron is used at a temperature of 100–150C° for application between sheets of silicone-coated release paper, and adhesion requires only about 5 seconds of heat application. The somewhat rough surface of the release paper helps to diminish the sheen of the mend.

TREATMENT

Optically cleared, heat-set tissues were applied to both of the objects introduced at the beginning of the article.

1. *Atlas Photographique de la Lune*: BC Tissue coated with 2:1:1 water/Plextol/Avanse, reactivated with a tacking iron (100 °C) between silicone-coated release paper.
2. "Wasmuth Portfolio": Somegami 5g coated with 2:1:1 water/Plextol/Avanse, reactivated with a tacking iron (100 °C) between silicone-coated release paper.

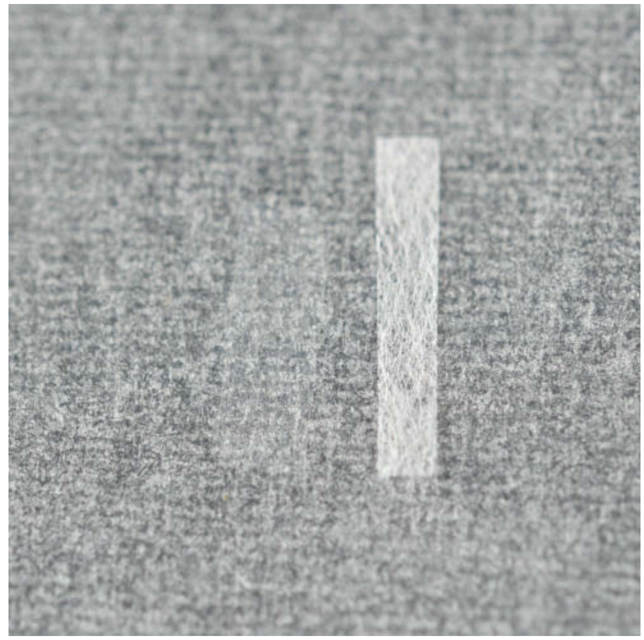


Fig. 26. A small strip of optically cleared tissue (left), adhered to a modern glassine. The sample is shown next to a strip of Tengujo of a similar size (right).

The cleared tissues are extremely easy to handle and quick to apply. The strength of the tissue/acrylic combination means that repair strips can be as narrow as 2 mm. This means that a little goes a long way: only one sheet (11.8″ × 16.5″) of the BC Tissue was used to mend all 25 of the tissues from *Atlas Photographique de la Lune* treated in this project.

The optically cleared mends are nearly invisible when viewed from a 90° angle (fig. 27), and, depending on the original opacity of the paper being treated, cause very little decrease in transparency.

REVERSIBILITY

As explored in the Varga, Herrmann, and Ludwig article, the Plextol/Avanse mixture can be reactivated with ethanol or acetone (Varga, Herrmann, and Ludwig 2015). These solvents can be applied passively with a vapor chamber.

The coated tissues were also found to be reversible using gellan gum as a poultice. In fact, this proved to be a much easier removal method. Though acrylic media is not soluble in water, films made from acrylic dispersions can be swelled with water. This may be due to the presence of surfactants that remain in the polymer film after drying. Surfactants possess both hydrophobic and hydrophilic ends (Chorng-Shyan 2008); their presence would allow water particles to soften the polymer network, enough for it to loosen its grip on the substrate fibers.

Optically cleared repairs that had been applied to interleaving tissue in Test 2 were removed with gellan gum

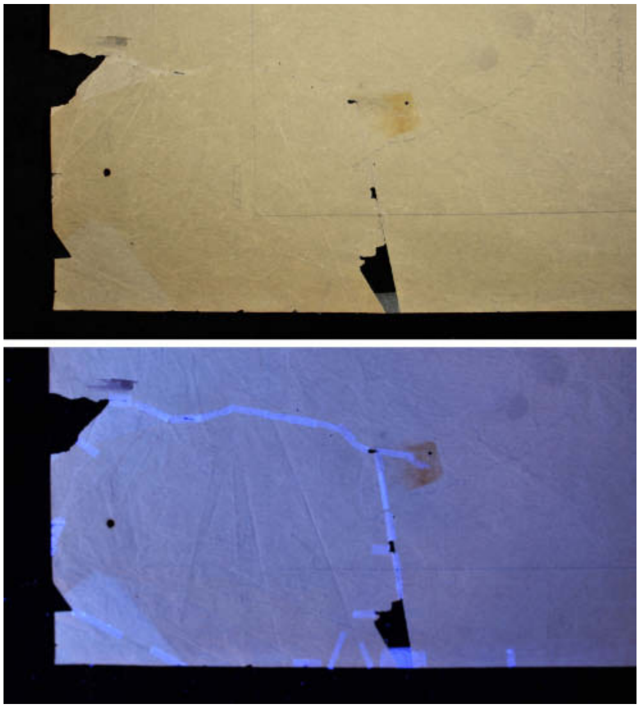


Fig. 27. A translucent overlay from *Atlas Photographique de la Lune*, viewed under visible light (top) and UV (bottom).

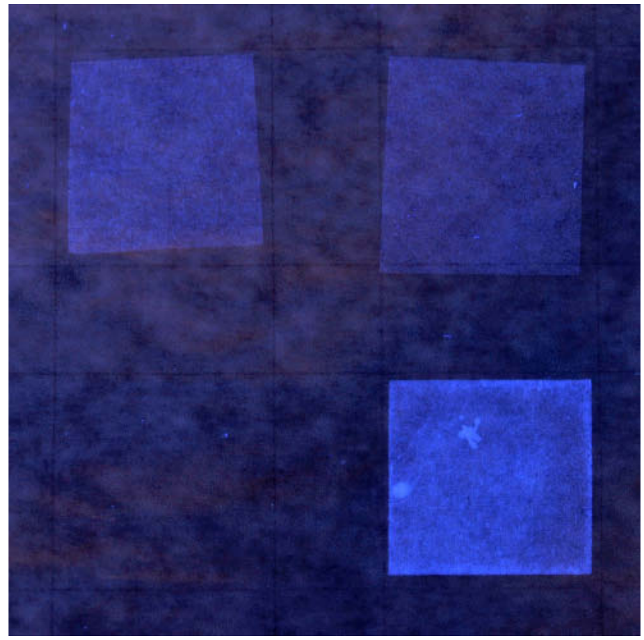


Fig. 28. Samples from the reversibility test, shown under UV. The lower left corner shows the area where an optically cleared repair was removed with gellan gum, leaving behind no residue.

following 2 months of aging. The gellan gum was cut to the same shape of the repairs and applied directly for 30 seconds, and the repairs came up cleanly. The hydrophobic nature of the film prevented any of the gellan's moisture to penetrate the substrate. Images taken under ultraviolet lighting before and after the removal showed no remaining residue on the substrate (fig. 28). Avanse MV-100 fluoresces under UV (Varga, Herrmann, and Ludwig 2015) and the repairs showed brightly before removal.

Because the thermoplastic adhesives in these repairs soften and conform to the surface of the substrate surface, rather than penetrating the substrate surface as in a wet application, the "reversibility" of heat-reactivated repairs may be considered superior to that of repairs applied wet, or even of precoated tissues reactivated with solvents. Scanning electron microscopy images were taken of repairs in cross-section. The adhesive was shown to conform to and "grip" the paper fibers, without significant penetration (fig. 29).

Further testing is required to determine whether this hydrophilic swellability is a temporary condition. Over time, cross-linking in the polymer network may prevent softening with water. The migration of surfactants to the acrylic film's surface may also decrease its swellability.

ALTERNATE RECIPES

Though the mini-*hikkake* coating method creates a less glossy tissue, conservators may find that they require an even more matte repair tissue—transparent papers vary in their own glossiness, so methods and recipes may need to change on a case-by-case basis for an aesthetic match. As observed in the gloss/opacity test (Test 4), matte acrylic mediums can be added to the acrylic adhesives to achieve a less glossy surface without greatly diminishing their clearing efficacy. They are also less tacky, so high-ratio mixtures may have a higher glass

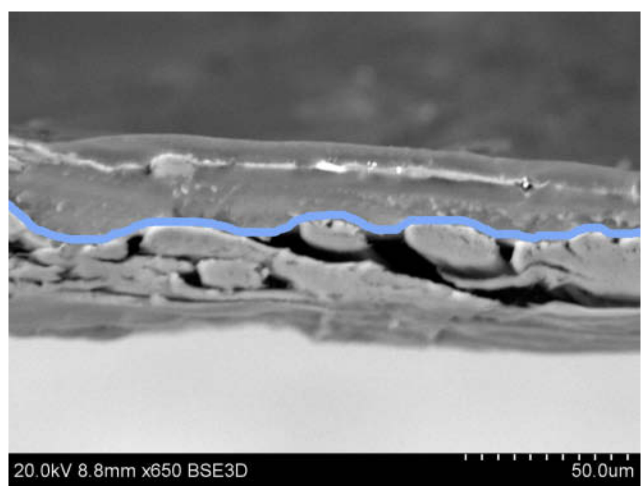


Fig. 29. A scanning electron microscope image of the cross-section of an optically cleared repair tissue (top) adhered to a modern interleaving tissue (bottom). The blue line shows the border of the acrylic adhesive, which lightly grips the fibers of the substrate without penetrating them.

transition temperature and require longer or higher heat application.

Though the acrylic dispersions proved the most effective clearing agents in general, other adhesives can make sufficient clearing agents, especially when applied to papers made with nanocellulose. MFC, which is a pure nanocellulose film, is extremely sensitive to moisture, and it can distort and break in the presence of water-based adhesives like acrylic emulsions. Aquazol proved to be the most efficient clearing agent for MFC. Because Aquazol is soluble in alcohols and is a thermoplastic, it could be used in conjunction with MFC for an effective optically cleared tissue.

A NOTE ON THE AGING PROPERTIES OF AVANSE AND PLEXTOL

Since the publication of their article on the subject, conservators at the National Archives and Records Administration (NARA) have observed some concerning aging qualities of their Avanse-Plextol Tissue (APT) recipe, including mends that have darkened in color over the years and inconsistent adhesion across various substrates.

In response to these observations, conservators and scientists at NARA and the Library of Congress are currently conducting research into the aging properties of APT alongside pre-coated tissues made with several other adhesives.

CONCLUSIONS

A number of conclusions can be drawn from the testing conducted in this project: Mending application method has a definite effect on treatment opacity. Optical clearing can effectively lower the opacity of repair tissues prior to application. Acrylic dispersions are generally the most effective clearing agents among conservation adhesives. High-density tissues (gampi, nanocellulose) are most effectively cleared.

Clearing agents can be lightly diluted, but thicker coatings are more effective. Matte acrylic media can be added to clearing agents to reduce gloss but maintain transparency.

The transparency of acrylic coatings has acceptable longevity. Optically cleared tissues made with acrylics exhibit high reversibility in the short-term, though further testing is needed.

A DEFINITION FOR OPTICALLY CLEARED REPAIR TISSUE

An optically cleared repair tissue is any precoated conservation tissue in which the adhesive coating serves the secondary function of optical clearing agent, reducing the scattering of light and encouraging transmission.

ACKNOWLEDGMENTS

I would first like to thank my supervisors, Susan Russick and Tonia Grafakos, for their support and encouragement during my fellowship at Northwestern University Libraries. I would also like to thank Karl Hagglund at the Northwestern University Atomic and Nanoscale Characterization Experimental Center (NUANCE) for his assistance with Scanning Electron Microscopy.

NOTES

1. The adhesives and coatings in Test 1 were applied generously to both sides of the samples. For the adhesives that required mixing, relatively high-density solutions were made (wheat starch paste: 10%; methyl cellulose: 5%; gelatin: 10%; Klucel G: 10%; Aquazol: 20%; Paraloid B-72: 10%). The environment in which the coating took place had a temperature range of 72–74°F and a humidity range of 35–40%.
2. The refractive indices of acrylic components:
Poly (methyl methacrylate): 1.491
Poly (ethyl methacrylate): 1.498
Poly (butyl methacrylate): 1.483
Poly (methyl acrylate): 1.476
Poly (ethyl acrylate): 1.467
Poly (butyl acrylate): 1.465
These fall within close range of the RI of cellulose: 1.469–1.55

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SOURCES OF MATERIALS

Avanse MV-100, Plextol B500, C-Gampi Paper 16 g/m2, Tengujo 5 g/m2, Usuyo Gampi-white 11 g/m2
Talas

Japanese Somegami 15.3 Kozo Conservation Tissue, 5 g
Japanese Paper Place

BC Tissue 4 g/m2 and Uso-Gami Thinnest 9 g/m2
Hiromi Paper, Inc.

Microfibrillated Cellulose (MFC)
Innovatech Engineering

Avian Black-S
Avian Technologies, LLC

Teflon RELIC WRAP film
Gaylord Archival

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Managing Expectations in Scrapbook Conservation Approaches

INTRODUCTION

As most book conservators know, historic scrapbooks are one of the most problematic formats found in many historical collections due to their complicated and deterioration-prone structures. However, they hold great value for historians and genealogists. While some scrapbooks contain only duplicate printed information, such as newspaper clippings of current events on particular topics or collectable printed cards or illustrations, many others contain a variety of materials such as photographs, postcards, letters, documents, and realia. Due to the nature of their construction, their previous use, and the deterioration of their contents, many historic scrapbooks are in very poor condition and present a myriad of handling and conservation challenges. These challenges range from binding deterioration and brittle paper to the—often dramatic—deterioration of their contents.

Overall, scrapbook formats are most commonly either post-bound or side-laced structures with heavyweight paper pages and cover boards of either paper or cloth. More modern scrapbooks also integrate ring-bound formats, plastic sleeves and pockets, the much-maligned magnetic pages, and many other creative but poor formats for long-term durability and preservation. The conservation concerns of the binding structures alone are significant, but compound that with the poor-quality sulfated papers and restrictive gutter openings and you've got a recipe for book structure failure even before content is placed inside. Additionally, we must also consider the preservation state of the materials mounted to the pages and how they are attached.

Generally, a wide array of paper documents and photographs are the most common materials found enclosed in scrapbooks. These can present sometimes significant but predictable challenges, but the conservation needs of such materials are well understood. However, it's the variety of other materials that may be held in a scrapbook's pages, such as balloons, felt, plastics, metals, and food items that make them simultaneously fascinating and such an incredible preservation challenge. Further, these materials are then held onto the pages by commonplace mechanisms such as any type of tape and/or glue imaginable, photo corners, paper straps, metal pins and clips, and more. Combine this wide-ranging variability of materials mounted within scrapbooks with the predictable degradation and the physical stress placed on the scrapbook structure by the weight of these materials, and it is easy to understand why many scrapbooks show high degrees of physical damage such as embrittled pages, broken bindings, and detached artifacts.

The University of Illinois Libraries holds over 750 cataloged historic scrapbooks dating from as early as the 1870s to as recent as the 1990s with concentrations of materials dating from the 1910s and 1920s, and the 1950s and 1960s. From a condition survey performed in 2006 at our Student Life and Culture Archives, which holds the greatest number of scrapbooks, we determined that almost one-third of the total collection was given an overall condition ranking of "poor" or "very poor." Many of these poor rankings were due to the condition of the scrapbook itself (i.e., the binding and paper of the book). However, in many cases the deterioration of the attached materials inside the scrapbook appeared to be exacerbated by the poor condition of the pages and bindings. And, of course, many of the ones in the worst condition were the ones of highest interest by researchers. Therefore, a wide array of treatment approaches and methods were conducted by our lab.

SCRAPBOOK TREATMENTS

Scrapbooks are identified for treatment for a variety of different reasons, including use by students and researchers, digitization projects, exhibitions, or often just identification and prioritization by curators simply because the items are so fragile. Depending upon what type of treatment is needed, conservation treatments may be undertaken by our conservators, technicians, interns, skilled hourly staff, or a combination thereof.

Nearly 250 scrapbooks have come through the University of Illinois Library's conservation lab since it was constructed in 2006. After the aforementioned 2006 survey, many of the most maligned scrapbooks reviewed came to the lab for full treatment, stabilization, or basic rehousing. Through that

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process and in the many intervening years, our conservation staff has learned that often what sounds relatively simple in a treatment proposal may take tens or even over a hundred hours per item, with a result in many cases of an item which is still chemically unstable, physically unsound (though improved), and generally rather unsatisfying treatment.

CASE STUDIES

To help illustrate the variation and complexity of some of our treatment approaches to various scrapbooks over the years, it is useful to review several case studies: the Alpha Tau Omega (ATO) scrapbook, the University of Illinois' Council of Administration Records, and the Alton IL Printer's Scrapbook.

The ATO scrapbook arrived in our lab with severe mold and water damage and a completely detached cover. The scrapbook's structure contained "magnetic" pages with plastic guard sheets. Due to the mold damage and unstable format of the scrapbook, the decision was made to reformat the scrapbook in a reproduction binding of archival quality materials. All items were removed from the pages, cleaned of mold, some items were washed and/or mended as needed, and all were remounted using photo corners into a new album structure (figs. 1 and 2).

Overall, this treatment took only 20 hours to complete and resulted in greatly enhanced accessibility and appearance. Some other scrapbook treatments have not been so rewarding.

Fig. 1. The Alpha Tau Omega (ATO) scrapbook as it arrived in the lab.

Fig. 2. The ATO scrapbook after treatment.

The University of Illinois' Council of Administration Records is a series of scrapbooks utilized to preserve early administrative records of the university. The full series of 32 volumes is used heavily by researchers in our University Archives and preservation and enhanced accessibility of the records is paramount to our university archivist. Each volume of approximately 100 leaves has historic documents (sometimes of several sheets) soundly adhered to both the recto and verso. The support paper is fragile and the bindings themselves are failing (figs. 3 and 4).

After long discussions with University Archives several years ago, the following treatment decision was made: disbind the volumes, surface clean and humidify each loose sheet to soften the adhesive, remove the documents from the support pages and reduce any remaining adhesive mass, flatten any planar distortions, mend for stabilization, and rehouse the documents as an archival collection. Although none of these steps are arduous and can be undertaken by skilled hourly staff and interns in our lab, the number of steps and shear repetition for the large bindings means that each volume necessitates nearly 100 hours of contact time, which is a very significant staff undertaking when extended out to all 32 volumes. Combining the heavy treatment time with the stabilization-level treatment approach to the final documents results in a less-than-satisfying use of our staff time (figs. 5–7).

Finally, there is the Alton Printer's Scrapbook, which entered our lab as the centerpiece for an upcoming exhibition on early printing in the State of Illinois. Through discussion with the curators, it was decided that many items would be removed from the scrapbook for the purposes of mounting the exhibit and that, after the exhibition, all items would be removed and stored as an archival collection. While similar in basic treatment approach to the Council of Administration Records, this item varied significantly in several key factors. First, the printer's scrapbook was created by the printer themselves and was an historic artifact in its own right; second, there was some (though limited) writing on the support pages

Fig. 3. An exemplar Council of Administration Records volume, before treatment.

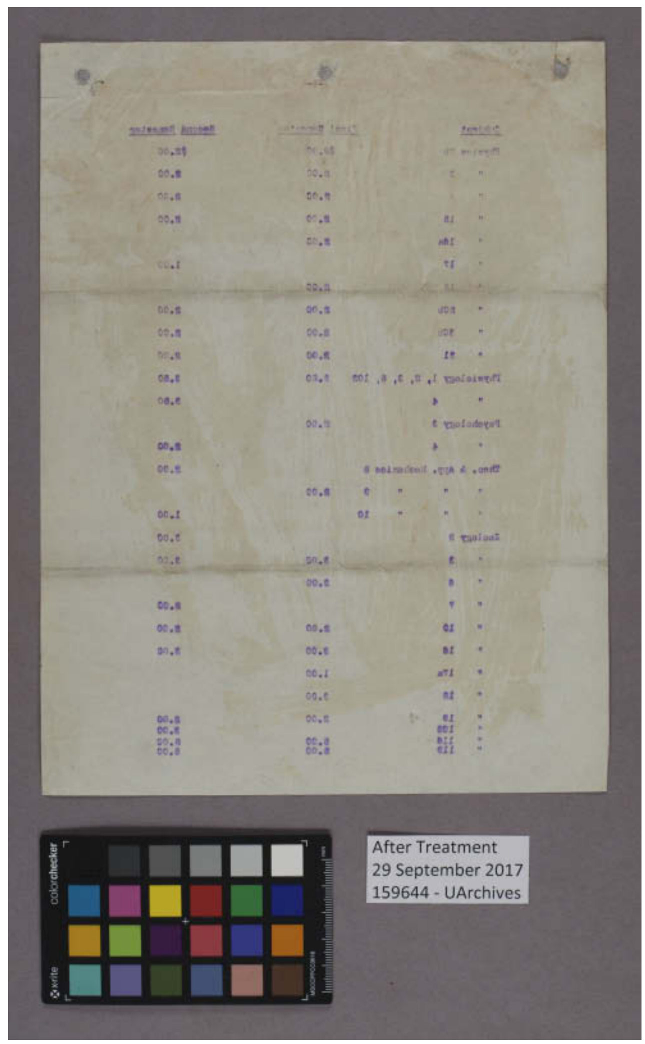
Fig. 4. Council of Administration Records volume, before treatment.

of the printer's scrapbook; and third, the adhesives, papers, and formats of the attached documents varied far more greatly in the printer's scrapbook (fig. 8).

So, while the exhibition was successfully mounted in the spring of 2018, several of the items identified to be separated from the scrapbook could not be removed without risk of significant damage due to intractable adhesives and fragile paper supports. The result is that after many hours of treatment, only a small subset of the documents in the whole volume were removed and conserved, leaving many in the scrapbook with a now-uncertain future as to whether any more will be removed or not (figs. 9 and 10).

THE NEED FOR A MORE STANDARDIZED APPROACH

As yet more scrapbooks continued to come into the lab, it was collectively agreed that some sort of "expectation framework" to help communicate treatment levels, final outcome expectations, and better time management might be



Figs. 5 and 6. After treatment, documents from the Council of Administration Records showing basic stabilization efforts.

Fig. 7. A completed Council of Administration Records in archival collection format.

Fig. 8. A two-page spread from the Alton printer's scrapbook, before treatment.

advantageous— or at least it couldn't hurt. Following on this decision, our first step was to see if any other library conservation labs had such a framework or guideline in place. As such, the framework was envisioned not as a dictation to our conservators, but merely a tool to frame the scope and depth of treatments and to manage the expectations of curators and collection managers.

A query was sent to the Conservation Distribution List (ConsDistList) as well as the American Library Association's Preservation Administrators Discussion List (PADG) in the fall of 2017 asking for any existing guidelines or documentation which would help standardize or contextualize treatment expectations for scrapbook conservation. While the query garnered several responses, only one institution responded as to having something similar, but it was not a formal guideline, more of an internal framework. So, having no real models to work off, we developed our own.

THE SCRAPBOOK TREATMENT GUIDE—WHAT IS IT AND HOW CAN WE APPLY IT?

The resulting guide, included in full as Appendix A, consists of several sections: Section 1 is an introduction to scrapbook structure and common failures, section 2 contains a few questions for curators in preparation for framing a treatment approach, and section 3 contains descriptions of the variously proposed treatment levels that are meant as a contextual guide to conservation staff as well as curators to better guide treatment expectations and priority setting. These different treatment levels contain descriptions of possible common treatment approaches and repetition levels that might be included, as well as general time ranges considered to be appropriate for each level. The inclusion of the time ranges was considered significant as it is our only "commodity." By listing time ranges versus just listing the types of treatments, conservators can help curators better understand how more intense scrapbook treatment approaches might require other treatments to be pushed back in priority. Lastly, the guide concludes with several treatment approaches to be avoided without just cause, including partial treatment and disbinding.

The guide was piloted on a scrapbook that was already sent to the lab and pending a treatment proposal. The scrapbook, an early sports history of the university dating from the late 1800s, presented all the typical challenges of an historic scrapbook including ribbons, pins, folded broadsides, detached objects, and extremely brittle support pages in a side-laced binding structure exhibiting many detached pages. The guide was utilized to present the owning archivist with treatment options at several of the treatment levels contextualized therein, ranging from enclosure only to midrange stabilization to full treatment. Utilizing the guide from a conservator's standpoint was very helpful in creating proposals for all treatment levels and in considering what level and types of repairs are truly necessary to make an item usable without necessarily undertaking full treatment. While the archivist responded that the proposal of various treatment levels and their explanations was helpful, she had a strong desire for full treatment and would not consider any midlevel treatment options in this case. Would the curator have been more comfortable with a midrange treatment option, the guide would have served to articulate more clear expectations for the time and depth of treatment to whomever then undertook the treatment in the lab—be they the proposing conservator, technician, or hourly employee.

The guide was also shared with all curators for feedback on how useful they perceived it to be in helping to better articulate treatment goals and expectations. While all curators responded positively, few had any constructive feedback on how it might be improved, which caused some concern as to its utility when time came to implement it. To garner more critical evaluation, the guide was shared with several past and present conservators who were familiar with our lab and the treatment of scrapbooks within our collections. This review garnered much more

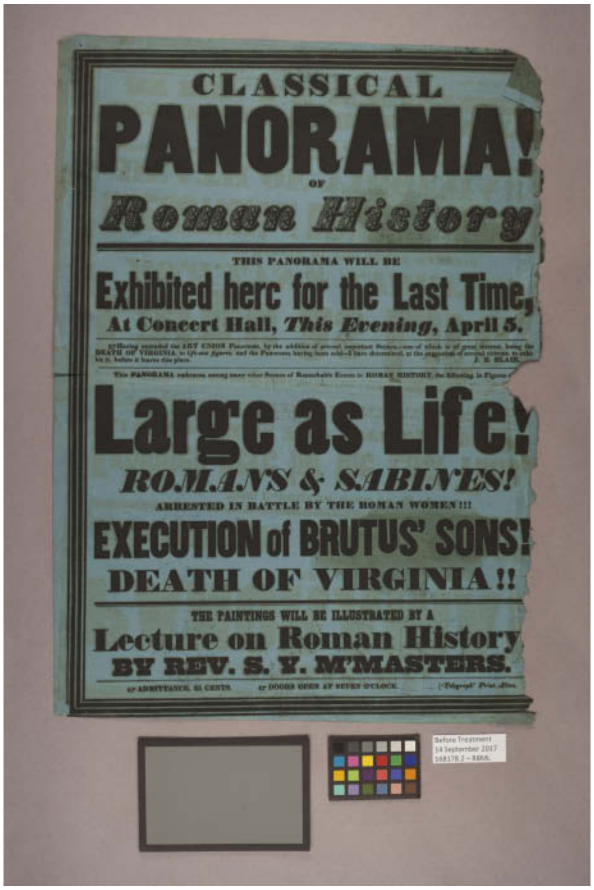


Fig. 9. One of the broadsides removed from the printer's scrapbook, before treatment.

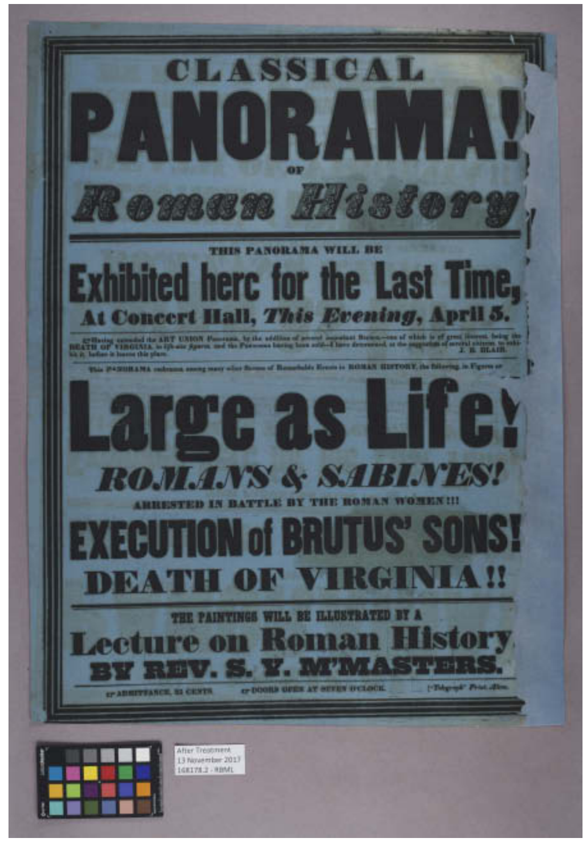


Fig. 10. One of the broadsides removed from the printer's scrapbook, after treatment.

significant constructive feedback, several elements of which are already included in the version of the guide presented here. However, the most critical question has yet to be answered: Will this document really change anything in our treatment approaches and our curators' expectations? Only time will tell.

NEXT STEPS

It is our hope that the Scrapbook Treatment Guide will prove useful in several ways: to better contextualize treatment approaches, to improve communication for the desired extent of repair for curators and those performing repairs, and to give the conservation staff a better ability to "dial back" from complex full treatment approaches, which is often considered to be our only option for scrapbook treatments. The guide will also encourage conservators to propose various levels of treatment for consideration instead of automatically proposing treatment options already assumed by the curators. Lastly, we hope that by providing treatment time range references for curators in context of different treatment options, it will lead to better treatment prioritization within the broader context of treatments in our lab.

ACKNOWLEDGMENTS

The authors wish to thank Laura Larkin, Henry Hébert, Cher Schneider, Quinn Ferris, Jody Waitzman, and Marco Perez Valladares for their thoughts and assistance.

APPENDIX A

SCRAPBOOK TREATMENT GUIDE

INTRODUCTION

Historic scrapbooks are one of the most problematic formats found in many historical collections due to their complicated and deterioration-prone structures and materials. This guide is meant to assist curators and collection managers in describing damage, understanding repair options and limitations, and considering factors that make scrapbooks unique objects within our collections. For the purposes of this guide, scrapbooks are defined as bound (or originally bound) objects on which papers, photographs, and other materials have been attached. Although photographic albums have many similarities and some of the following may apply to repair considerations for photographic albums, they are not inherently considered the same as a scrapbook.

SCRAPBOOKS AS PHYSICAL OBJECTS

Certain scrapbooks contain only duplicate printed information, such as newspaper clippings of current events on particular topics or collectable printed cards, etc. Others contain a wide variety of materials such as photographs, postcards, letters, documents, and realia. In either case, scrapbooks can serve as a valuable resource for researchers. Unfortunately, due to the nature of their construction, their previous use, and the deterioration of their contents, many historic scrapbooks are in very poor condition and present a myriad of preservation challenges. These challenges range from binding deterioration and brittle paper to the—often dramatic—deterioration of their contents. Due to this, scrapbooks often present significant handling and display challenges.

Despite their challenges, it is important to consider the scrapbook in its entirety as an object, not just as a container for smaller objects. Standard practice for storage of any historic scrapbook should involve a well-fitted, preservation-quality enclosure. This may be either a custom measured enclosure, or a standard box with interior modifications to properly support the item in storage. If a scrapbook is fragile but not yet broken, in almost all cases an enclosure and careful handling will be the extent of treatment necessary. In instances where the scrapbook is damaged in some way, consideration should be given to whether repair is advisable. This is most pressing when the damage may present significant handling concerns, which could result in further damage to the artifact with use. In instances where risk of increasing damage is paired with an historic or strong potential for high use, more intensive treatments may be necessary. *Disbinding of scrapbooks simply for ease of storage is generally avoided unless the scrapbook format was only originally an archival organization method, and not a creative output.*

OVERVIEW OF TYPICAL SCRAPBOOK FAILURES

Support Paper Failure. The most common condition issue with scrapbooks is deteriorating strength of the support paper, which is frequently of poor quality and embrittled/discolored.

- Overall Embrittlement: Overall paper has become brittle and may be breaking along edges, in gutters, or failing at points of attachment.
- Gutter Fractures: Paper is breaking along the gutter edges, parallel to the spine.

Page Attachment Failure. Similar to gutter fractures, this damage is due to paper strength failure at the point of attachment, but focuses on damage due to stress/wear against hardware or mechanical failure. This can be exacerbated by planar distortion of the pages, if it exists.

- Page attachment failure at posts, laces, rings, etc.
- Hinge attachment failure of adhesive or other attachment of page to a hinge or stub at the gutter

Binding Failure. Fairly common damage found in older scrapbooks, or those that have been heavily handled or overfilled with memorabilia (thus creating stress).

- Hinge Damage: Damage may occur to either the internal or external hinges of the cover. If external, this compromises the attachment of the cover board and spine. If internal, it compromises the attachment of the textblock to the cover.
- Loss of Cover Components: Scrapbooks may lose one or both boards and/or their spines. However some scrapbooks, particularly post-bound formats, may not have a spine covering originally.

Mounting Failure. Materials can be mounted to a page using a wide variety of materials, often varying methods are used within one scrapbook. Many of these methods will also fail over time for a variety of reasons.

- Glue: Glue damage may include loss of tack (detachment), staining, and embrittlement. In limited cases, there may also be sticky adhesive migration.
- Magnetic Pages: These pages, covered with a tacky paraffin-based substance, can lose tack or the adhesive can migrate into the ephemeral items.
- Corners/Straps: Both of these methods do not involve any adhesive applied directly to the items, however they can fail mechanically (tear) or corners mounted to the support paper can suffer from adhesive failure
- Tape/Stickers: Like glue, tape damage may include loss of tack (detachment), staining, and embrittlement. In limited cases, there may also be sticky adhesive migration.
- Lamination: Basically, two giant pieces of pressure-sensitive tape; damage from lamination often involves ink feathering, discoloration, or shrinkage of the plastic film.
- Other methods may include pins, staples, paper clips, sewing, etc.

Ephemera Deterioration. Due to the infinite range of materials that can be mounted (or laid) into scrapbooks, many different types of deterioration are possible. However, most fall into one of three classes:

- Deterioration of a chemically unstable item (dye fading, silver mirroring, paper discoloration, etc.)
- Deterioration of an item due to contact with adjacent materials (adhesives, papers, interleaving, and other ephemera), often resulting in localized staining or deterioration

- Deterioration/damage due to physical stressors, including use

Included within the considerations here should be items that can cause risk to other items near it, including (but not limited to) food items, rubber, some plastics, felts, pressed plants, and suedes.

Other Damage. Although a wide range of damage can fall into this category, the most common "other" types of damage include mold, insect damage, water damage, damaging previous repairs, and pages which are stuck together.

STANDARD TREATMENT LEVELS

To better approach scrapbook treatments, the conservation program recommends considering proposed scrapbook repairs or treatments in the following levels. These levels are not meant to be prescriptive, but instead are meant to guide archivists, curators, and conservators in their practical and philosophical approach to the level of treatment intensity and physical intervention on the object to create a common goal and understanding on treatment expectations. Examples of each level are described and examples are given for each including expected treatment time ranges.

Level I (Stabilization Only). This treatment is appropriate for nearly all historic scrapbooks, as all will benefit from a well-fitting enclosure. Options may include a custom-sized enclosure, outfitting a commercial/standard box with interior fittings for a bitter fit to item, or actions such as interleaving. Estimated treatment time: under 2 hours.

Level II. This treatment level incorporates a minor conservation treatment that alters or repairs the artifact but is typically only one necessary treatment type and not a combination of treatments. Treatments may include reattaching a few (<10?) loose items, binding repairs on cloth or paper bindings (such as spine reattachment, board reconstruction, hinge-reconstruction, etc.), repairing a few pieces of mounted or unmounted ephemera (<10?), unmounting of a few (<10) materials from pages (due to a variety of reasons), or the replacement or rebuilding of a page attachment mechanism, such as replacing side lacing, rebuilding posts, etc. Estimated treatment time: under 5 hours, frequently under 2.

Level III. This treatment level involves more invasive treatments to the object and more intervention by the conservation staff. It may involve several treatment approaches in one scrapbook. Examples of treatments may include reinforcing or rebuilding page attachment (stubbing, mending gutter breaks, or repairing punched holes), isolated separation of blocked/stuck pages (<5), moderate levels of reattaching loose items (11–50?), moderate levels of repairing ephemera (11–25?), moderate levels of umounting items from support pages (11–25?), isolated page reinforcement with polyester film, and mold remediation or cleaning that does not involve removing any ephemera from support pages nor disbinding. Estimated treatment time: 5–20 hours.

Level IV. This is the most advanced treatment level and involves either treatments that are a combination of many individual approaches or extensive, repeated treatments over a whole volume. Examples of treatments may include extensive separation of blocked/stuck pages (>5), high levels of reattaching loose items (>50), high levels of repairing ephemera (>25), high levels of unmounting items from support pages (>25), extensive page reinforcement with polyester film, and mold remediation or cleaning that involves removing ephemera from support pages and/or disbinding. Estimated treatment time: >20 hours.

Level V. This is the most advanced treatment level and involves all treatment approaches covered in Level IV, but are either greater in number or treatment intensity. Estimated treatment time: >50 hours.

TREATMENT APPROACHES TO BE AVOIDED

Other, less common treatment approaches may be considered only when there is significant cause for such an approach by a curator or archivist. In general, however, conservation recommends against the following treatment approaches.

Partial Treatment. This approach often takes place in relation to an exhibition or digitization effort. However, it leaves an item only partially repaired, which can lead to stress or separation of items from the original context.

Disbinding. As stated above, disbinding of a scrapbook changes the context and intent of the original artifact. While there are particular instances (books exclusively of business records or clippings, for instance) where this may be appropriate, most historical scrapbooks with a variety of ephemera should ideally not be disbound unless there is no other viable repair option available.

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The Painting's Life, Silk or Paper: Materials and Methods for Lining a 15th-Century Chinese Handscroll at the Cleveland Museum of Art

INTRODUCTION

Asian scroll paintings are often executed on delicate and fragile silk. Many aging paintings on silk show different degrees of deterioration, including extensive loss to the silk support. For treating these scrolls, removing and replacing the first lining is a crucial step to stabilizing the damage by compensating/filling the losses.

For silk paintings, the conservation technique of overall lining with a sheet of silk had been widely used throughout generations in China, Japan, and Korea. The method involves applying a laminate of silk and paper with paste overall to the back of the painting. This technique is still used when a silk painting is lacking in strength or suffering from a number of losses, or when a Buddhist painting has a generous commission for using more expensive materials for mounting and restoration.

However, lining a scroll painting with an overall sheet of silk is not used as commonly as in the past because of its limitations. This paper will discuss the techniques for filling silk painting losses and discuss the advantages and disadvantages of lining with silk and paper. The methods and materials for filling and lining a 15th-century handscroll at the Cleveland Museum of Art are also introduced.

CONSTRUCTION OF CHINESE HANDSCROLLS ON SILK

Traditional Chinese mounting includes handscrolls, hanging scrolls, albums, and panel formats. The earliest format is handscroll. This format is the most difficult to make because it consists of many components (fig. 1). The handscroll is designed for viewing from right to left. The components and structure of a traditional handscroll can be described as follows: on the surface, starting from the right, there is a head section followed by a separating silk; a frontispiece followed by another separating silk; the painting followed by a final separating silk; and the end section, sometimes with or without an inscription. On the back of the handscroll, there are primary linings for each component.

The first lining on the back of the painting is called *ming zhi*. *Ming* means life and *zhi* means paper, indicating this lining is crucial to the life of a painting. The term *zhi* explains that paper is most commonly used as a first lining. After all components are joined, the scroll becomes a long horizontal piece. Finally, two sheets of *xuan* paper are laminated and applied as the final lining on the back of this long horizontal piece.

TECHNIQUES FOR FILLING SILK PAINTING LOSSES

Many aged scroll paintings on silk exhibit deterioration due to mounting format, frequent handling, and materials used. Compared to paper as a substrate, delicate and fragile silk tends to deteriorate more readily, which may result in loss. There are three commonly used techniques of filling losses in silk paintings.

INLAY FILLING

The first technique is inlay filling, which is to fill the losses with silk fills the exact shape of the loss, followed by lining the painting with a sheet of paper (fig. 2). The shape of the loss is carefully traced onto a fill silk using transmitted light, which is then precisely trimmed and then inlaid to fill the loss (fig. 3). Aged silk is used for this filling technique.

OVERLAP FILLING

The second technique is overlap filling, which is to fill the loss from the back with square and rectangular silk shapes slightly bigger than the loss, followed by lining the painting with a sheet of paper (fig. 4). This technique might affect the appearance of the silk painting if the silk has an open weave. Typically, the overlapping edges appear as a dark outline from

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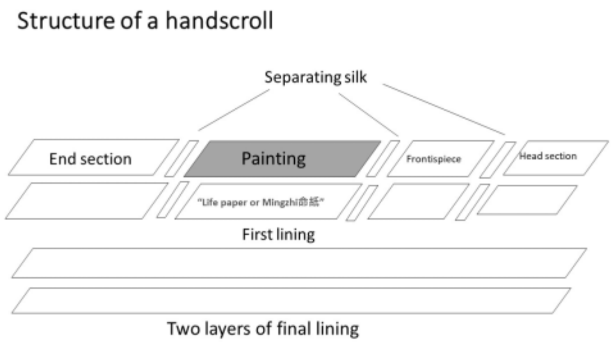

Fig. 1. Structure of a Chinese handscroll.

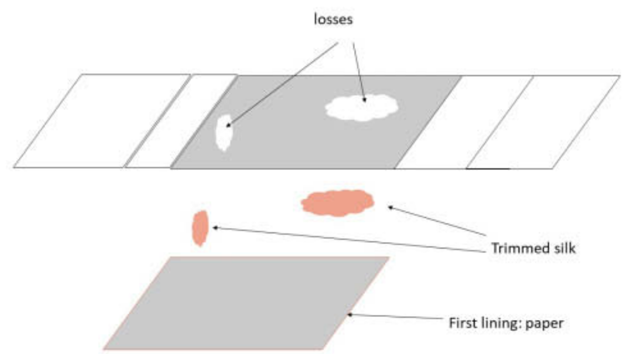

Fig. 2. Inlay filling and lining with paper.

Fig. 3. Inlay filling an open weave silk.

the front of an open weave silk painting (fig. 5). However, this technique does not affect the appearance on a closed weave silk. Some Chinese painting conservators prefer to fill the losses with square and rectangular silk shapes and pare down the edges of the overlapping fill silk afterwards. Li Shang, conservator of Chinese painting at the Palace Museum in Beijing, is very careful to hold the knife tight and balanced to

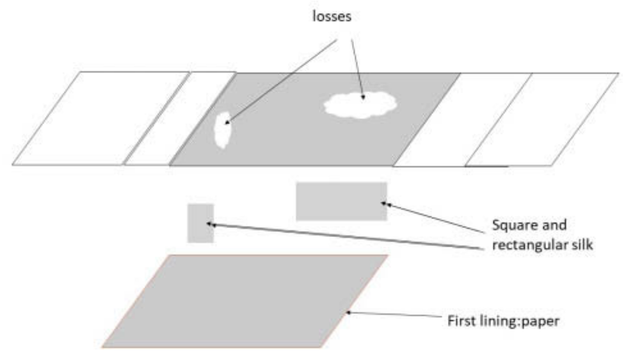

Fig. 4. Overlap filling and lining with paper.

Fig. 5. Overlap filling a loss in an open weave silk painting resulting in a dark outline visible from the front.

pare down the edges of the overlapping fill silk (fig. 6). The overlapping edges of her fills are not visible from the front because the painting is on a closed weave silk (fig. 7).

OVERALL LINING

The third technique is overall lining with silk, which is to line the painting with a sheet of silk to compensate for loss without any additional filling (figs. 8 and 9). Lining a silk

Fig. 6. Overlap filling losses on a closed weave silk painting.

Fig. 7. After overlap filling and lining with a sheet of paper.

painting with another whole sheet of silk requires thick and strong paste to adequately bind the two layers, resulting in stiffness. Chinese scrolls are intended to be soft, flat, thin, and smooth—not rigid. The resulting inflexibility from overall lining with silk can cause harsh creases when rolled and unrolled over time. This causes delamination of the painting silk from the lining silk and causes the silk to fracture, leading

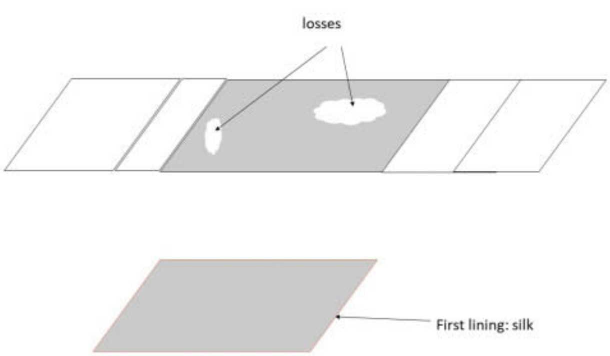

Fig. 8. Overall lining with silk.

Fig. 9. Overall lining with silk.

to loss. In contrast, when lined with paper, a silk painting is less prone to delamination because silk adheres better to paper and thinner, more dilute paste is used. Additionally, lining overall is considered a "lazy" way to disguise losses as opposed to the method of filling the losses individually with silk trimmed to the same shapes as the losses.

However, this third technique might be preferred in terms of the scroll's condition or historical context. Lining with an overall sheet of silk might be used to fully support a very worn and damaged silk painting with extensive losses. Some Chinese painting conservators prefer using a very thin silk to line an extremely damaged silk painting. This kind of thin silk is called *wang wang jua*, meaning thin and open weave silk. The losses can be fully supported if the painting is very worn and weak with a number of tiny losses. A silk painting lined to a very thin silk has a stronger bond than if lined to regular painting silk. Therefore, the condition of the painting may determine whether to use a sheet of silk or paper for the first lining.

If a silk painting with extensive loss can be mounted in a flat panel format, lining with an overall sheet of silk is applicable as it will not be rolled and unrolled.

Furthermore, some silk paintings are strongly associated with lay Buddhist practitioners. The purpose of making paintings was to gain merit through commissioning paintings. Therefore, there might be some Buddhist silk paintings lined with a sheet of silk simply because silk is expensive and considered more luxurious and the best material to show proper reverence to the painting.

COMPARISON OF INLAY AND OVERLAP FILLING

Inlay filling is time-consuming, while overlap filling is time-saving. When inlay filling, tiny fills might "fly away" and the filling silk might shrink or expand differently from the painting silk during the subsequent lining process, resulting in gaps. Overlap filling is more secure, but overlapping edges need to be pared down, otherwise the overlapping may create hard and thicker edges, which can damage the original when rolling and unrolling the painting. Inlay filling can be applied either from the front or back depending on different tones of fills, while overlap filling has to be applied from the back.

Inlay filling could be applied on both open and closed weave silk, while overlap filling can only be applied on a closed weave silk because the overlapping filling would show on an open weave silk.

CASE STUDY

A 15th-century Chinese handscroll in the collection of the Cleveland Museum of Art, *Waiting for the Moon in the Mid Autumn Festival* by Shi Rui (fig. 10) needed to be remounted due to severe damages. It had been lined with an overall sheet of silk to compensate for extensive losses. The painting was delaminating between the primary support and lining silks due to rolling and unrolling over time, and this delamination had caused sharp creases, resulting in some fracturing and loss of the original silk (fig. 11).

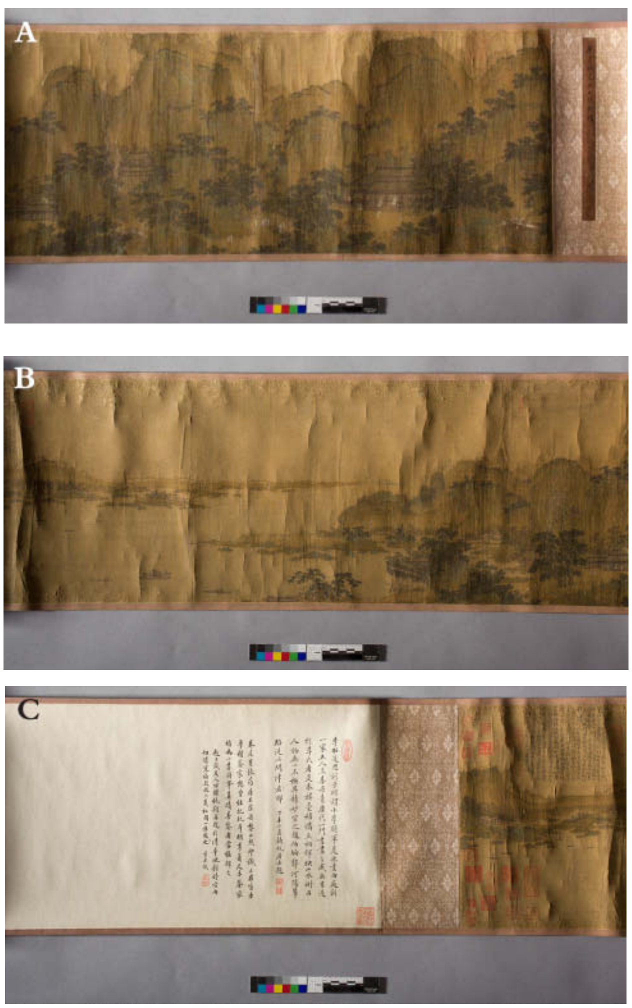

Fig. 10. Detail of (a) front section, (b) middle section, and (c) end section of Shi Rui, *Waiting for the Moon in the Mid Autumn Festival,* 15th century Chinese handscroll painting on silk, Cleveland Museum of Art, 1973.72.

Fig. 11. Detail, recto: weblike creases and splitting with the overall silk lining.

DECISION-MAKING AND TREATMENT PROPOSAL

Here lies the crux of this discussion: If the painting with losses was lined to compensate the losses using an overall silk lining, it might cause the same problem of delamination over time. If the back of the painting was lined with a sheet of paper, the losses then had to be filled with trimmed silk. With extensive losses (fig. 12), this would be extremely time-consuming. Most of the losses are the size of pencil dots. Therefore, filling with the same size of trimmed silk would be impractical because there was not enough surface area for paste application and the fills could easily be lost due to poor adhesion during subsequent mounting processes. Furthermore, the silk painting might shrink or expand differently than the fills while drying, resulting in gaps or overlapping around losses. As the painting has a closed weave silk, it was decided to replace the silk lining using the second technique: overlap filling.

TREATMENT STEPS

Major treatment steps included paint consolidation, facing, lining removal (including the overall sheet of lining silk), filling losses, lining with a sheet of xuan paper, reinforcing creases, inpainting, and mounting.

When the overall lining paper was removed, extensive tiny losses and splits were visible (fig. 13). After the surface of the painting was faced, the lining silk and paper were removed. Many creases marked with pencil on the lining paper were revealed (fig. 14). After lining removal, the filling silk was trimmed slightly larger than losses and applied to the back of the painting (fig. 15). Smaller losses were filled with square and rectangular pieces of silk. Tiny splits were reinforced with narrow strips of silk to prevent future expanding and shrinkage. The overlapping portions were then pared down with a

Fig. 12. Damage map; the red marks indicate losses.

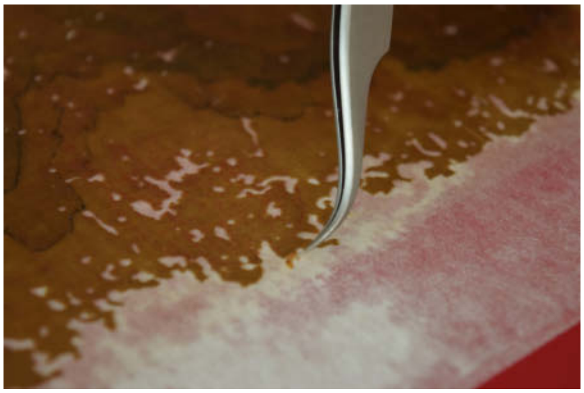

Fig. 13. Detail, verso: tiny losses visible after removing the overall lining silk.

Fig. 14. Detail, verso: creases marked with pencil on the lining.

Fig. 15. Detail, verso: overlap filling by Li-Ling Ho.

Fig. 16. Detail, verso: (a) before filling losses and (b) after filling losses.

Fig. 17. Lining the painting with a sheet of toned *xuan* paper by Li Shang and the author.

knife (fig. 16). After filling, the painting was lined with a sheet of toned *xuan* paper (fig. 17). The facing paper was removed after lining (fig. 18). Creases were reinforced with paper strips applied to the back of the lining paper (fig. 19). Finally, fills were inpainted to compensate their tone (figs. 20 and 21).

Fig. 18. Removing the facing paper after lining.

Fig. 19. Detail, verso: (a) creases were reinforced with paper strips by Li Shang; (b) after lining and reinforcing creases.

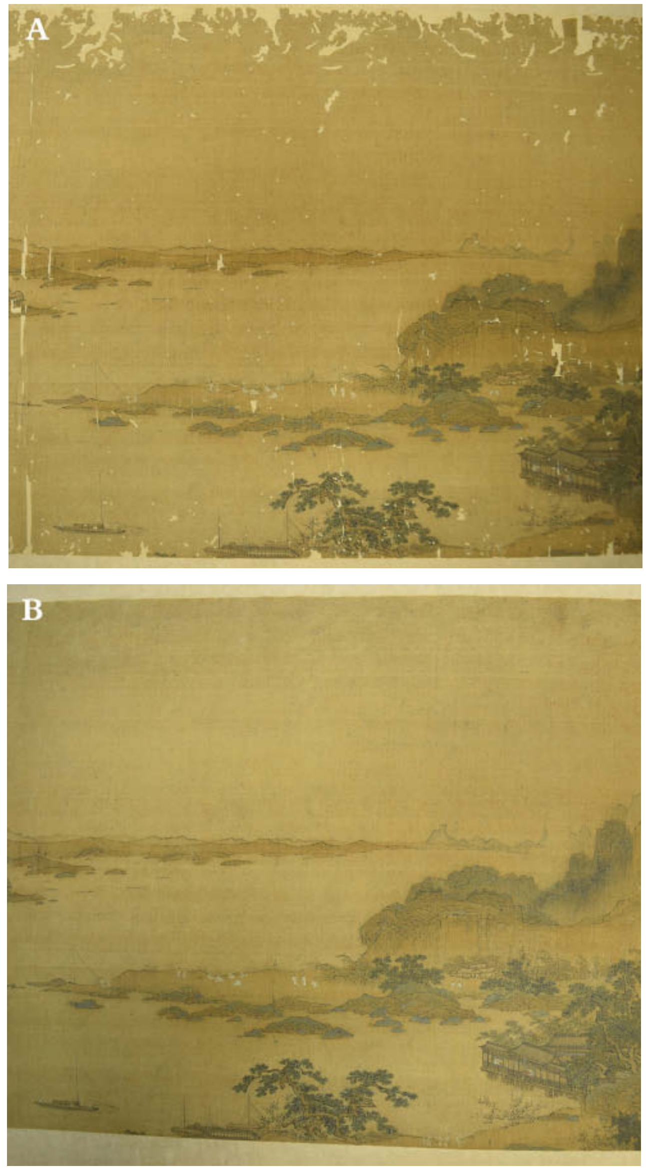

Fig. 20. Detail, recto: (a) before inpainting and (b) after inpainting.

Fig. 21. Overall, recto: (a) before inpainting and (b) after inpainting.

CONCLUSION

In summary, inlay filling losses with exact shapes of silk is a good application if the painting is on an open weave silk. Overlap filling losses with a square or rectangular silk that is slightly bigger than the losses is a good technique if the painting is on a closed weave silk. Lining with paper makes the scroll flexible, while lining with an overall sheet of silk is acceptable if the painting is going to be a panel or if the scroll has numerous losses and significant loss of structural integrity.

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Smudges, Snakeskins, and Pins, Oh My!

BACKGROUND

The Field Book Project at the Smithsonian Institution has been a focus of interdisciplinary collaboration since 2010, with the Smithsonian Institution Archives (SIA) and Smithsonian Libraries working with diverse collection departments within the National Museum of Natural History to catalog, describe, digitize, and physically preserve unique research records related to field work, and to join them to comparable collections worldwide through such resources as the Smithsonian Transcription Center, the Biodiversity Heritage Library (BHL), and Digital Public Library of America. Much about the digital and social networking infrastructure for these efforts has been published (Decker 2016); the aim of this contribution is to present conservation and preservation approaches that have heretofore only been published in blogs, feeding the digital humanities engagement that has made this project so exciting (Parilla and Ferriter 2016).

Field books are legacies of research—sometimes still ongoing—complenting the understanding of specimens and/or continuance of research programs and their output. Habitually, field books were held closely by generations of researchers, in individuals' offices or file drawers, sometimes adopted and arranged into department libraries. While enumerating and cataloging these born-Smithsonian records was the first project focus, goals grew to include digitization and transcription of these varied materials that are unfriendly to optical character recognition. Aside from the difficulty of scanning characters, many of the books presented physical challenges to mass digitization—or were vulnerable to damage and unacceptable losses. A pilot condition assessment survey identified needs that were used as the basis for strategic grant requests to support intern and staff time for assessment, digital preparation, collections care, and conservation treatment interventions, to complement the staff already committed to cataloging and digitization.

Papers presented at the General Session, AIC's 46th Annual Meeting, May 29–June 2, 2018, Houston, Texas

DEFINITIONS AND TERMS

A word about words: In this text, the authors refer to *field books* and *field notes*, and *book blocks* rather than *text blocks*, to describe the many forms of *blankbook* structure in stationery binding and information-recording tools used throughout the history of note-taking (Etherington and Roberts 1982; Metzger 2013; Miller 2014). Across different institutions and cultures of archives, libraries, and field research, the accumulated material of notes, sketches, and other data may be described variously over time as field- [diaries, books, journals, logs, logbooks, note-books, notebooks, notes, records], with hyphenation or without. Sometimes the trailing word has a specific intent or meaning, which will be briefly addressed in sections below. (In languages other than English, the same pattern may apply, such as *cahier de recolte*; *nota/s de campaña*, whereas languages with compound words incorporate context, such as *feldnotiz* or *veldaantekeningen.*)

Why should one care about the use of one word for another? First, because you may run into nomenclature used differently between subject areas and professional disciplines. Such precisions matter to better understand the nature of the work and associated accessioned collection material. For example, in natural history collections (but which may apply in other field work, such as anthropology or other types of surveying), field notes, whatever their structure, are unique research records that are considered *ancillary collections* that help with interpretation: "for example details of the collection locality and the date of collection, add considerably to the value of any material" (Ethics Working Group of the ICOM NATHIST 2013). Ancillary collections might not be accessioned items, as compared to departments' "working records," but are retained to support collections, especially where the collections are specimens, and stand as proofs in case of loss of the accessioned object. Also, they may be considered to be permanent records for federally funded research (Smithsonian Institution 2015; Smithsonian Institution Archives 2018). To this end, SIA's recently revised guidance for retention of *research records* expands beyond book formats to "any materials created or collected while conducting research as part of a Smithsonian employee's official duties," which include ancillary collection material such as "raw data, written observations, field books, annotated maps, and images and audiovisual recordings taken for observational purposes" (Smithsonian Institution Archives 2018).

Second, it follows that conservators, preservation librarians, archivists, and collection care professionals, like their colleagues in the natural sciences, should enjoy taxonomic classification for the following reasons:

- Nomenclature and classification as expressed in controlled taxonomic vocabularies help to identify characteristics of a work. Description of characteristics informs values, which helps guide decisions about keeping, assessing, using, or potentially making a change to that structure. Definitions vary from *field notes* (Getty Art and Architecture Thesaurus; American Library Association-Rare Books and Manuscripts Section) to *field book* (Society of American Archivists).
- Until the emergence of a notebook with intentional formatting that separates it from other uses, it is only the *contextual* use and/or inscription or afterthought applied label added by the user to a stationer's blankbook that clarifies the use as a field book, as opposed to any other type of diary, journal, sketchbook, or scrapbook album, that was used for simultaneous note-taking, drawing, or recording.
- The narrower definition of *field book* (specifically, a stationer's blankbook made for note keeping *and was used for the collection of scientific data or observations in the field)* may have been, or should be, used in controlled vocabulary fields for description such as scope, genre or object type in collection databases, and treatment reports. Whether the material is bound in a permanent or a loose-leaf structure, or none at all, such as a grouping of sheets of paper intended or not for later binding, may apply per the local definition (Parilla 2013). Alternately, *field notes* may be used as a larger concept. (Note: a Google Ngram shows a steady rise of the latter term from 1800–2000, trending sharply upward and predominating after 1880, although this analysis may not cover all relevant topical contemporary use.)

Lastly, with some of the newer technology in field-note-taking, it is known that the preservation process will necessarily include migration to new stable formats as the original media and tools to read it may not last. This paper argues that for original field *book* formats, which range over a couple of hundred years of blankbook history, preserving their technological changes over time, or reversing wholesale changes applied to original structures, are also worth examining—and hence, onward to the material matters.

THE MATERIAL MATTERS

CHARACTERISTICS OF STATIONERY BINDINGS AS FIELD BOOKS: THEIR FORM

A factor in assessment of field books is to consider both how the material *matters* (v) and the *material* matters (n). For the former, are content and context irrevocably changed if the structure is physically altered but the information is carried forward in a rebound or altered state? For the latter, does it matter to the end user if the written content is presented in a virtual form via reformatting or digitization? In the observations to follow, the authors find that preservation and representation of the physical material are both implicit and mutual goals, that one approach does not fit all, and also advocate for weighing needs of multiple end uses, including conservation intervention for better digitization and access, and preservation of the material culture and historiography of science.

Structures and forms matter to use and content, in note-taking and -keeping, even in the most prosaic or *commonplace* book. Form ever follows function, and this gave rise to the primary divisions in the industrial bookbinding trade, between *stationery*—those books made to be written in, and *letterpress binding*—those texts bound after being printed. (Etherington and Roberts 1982, Metzger 2013). From the commonplace blankbook to ruled and lined or otherwise preformatted books, to padded or punched sheets meant for a loose-leaf binder to water-resistant or waterproof plastic "paper," technical innovations continue to abound for the keeping of permanent accounts, journals, or other writing or list-making practices. The preference and trends of a researcher for a certain style of field book tell something about their planning and practice in the field or their academic lineage, regional travels, and habits to the perceptive user.

Regardless of the book structure—sewn folios (supported or unsupported), bound or cased, stubbed-out album, its orientation in the horizontal or vertical axis (as in a reporter's memoranda or stenographer's book), or made up of single leaf attachments (spiral binding, loose leaf), and is pocket-sized or larger—a central principle uniting field books and other notebooks is the requirement to lay flat when opened for writing (Miller 2014). The ability to lay flat allows for full use of the page, into the margins, and is often exceeded by some thrifty or copious notetakers!

The transition to a lay-flat book made up as a purposeful field book likely occurs before the formalization of systematics in the 18th century. Functional structural elements such as wallet pockets in boards, fore edge flaps, keeper straps, loops, or pen-holders (fig. 1), and useful preformatting such as ruling lines are described in books made for diverse uses by other scholars (Metzger 2013). Another significant feature common to the field book is a preference toward minimal squares or flush boards, the better to slip into pockets or

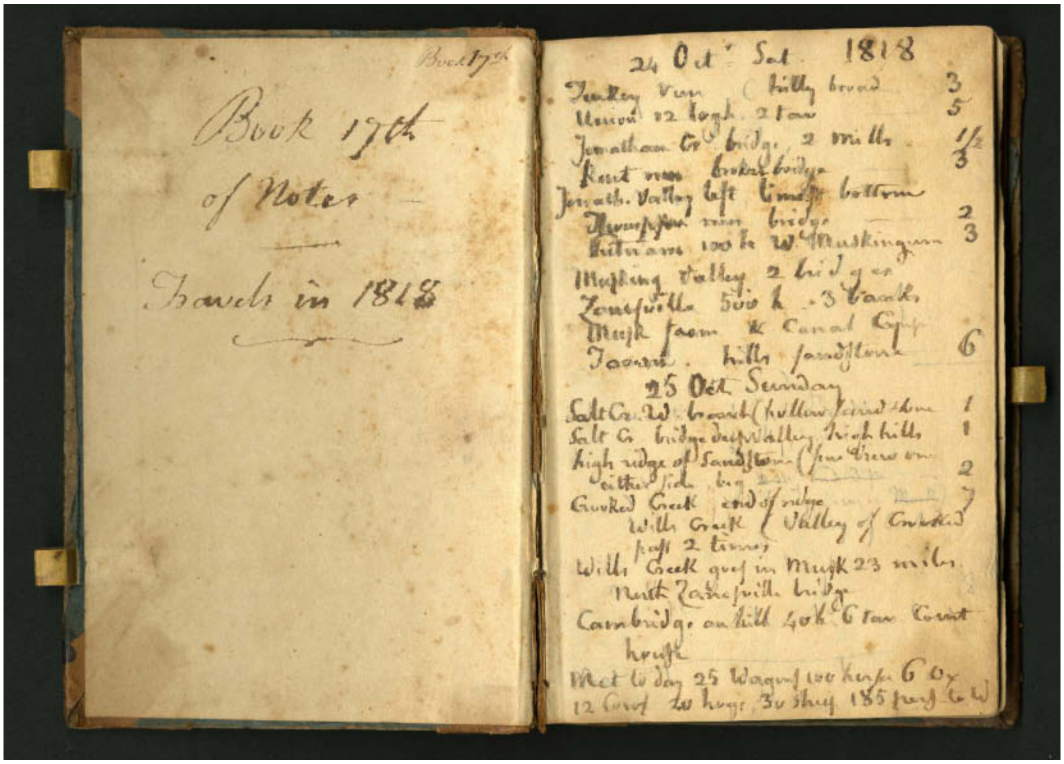

Fig. 1. An early field book (1818), made up of a blankbook with intentional pen loops, made of parchment, attached under the pastedowns. C. S. (Constantine Samuel) Rafinesque Papers, 1815-1834 and undated. Smithsonian Institution Archives. Record Unit 7250, Box 1, Folder 3, Image SIA2012-6043.

satchels, especially in small formats. While sturdiness under heavy field use is a desirable characteristic, so is flexibility and minimal expense, and one can observe minimally supported sewing, tight backs of leather and cloth, and covering material trimmed and/or colored with the book block. If handy details such as pen loops, ribbon ties to prevent loss, and cartouches or labels to bear owner information are not found in the purchased book, they may appear as vernacular afterthought interventions by the user (fig. 2). Specifically, labels and marks that designate the blankbook as a field book may be penned onto the front cover, endpapers, or first leaf. This customization is not limited to the 18th century, continuing well into today (fig. 3).

Instructions for Use(rs); Creators and Collectors

As exploration and Western expansion campaigns, systematics, and museology become more formalized in the 18th and 19th centuries, so do instructions for collecting (Overstreet 2018). Aside from specifying manner of capturing, describing, and preserving specimens, suggestions for documentation of observed phenomena that cannot be expected to be preserved—such as color—arise likely due to frustrations arising from incomplete information; the suggestions become more detailed by the provision of tabulated lists or preformatted forms for recording data. In the Smithsonian's own *Directions for Collecting, Preserving and Transporting Specimens of Natural History*, this is clearly observable with changes made from the initial publication of a "general list of apparatus for collecting" in which no notebook is mentioned (Smithsonian Institution and Baird 1852), to the later edition, which includes an enumerated list including a "Pocket note-book" (moreover, one "not liable to being defaced," which suggests one made up of a paper prepared for metal point [Baird 1859; see also L.R. 1828].

Eventually, envisioning repeat voyages to the same area over time, or to plan future uses of land, some sources—such as the U.S. Geological Survey (Rabbitt 1975), and Joseph Grinnell at Museum of Vertebrate Zoology, UCLA at Berkeley (Herman 1986)—develop complex systems for recording data in a consistent manner, so that notes over decades of research may be compared. Grinnell in particular made important contributions to regularization of note-taking, using a "card-system" (Grinnell 1912), leaving ample space on leaf versos of a written "field note-book" for drawings, maps, or photograph, recommendations to "always use Higgins' Eternal ink!" and "high-quality bond stock of a standard page size" for later permanent binding (Perrine and Patton 2011). The Grinnell Method is a triad system, regularized by 1908, of Species Notes, Catalogue, and Journal

Fig. 2. Fielding Meek's field books shows a preference for closures, perhaps for holding his pen. This series shows one with purposeful loops (left), and two altered after purchase with punched slits through which a leather strip (center) and a woven ribbon (right) are laced, respectively. Notebooks 2–4. Smithsonian Institution Archives Record Unit 7062, Fielding B. Meek Papers, 1843-1877 and undated. Box 10, Folder 2.

(completed in longhand with a lengthier description at the close of day from the "field-notes"), which continues in use today (Fidler 2013). Although Grinnell describes occasional pauses to write observations in a field notebook in 1912, when teaching, he actually did not include a notebook for use *in* the field (Perrine and Patton 2011), although many of his students surreptitiously relied upon them in actual practice, ever in fear of being caught out by teaching assistants (Herman 1986)! It is extraordinary to compare Grinnell's field notes, which appear remarkably consistent from over some 30 years' time, and also the legacy of scholarship built on that foundation (Museum of Vertebrate Zoology at Berkeley 2015).

Preformatting and Systematization

While many field books may be ruled, they may also be numbered or otherwise preprinted in a tabulated manner to provide the basis of lists of specimens, dimensions, land features, or other requirements. Again, this may be born of frustration of returning from the field with messy, irregular, or incomplete data. Form-based approaches lead to single-sheet loose-leaf or tear-away padded notebooks that may be then reshuffled, indexed, and compared via mechanical and, later, automated sorting systems. Perforated memo pads and prepunched holes offer utilitarian reorganizing ability from which formal notes can be written up longhand, or typed up more consistently, or with further interpretation in field journals. (Modern versions of these are discussed in a later section.) With the organization of museums and other formal survey organizations, labels declaring the function of the now-purposeful field book begin to appear mid-19th century.

CONTENT PROBLEMS

While it may be that form ever follows function, unsurprisingly, not every user follows the intended form, or intended function (of permanence, durability, and legibility). This next section shows some physical problems that result.

Smudges/Media Offset

A primary issue that we see that threatens access is legibility. Leaving aside critique of handwriting habits (see later section), soft or unbound media smudged and offset onto facing pages is nothing new to book and paper conservators. This is a similar condition typology to artists' sketchbooks and ledger art, more about which can be researched in the literature (fig. 4). Whether this happened from use in the field, is due to years of unmoderated direct handling, or derives from a condition issue that promotes friction such as a weakened structural issue, all are to be considered if one is assessing treatment to reverse smudges through erasure.

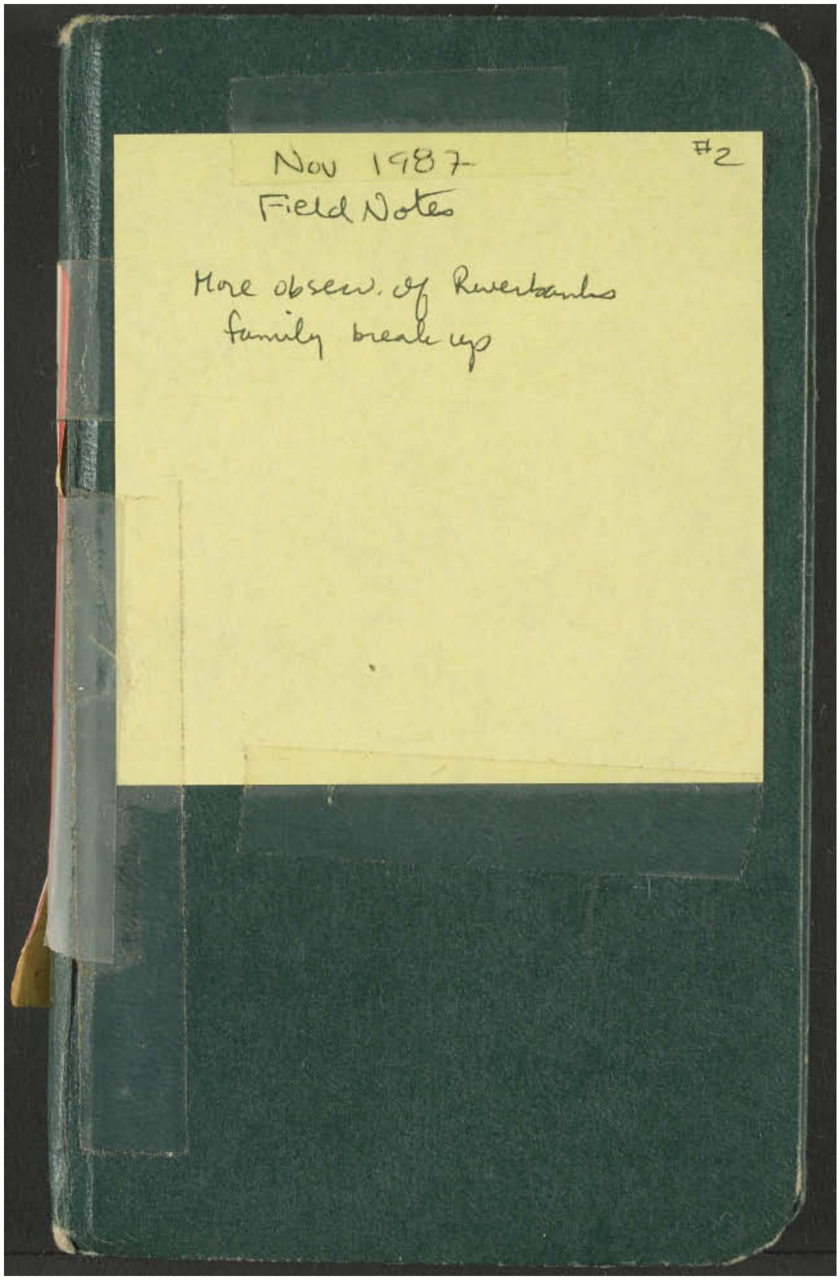

Fig. 3. The Post-it note as afterthought label, presumably placed by the creator. Indeed, her other ad hoc stationery blankbooks bear her handwriting on address labels, and other pressure-sensitive label stocks, reinforced with tape. Brazil field notes, November 1987, #2. Devra G. Kleiman Papers, 1967-2010. Smithsonian Institution Archives Accession 11-124, Box 9, Folder 21. SIA2018-036340.

Water Exposure

Also threatening legibility may be bleeding from water spots, water events, and more mysterious stains or splotches. While these may be evidence of use in wet field conditions or arrived via habit of taking refreshment at one's desk at the close of a long field day, certainly moisture-driven bleeding of manuscript indicates solubility. The worst byproduct of solubility includes loss of comprehension and risk of dissociation to specimens (fig. 5).

Inclusions

Inclusions, as used here, cover a very large portion of potential problems—adherends, inserts, attachments, specimens, photographs—in short, stuff.

Generally, original content relevant to the collector's practice or the collected objects is a reasonable part of practice. However, the choice to stuff contents into bindings not designed for that purpose can at times present issues of legibility, order, meaning, and physical behavior, including

Fig. 4. Soft pencil has offset onto drawings in ink on upper leaf, notes have faded and smudged to a point of illegibility (as noted by a transcriber in the online edition). Diary 1865–1867. William H. Dall Papers, ca. 1839–1858, 1862–1927. Smithsonian Institution Archives. Record Unit 7073, Box 20, Folder 3. https://transcription.si.edu/transcribe/8555/SIA-SIA2015-004545.

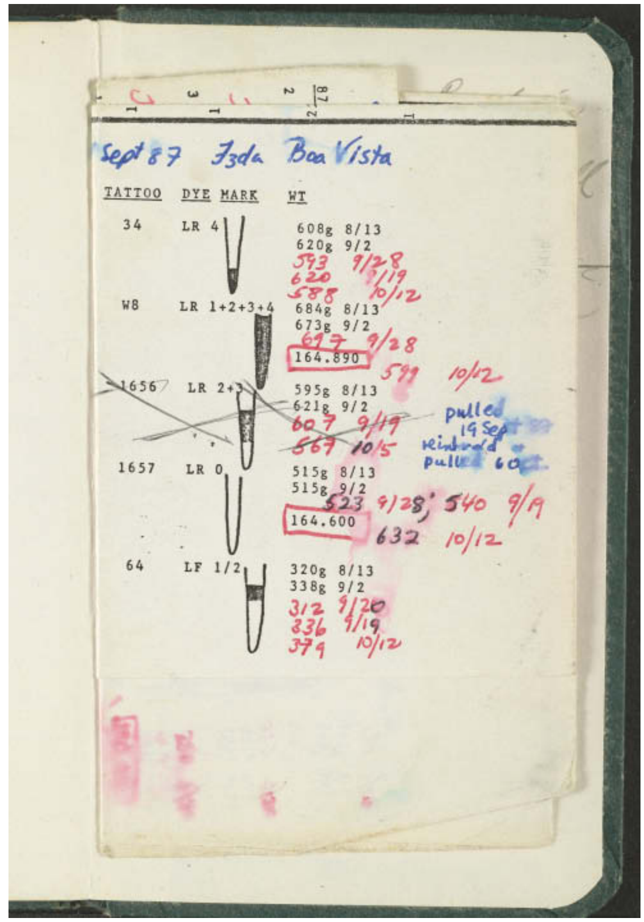

Fig. 5. Solubility leading to partial illegibility of field notes made with water soluble media. Brazil field notes, November 1987 #2. Devra G. Kleiman Papers, 1967–2010 Smithsonian Institution Archives Accession 11-124, Box 9, Folder 21. SIA2018-036357.

breakage and potential for loss whether in the researcher's workplace, catalogers' or digitization station, reading room, or stacks. Inclusions must be literally reckoned for image capture, as items must be enumerated for digital object naming, their placement should be in as reasonable an order as possible and the individual objects, tipped or loose, may have to be lifted or turned over by the photographer to be captured as unique objects themselves, and to view the written information on the primary support.

This is not dissimilar to intentional scrapbooks and albums for which much insight can be gained from the excellent contributions already in the literature (Scrapbooks 2018). However, those often have space built into them for the accumulation of content. In field books, inclusions can lead to: books yawning open; objects, heavier than the pages are meant to hold, dragging on page openings, and any number of afterthought attachments and ties meant to keep the contents inside.

Fragility or brittleness, crumpled edges or folds, chemical sensitivity, adhesive or attached restraints all present handling challenges to the end user. As such, interventions for handling purposes should be clear and easy to understand, and not add new complications, thickness, or change context and order, where it can be avoided. If an inserted object must be relocated due to an excess of dimensions, a key or list should be provided in the catalog record and annotation on the new housing to indicate original placement. Ideally, visual means such as digitization or conservation documentation in the original order will supplement the future reader's understanding. However, the reality is that for many projects on a library or archive level, mass treatment protocols apply and the documentation may not exist or be attached in a manner that follows the object into the revised or annotated catalog description. This is even true of some museums, as technical documentation often lives behind the firewall of the image service portal.

Order, like condition, is part of the object's history. Questions that should be asked prior to intervention toward inclusions include:

- Is the placement known or able to be reasonably assumed from dates, annotations, or contextual clues, such as adhesive remnants, stains or matching edges, handwriting, and content?
- Does the placement reflect the creator or a legacy user?
- Can the creator or colleagues in the research group be interviewed about habits or annotations they recognize?
- Is the inclusion actually damaging anything or at risk itself?

Inclusions—Adherends

For adhered objects, failure of the adhesive can lead to simple detachment or create page turning issues, such as hanging and pulling away from the recto during turning, which can lead to creases and dog-ears or detached body, leaving corner remnants behind still adhered to the page. Attempts can and should be made to treat in situ, but if the problems will likely reoccur, it may make sense to sleeve the inclusion in place rather than reattach. Alternately, reattachment with a flexible method, such as lightweight hinges rather than spots of adhesive, may be more sympathetic.

Inclusions—Attached and Inserted

In archives and libraries, original fasteners such as paper clips, staples, and pins, are usually seen as the enemy and are removed for the sake of bulk as well as rust- and tear-prevention measures. Yet to a hammer, everything may look like a nail—or pin—and important contextual history may be lost. There are reasons to review immediate discarding practices, if not substitution of hinges or sleeve for the mode of attachment, of pins. Use of pins to attach important items in books and correspondence are a tangible record of early writing practice (Sutherland 2010, Duroselle-Melish 2015). In field work, colleagues may travel in multidisciplinary research teams, and may be sharing scarce material resources. If perhaps one's mucilage had frozen or wafer seals had run out, it would not be surprising to ask a neighboring entomologist for an extra pin, or to purchase ad hoc materials in the next available town (Hall 2013; Young 2014).

Loose inserted materials may be bundled in envelopes, tied, or rubber banded together. For folded materials tucked in alone or in envelopes, risk of repeated wear and tear to view the contents may be the primary reason to intervene, but bulk too can play a part (see Structural Problems: Breakage and Difficulty in Opening).

Inclusions—Biological

Aside from dimensional materials that may be held in place by pins, such as extra voucher specimens, some biological inclusions might at first fall under the category of mysterious stain or splotch. In botany, it is not uncommon practice to take rubbings or prints of leaves to capture vein formation; for example, a researcher took prints directly from a prickly pear fruit to capture the cross-section (fig. 6). A vertebrate specialist noted their attempt to retain the distinct color and reproductive organs of a frog (fig. 7), although, from the written description, it appears the color did not stand the test of time or pH change as it dried and aged. Although degraded, there could be genetic material present in either sample that could be a subject for future analysis.

Inclusions—Specimens

As a fitting end to Inclusions, the eponymous snakeskin of the title was a surprising find, loose and flat but nearly broken between pages of a field book. This, among more usual finds of leaves and flowers, can be mounted as a specimen, following guidelines for herbarium mounting including the use of nonbuffered rigid supports and ribbons of *hanji* or *washi* to serve as retention strips, rather than adhering the specimen overall. Alternately, for very small or irregularly shaped objects, scrap slips of .003 in. Mylar might be used to spot encapsulate. Because the rigidity of even a 40-point folder stock with overleaf adds extra bulk to a small volume, consider insertion of a note placed at the back of volume or within a four-flap enclosure with an annotation about where the object was found (e.g., found between pp. 14–15; facing entry for July 16).

STRUCTURAL PROBLEMS

BREAKAGE AND DIFFICULTY IN OPENING

Breakage can happen against hard edges for brittle papers, perforated pages (intentional tearaway pads, punctures from

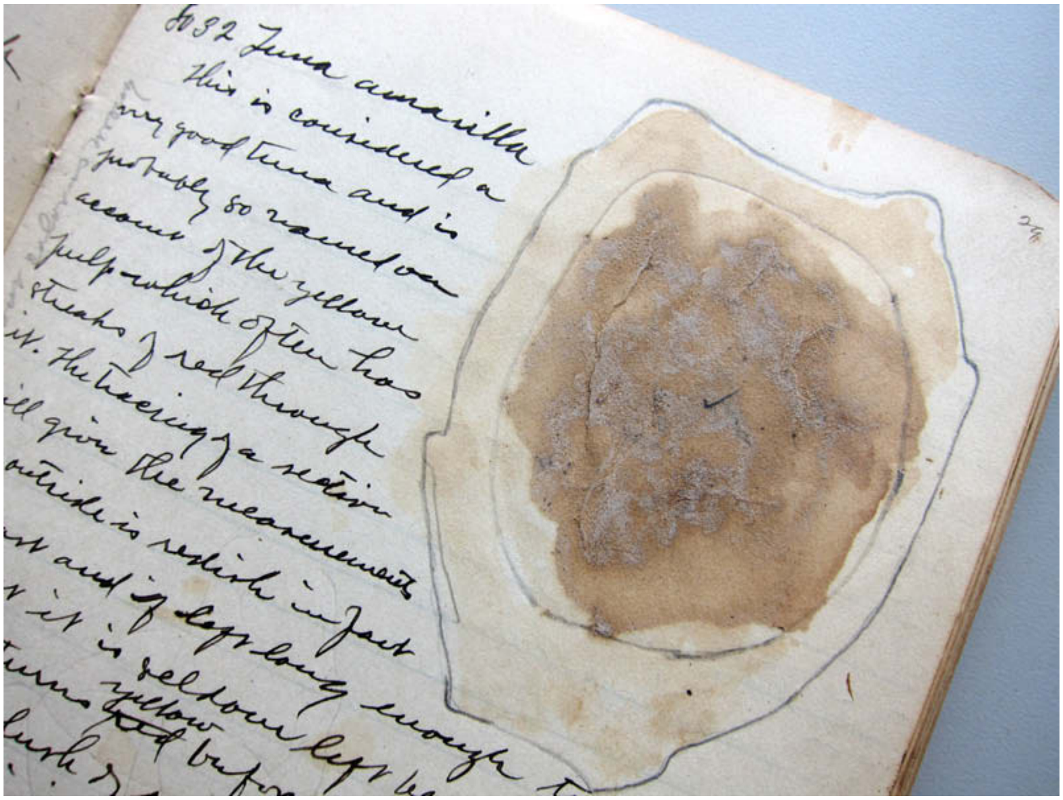

Fig. 6. Print taken directly from the prickly pear fruit, with encrustations of biological material. D. Griffiths' field notes, Texas and Mexico, 1905. Smithsonian Institution Archives Acc. 11-106. Photo by Emily Hunter (Hunter 2012).

machine top-stitching, spiral wire binding, screwpost binding, aggressive oversewing), or those restrained by metal keeper strips or restrictive clamp binders. Figure 8 is a composite image showing many features that lead to breakage. Although the intention is a tearaway structure for later use of individual page content in a loose-leaf system, its *actual* use was as a journal written out in a serial codex and was retained in that fashion. In long-term use, the perforated leaves break against the rigid tearaway strip with repeated turning.

SECONDARY BINDINGS

Bound-withs/sammelbands/*stubbed-out Library Bindings*

Over time, and for various reasons, original field books may have been relieved of their primary bindings and rebound. In the Grinnell system, that may always have been a goal, to bind into a permanent sewn structure beyond their ring-binder format of matched size. For some books found at the Smithsonian, secondary bindings appear to have been a way of uniting no-longer "working materials" in a more physically convenient, that is to say, *shelvable* library, not archive, format. At some point in their history, the decision to remove original covers and sew small and tall, thick and thin books into stout buckram library bindings (reflecting a series of numbered logs or the results of a, or several, field seasons' work) was made. It is a general assumption that the books were sent out to the Government Printing Office, which previously served as bindery for the Smithsonian Institution. It is important to recognize that this imposition of library binding practice was done presumably as a preservation effort prior to establishment of current best practice preservation standards. It is unclear whether it was the creator's or a legacy researcher's decision to rebind the books or if it was understood that there would be limited openability of the chosen structure. Even books that opened well and stood steadily on shelves (such as the ubiquitous green cloth-covered government "record book") were occasionally subjected to this procedure (fig. 9).

Many of the manuscripts were pulled from their original covers and method of attachment, guarded with adhesive tape, sawn-in, oversewn, or sewn through the fold over cords or tapes along with makeup stubs added to manage height differences, rounded and/or backed, (sometimes) trimmed, and heavily lined before casing in. The degree of opening already being limited by the heavy hand of the bookbinder, excess material, and rounding, over time the opening behavior became worse as the materials deteriorated. In most cases,

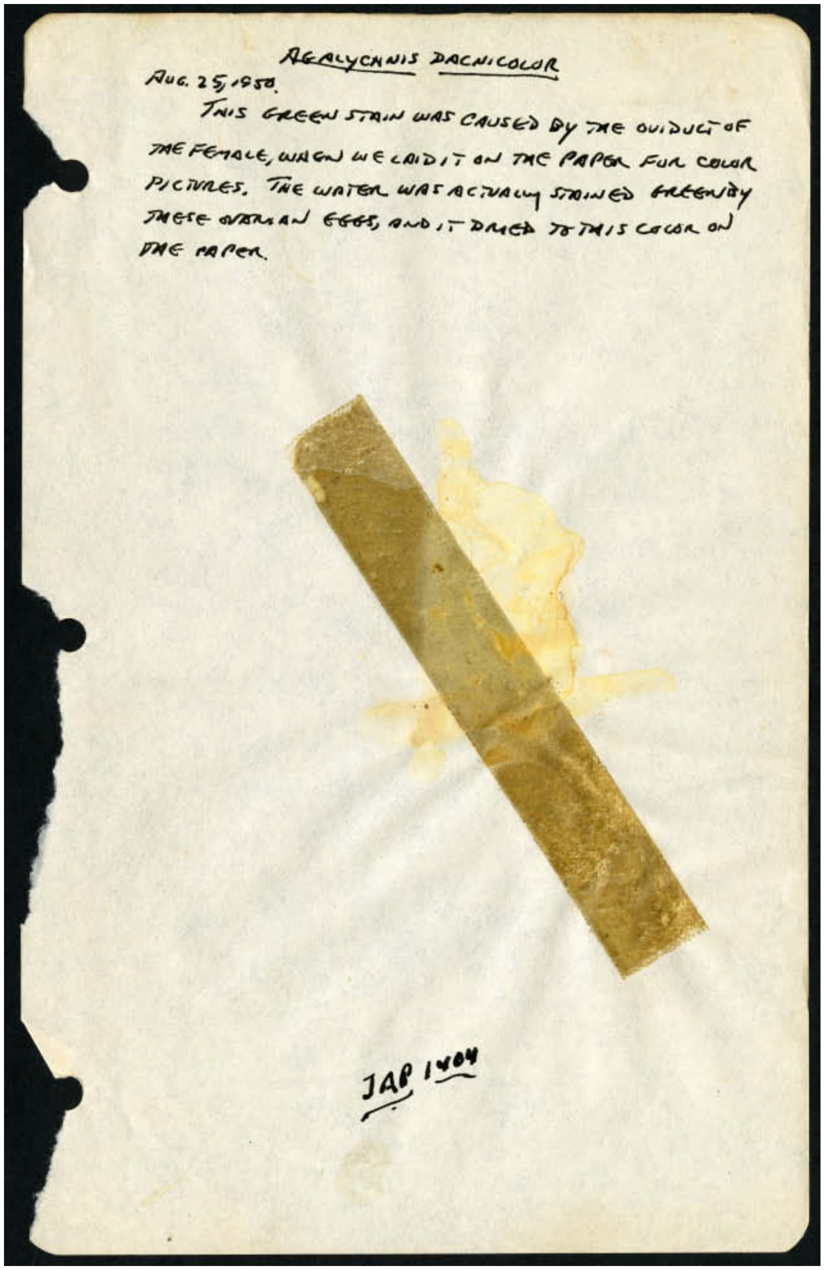

Fig. 7. This inclusion may contain DNA from soft tissue materials and its original color is described above: "This green stain was caused by the oviduct of the female, when we laid it on the paper for color pictures.… it dried to this color on the paper." Field notes: Mexico. James A. Peters papers, and records of the Division of Reptiles and Amphibians: series 15, field notes, 1946–1965. Smithsonian Institution Archives RU 007175, Box 49, Folder 4. SIA2012-6355.

but especially where the researcher had a habit of scribbling well into the center margins, the content simply could not be read, now being trapped in the spine fold. Worse, to gain access to the information, users pushed open the book to the extent possible and beyond, leading to breakage at the spine and in the leaves.

The degree to which the book opens—or will open as a result of treatment—is an extremely important consideration in choosing a course of action. Not only does it permanently affect the book and its contextual understanding, it also affects the apportioning of staff time and labor, from the conservation lab down through the workflow queue. A flat or nearly flat opening greatly increases the ease and success of digital imaging and readership. For the field books, a flat opening is nearly always an original characteristic that was lost through a well-meant but overzealous intervention. The behavior

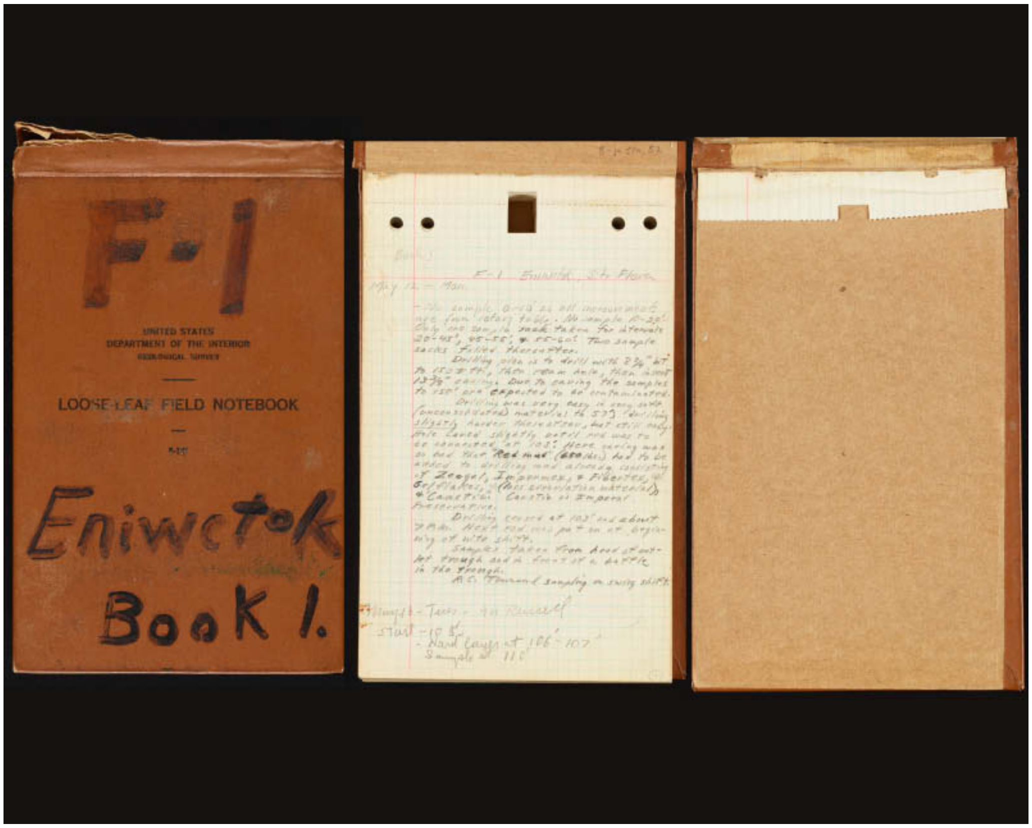

Fig. 8. This composite image usefully shows several features that lead to breakage. Rigid cover (left), rigid strip to tear against and punched holes for a Rolodex type binder with serial descriptive writing that continues to the following page (center); last leaf torn away at perforations (right). Harry S. Ladd-Eniwetok, book 1, May 12–June 1, 1952. Chalmer L. Cooper papers, ca. 1932–1944. SIA Acc. 16-046.

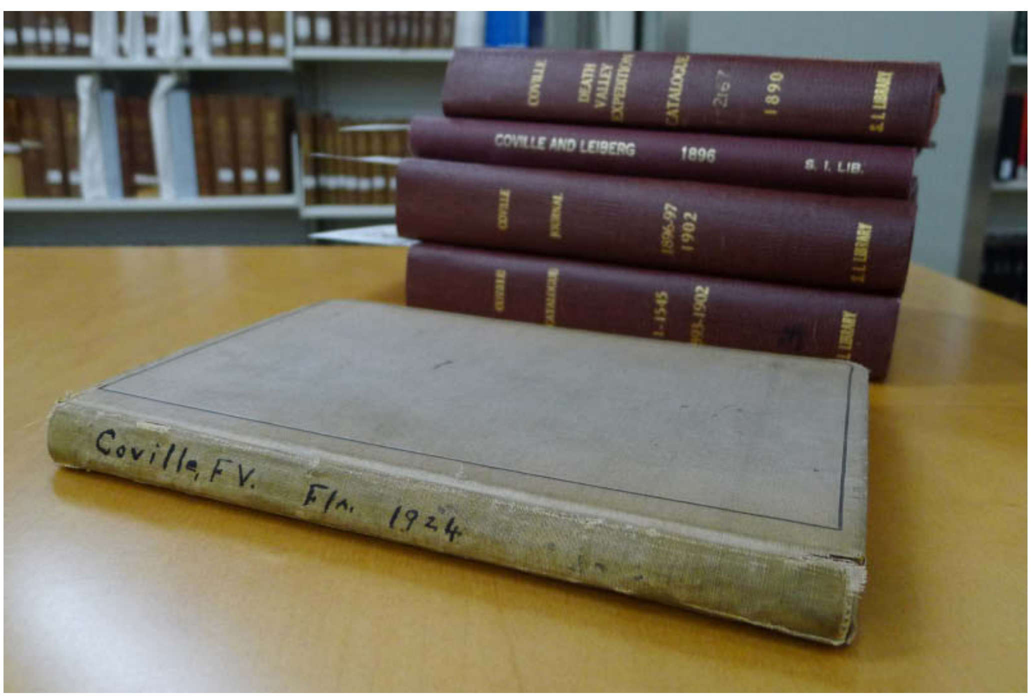

Fig. 9. A Frederick Coville field book in its original format, a typical green canvas government notebook, in front of bound-withs of his later notes.

many researchers had of writing well into the page margins can be proof of this. Important data such as specimen numbers, names, drawings, and more may be blocked from view by secondary bindings. Inclusions—often specimens, or evidence thereof—encountered trapped between the pages are at risk of disassociation or breakage. A restricted opening due to oversewing, adhesive run-in or pressure-sensitive adhesive creep, or other factors can lead to damage incurred and loss of information during digitization or handling in the reading room, particularly if the bookblock is made of fragile or deteriorating paper. These problems all lead to risk of disassociation and loss of meaning of the related collection object.

Treatment Options

For these reasons of preservation and access, where possible, the authors' choice to restore the flat opening characteristic serves to fulfill their purpose as data recording tools that communicate over centuries. A conservation rebinding treatment that facilitates flat opening for imaging of the book is desirable and helpful and may demand the disbinding of a secondary structure, for an improved preservation status (fig. 10).

When making a treatment choice that affects the structure of the volume, several factors are at play; returning a book to its original, working, or most complete state is often the goal. However, there is not always sufficient evidence to determine an original structure exactly. Some clues may remain, such as a lone volume—one by the same researcher that was left out of a rebinding campaign, or a clipped fragment of a cover that was bound in as a vestige (fig. 11). These can serve as models to match a particular researcher's habits in material selection and preferences of notebook style.

In rebuttal to the practices of the past, the conservators on the Field Book Project have found that one size does not fit all, and have had an opportunity to experiment with

Fig. 10. A composite image of a secondary bound-with, including adhesive tape guards (now brittle), makeup stubs, and heavily lined binding, compared with a flat-opening conservation binding.

Fig. 11. For it's secondary binding, the library binder had obligingly cut and pasted in a fragment of the original cover onto the flyleaf, from which the color of the covering material was selected for the conservation binding (long-stitch with sewn-boards). Alaska notes 1897. Walter H. Evans field book, 1897. Smithsonian Institution Archives. Acc. 12-033.

applying treatment variations on sewn-board, long-stitch, and laced-case bindings, which with their flat opening and flexible structure (Miller 2014) particularly suit the needs of both the object and the end user. In addition, choosing to rebind bound-withs into individual volumes returns both intimacy to the unique field book and improves space use and handling if the book is transferred to a managed archive as has happened for some of these collections. (The irony of imposing another treatment to aid a storage need is noted.) The variations on these treatment options are explored fully in the accompanying poster session from Houston 2018 (Bennett and Lockshin 2018). A treatment matrix, arranged along axes of lower-higher technical complexity and closer-further fidelity to the original is incorporated, along with images showing degree of opening and other practical considerations for the conservator. Some notes are captured here and in table 1.

- Rather than restoring the oft-found tightback spine in these practical but inexpensive bookblocks, choosing a natural hollow or baggy back allows the spine of the bookblock to flex freely and open flat.
- Insertion of blank endpaper folios with return guards in a sewn-board binding may provide added protection but may be discordant with the material experience of reading notebooks, which are not always preceded by flyleaves.
- Variations on the sewn-board binding and covering include one- and three-piece styles:
    - Covering sewn-board bindings may be easily done from one piece of case paper, done up as for traditional covering in full leather (turned in or trimmed). This echoes the standard sewn-board convention of incorporating the exterior covering into the sewing structure of the book, albeit in a different manner.
    - The three-piece version permits an aesthetic finish that mimics the cloth or leather quarter binding, and in a long-stitch allows a separate scored spine piece to be perfectly sized to the spine during sewing and tucked into boards used with their opening to the spine, and the fold to the fore edge without worry of premaking a full case of folder stock. This can make for effective use of scrap material.
    - In instructions for sewn-board binding for modern editioned books, squares are trimmed flush at board edges—this mimics an original characteristic of stationery notebooks. However, since the book will no longer need to be slipped into a vest pocket or satchel (one hopes!), choosing to extend length and height of the sewn boards a few millimeters to protect vulnerable edges at all sides is a preferable option. A yapp edge can also be factored into one's measurements.
    - Similarly, while double-sided pressure sensitive adhesives are used in some sewn-board bindings for modern works for speed and simplicity, more stable adhesives that do not creep may be preferred for items of permanent value.

Problem	Goal	Strategy	Solutions
Breakage—along leaves, against memo pad stiffeners, perforations, or tight-turning radius	Loss prevention; mitigate damage	Reduce handling. Intervene. Consider release or modification of restrictive stiffener, prong clamps, posts, ties. Consider rebinding to a conservation structure.	Intervene with damaging structures, retaining parts of attachment method with book in box or enclosure. Mend tears. Add alternate hinges, channels, or photo corners. Adhere/tip with reversible adhesive where appropriate. Sleeve in buffered paper folders or safe plastic enclosures if static is not a problem for adjacent material. Reduce pressure-sensitive adhesive.
Difficulty opening, content inaccessible or damaged due to structure[1]	Increase access	See Breakage above. After due consideration of creator's intent and practice, consider rebinding to a period-appropriate or conservation structure.	For secondary bindings: Disbind (pull oversewing), repair, and rebind in original or sympathetic format, or box if brittle. Consider individual bindings such as sewn-board binding or long-stitch binding for small pamphlet, pocket-size notebooks, and/or boxing individual small books or pamphlets together in a set. For loose-leaf material in damaging binders: Remove/release damaging attachments (prongs, spring clamps). Provide enclosure (box or four flap). Consider double fan adhesive bind.
Inclusions—adherends	Loss prevention; mitigate damage	Reduce handling. Isolate damaging chemical interactions.	Add photo corners or hinges. Adhere/tip with reversible adhesive where appropriate. Sleeve in buffered paper folders or safe plastic enclosures if static is not a problem for adjacent material.
Inclusions—pressure-sensitive adherends	Loss prevention; mitigate damage, w/o interfering with meaning	Consider value of creators' field use and repair vs. binders' conservation campaign	Pressure-sensitive adhesive removal, if content is not soluble or written on tape. If appropriate to replace in situ, replace tacky or nontacky adhesives with reversible conservation-grade adhesives or add hinges.
Inclusions—loose, biological	Loss prevention; mitigate damage; retain physical integrity (DNA; parts for identification)	Reduce handling. Provide in situ mount or move to back within a new enclosure, noting location.	Mount per herbaria specifications. Use thin four-flaps and folder stock to add rigidity. Use unbuffered materials if possible. Consider creating layers or tray in a box or enclosure to protect materials from flexing, weight, and abrasion.
Inclusions—photographs	Loss prevention; mitigate damage	Reduce handling. Isolate from damaging chemical interactions.	Add PAT-passed photo corners or hinges. Add PAT-passed interleaving.[2]
Pressure-sensitive tape (see also Inclusions—pressure-sensitive adherends)	Mitigate damage, w/o interfering with meaning	Intervene or retain. Consider value of creator's field use and repair vs. prior conservation campaign	Tape removal, if content is not soluble or written on tape. If appropriate to replace content in situ, replace adhesives with reversible conservation-grade adhesives or add hinges.
Smudges, offset media	Reduce loss of meaning	Reduce friction and movement	Consider interleaving with low-friction papers. Create enclosure or box. Stabilize sewing with physical intervention. Consider using variable wavelength imaging for virtual restoration. If media can be differentiated, consider surface cleaning for legibility.

1 Restrictive or damaged opening behavior, due to stab sewing, spring-clamp binder, stiff makeup stubs in bound-with/*Sammelband,* crumpled spiral wire, or secondary oversewing or library binding (Bennett & Lockshin 2018).
2 (Bennett 2017)

Table 1. Best Practices for Preservation of Field Books

OTHER ISSUES

FIELD ADAPTATIONS AS EVIDENCE

Field conditions may result in visual clues that impact the creation of the field book, such as running out of space or materials, which might be commented upon in a close read of the text. For instance, problems with media: *"Still pencil. Well, I've got time and temperature to write. Just sharpened the pencil with a now know [sic]. We are parked smack in the middle of Southampton Island, in a bloody wind storm …. the ink is still frozen solid, in fact everything that I own is frozen solid -- camera etc."* (Smith, n.d.).

For copious writers, running out of material in the field can be an issue. There is both charm and site specificity to be found in material evidence of a quick trip to the local stationer for a suitable blankbook, observable by the close reader from a stamped cover or stationers' ticket printed in the language of that place. However, if re-provisioning is difficult, when needed, it seems that researchers in the field will perhaps turn to almost anything to scribble a needed note. Purloined hotel letter paper, the backs of envelopes, forms or field labels, or local receipts have all found their way into the sections or between covers of a formerly slim, now yawning book. For those creators who were habitual scrap-hoarders, the overstuffing can lead to problems of retention of notes, overuse of attachments like clips, tape and staples, and stuffed envelopes (Bailey 2012).

CREATORS' QUIRKS

Aside from hoarding and creative reuse of material, another strategy of the thrifty writer that may create media legibility issues is the technique of crosswriting, self-annotating, and/or use of the field book in reverse orientation from back to front, which can cause headaches for the most attentive user in trying to work out a beginning or end (fig. 12).

STAKEHOLDERS' PERSPECTIVE

The conservation team at the outset must consider the impact of treatment on the end user, whomever that may be. Whether professional staff or an outside researcher of any level of education and experience, physical interventions should make sense to operate or be recognizable so that interpretation is of the original object. In a virtual space, how are interventions perceived? Some might suggest that interventions (such as housing supports) should not be seen at all, but the fact is that, often, digitizing campaigns are staffed and proceed at a pace that outstrips that of the conservation lab. The balance of "low-hanging fruit," easy-to-scan material that someone assessed as not needing to pass through a conservation queue, may show more items in worse condition with more tears and tape than can be mended, although one wishes the reverse were true.

A hubris of having a supervised reading room is that an assumption is made that the reader will natively understand the workings of a four-flap envelope, the arrangement of a layered storage box, etc., or will ask for assistance. In the virtual space, when persons are focused on clickable content and not perceiving as much dimension and do not have the immediate ability to raise a hand to request assistance (aside from Twitter), misinterpretations can and have happened. For instance, the eponymous snakeskin was described in the Transcription Center as "shed snakeskin taped to page," when in fact it was a painstaking adaptation of an herbarium mount without any adhesive contact, and certainly not to a page of

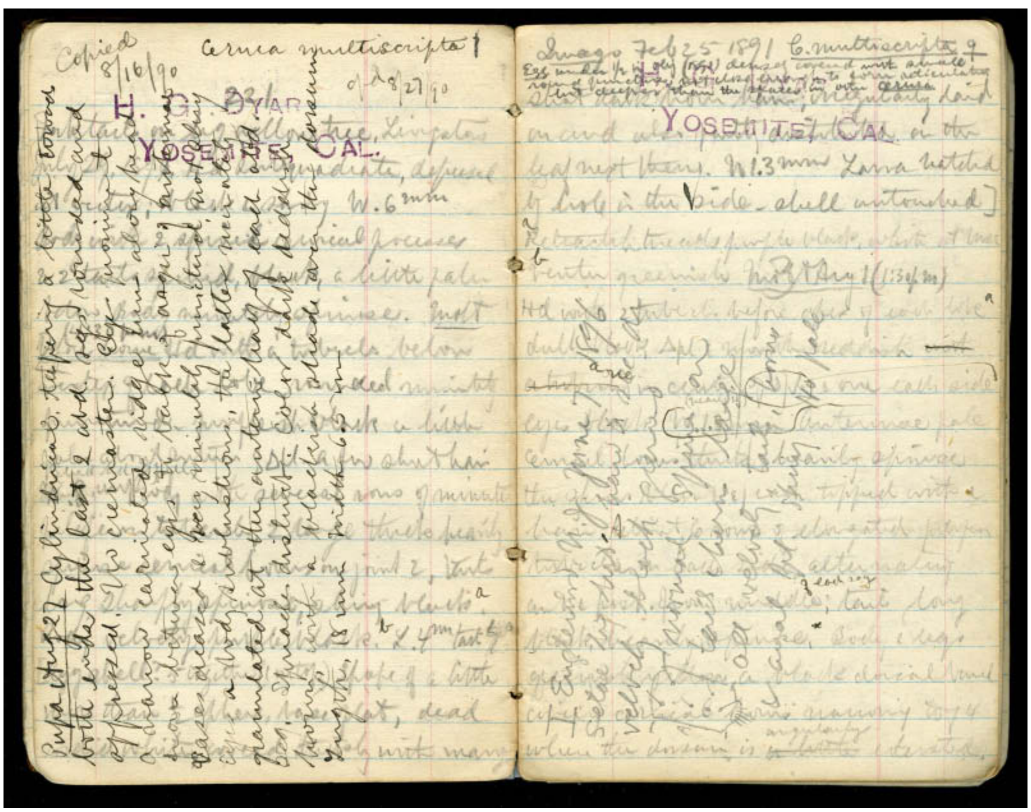

Fig. 12. Harrison Dyar had many quirks, one of which was extreme use of annotation, writing extremely small notes between the lines, cross-writing, and use of stamps. He also was a copious user and stuffer-in of scrap papers. H. G. Dyar bluebook 213–270. Smithsonian Institution Archives. Harrison G. Dyar Notebooks, Department of Entomology, 1882–1925. Box 1 Folder 5. SIA2013-00700.

the field book. This may be a nitpicking blow to a conservator's ego but, more importantly, this instance teaches that not all aspects of standards of care are well communicated to the end user in ongoing mass digitization. There is hidden labor that is ignored, and teaching opportunities are missed. Happily, the virtual space is editable, and now reads "shed snakeskin, mounted to support board, inserted between pages." When they have raised their virtual hands via Twitter, our Volunpeers have meaningful interactions with each other and staff on material matters.[1] Comments on digital humanities topics have included "[t]he paper…could be evidence" and "Didn't know they had hot pink pens in 1888!" resulted in a dialog on the invention of synthetic dyes. Working with the Transcription Center staff going forward, it is hoped that a guide will be developed to encourage transcribers to use the comments field to remark on physical aspects, outside of the textual transcription only.

PRESERVATION OF FIELD BOOKS

The preservation and conservation practices established at SIA are based on values and goals mutually held by the entire project team across the collecting units. Over the course of the project, a local manual with visual guide and condition ranking guidelines was developed to guide catalogers in assessment of potential intervention needs as books passed through their workflow. With training in preventive care, based upon technical capabilities of flatbed and overhead imaging, the preliminary assessment of condition led either to preservation review or was bypassed directly to imaging. Ideally, in this work plan, problems are addressed prior to digitization, but it happens that a cataloger or conservation assessor might miss identification of a potential problem that would be encountered later in the workflow. As a good portion of the funding of this particular project has been through sequential grants, staffing levels, fluidity, and expertise with the established protocols have naturally varied over time. Happily, quality and longevity of a project may be improved with access to new technologies or equipment, or increased attention, interest, and support; however, these factors may increase demands in terms of numbers of objects to put through, based on staffing increases in one area versus another. On any long-term project, at times, the work of cataloging, collection management, conservation preparation, and imaging staff may become out of sync in an envisioned ideal workflow, due to attrition or increased demands. This eventuality should be a consideration in any treatment that causes a significant change to an object that may put safe handling and use at risk for an unknown period.[2]

For those books that needed preservation review and further conservation intervention, a summary of best practices derived from reviewing the solutions applied in conservation over the years are presented in table 1. This list is not exhaustive but runs a gamut of options for collection care managers, preservation managers, and conservators. Basic technical skills such as selecting or making enclosures are presumed, while options for intermediate and advanced skill mending, board reattachment, sewing stabilization, and conservation rebinding are presented for those with such resources at hand.

FUTURE OF FIELD BOOKS—GOALS AND NEW FORMATS

Support for ongoing contributions to the Smithsonian Field Book Project blog, archived on BHL, is moving to SIA. As field books continue to be cataloged and added to collections as official accessions, they will be given preservation assessments and prepared for digitization along with the rest of the archives' imaging goals. While grant funding has concluded for the time period, future goals include (starting with this publication) contributions for varied audiences through parallel publications that reach a variety of collections professionals. An informal but terrific resource includes offering pathways to guidelines and best practices through conservation-wiki.com and SPNHC Wiki, both accessible resources online without subscription. The authors invite collaboration and suggestions to improve information on preservation of field books and notes.

CONTEMPORARY FIELD BOOKS

Areas for Research

As the field-note-taking practice has expanded with technologies (from writing and drawing to silver and color photography to tabulating and computing to born-digital documentation and mapping), still the physical field book persists. For a culture heritage worker, it is extraordinary to observe the emergence of debate about the physical act of writing as a memory aid in everything from technical to self-help literature to marketing materials for the newest, most perfect notebook or note-taking system ever invented. There is even now an enormously popular brand of pocket journal called Field Notes (2007–), along with stalwart tools of the trade, Rite in the Rain (1916–), and specifications for USDA field books (National Resources Conservation Service n.d.; Schoeneberger et al. 2012) meant for outdoor, foul weather, or underwater use. Aside from field book characteristics and features previously mentioned, the latter offer options for water-resistant or waterproof substrates. These plastic-coated, infused, or fully plastic "papers" are made with a variety of processes and have qualities of permanence, as proven in use demonstrations and anecdotal testimony of at least one conservator (Wellman 2018)! Materials such as Rite in the Rain's proprietary papers (Rite in the Rain writing paper, DuraCopy, and Weatherjet) do not appear to have been examined in conservation literature and provide a research opportunity.

Technical Performance and Permanence of Marking Media and Proprietary Substrates

Although marketed as durable, and some meet standards of permanence, what are the aging characteristics of such field books and media used in them? A brief interview with Rite in the Rain specialists advises that their use of archival paper, coated with a water-based acrylic resin, meeting NISO Z39 specifications for some parts of the product line, has been in production since 2006, which can offer a timeline cutoff for expectations of aging behavior. Prior to that, a variety of paper stocks were used that were coated or infused with "a solvent borne material" (Kopriva and Mattingly, pers. comm.). Fully synthetic polymer field books made by Field Notes and Rite in the Rain DuraRite (and DuraCopy) use "tree-free" Yupo, an extruded and stretched polypropylene sheet. Elan Publishing Company's Surveyor Field Books vary between the Indestructible, made of an unspecified polymer and one with "50% cotton content … especially formulated for maximum archival service, ease of erasure and protected by a water-resistant surface" versions (for those companies not yet interviewed, these descriptions are taken from marketing materials). In author Lockshin's casual "field tests," writing when dry or wet using a variety of pens (Fisher Space Pen, Rite in the Rain All-Weather Pen), marketed for use on all of these brands' substrates, produced varied results for solubility, traction, and precision of mark.

Hybrid Physical and Born Digital Proprietary Formats

Newer to the field of stationery and the physical notebook are the hybrid physical and born-digital proprietary mated formats. Some are preformatted with dot grids or other print encoding to work synchronously with imaging and "smart" devices and systems, such as recording pens that interpolate movement into text capture or graphics for immediate use in e-devices or cloud-based storage (Evernote, Moleskine Smart Writing System). Lastly, other styles of erasable substrate (Elfinbook, Rocketbook) notebooks designed for image capture in pdf or other digital format echo the earliest of recording instruments, the clay or wax tablet and stylus. It is to be wondered if these, in any subject area (field book, notebook, or sketchbook), will become the palimpsest data and imaging challenge of researchers in the future.

ACKNOWLEDGMENTS

This overview would not have made possible without the work of many staff and colleagues in the National Museum of Natural History, Office of the Chief Information Officer, Smithsonian Institution Archives, and Smithsonian Institution Libraries involved in the Field Book Project. For their transcriptions, which allowed keyword searches for the physical phenomena described above, our keen-eyed interns and Volunpeers, who continue to do great work and may be followed on Twitter via @FieldBookProj and @TranscribeSI. For helping to open, fill in, and close the contents of these notes, Sarah D. Stauderman, Lesley L. Parilla, and Consuela E. Metzger. Funding for the project was received from the Arcadia Foundation, the Council for Library and Information Resources, Save America's Treasures, and the Smithsonian Women's Committee.

NOTES

1. "Volunpeers" was promoted for use as a Twitter hashtag along with @fieldbookproj by Meghan Ferriter, Smithsonian Transcription Center Project Coordinator, in 2014. She worked in the social space to create "increased opportunities for interactivity and connection over task and content….'Volunpeers' underscores the values articulated by volunteers describing their activities and personal goals on the TC, including to learn to help and to give back to something bigger." For Ferriter: "establishing a collaborative space that uses peer review means foregrounding what is being done *together* rather than exclusively highlighting what is being done by particular individuals" (Ferriter 2016).
2. With the benefit of hindsight and an overarching view from the pilot initiative to today, the lead author notes that a beautifully envisioned workflow that serves all teams' efficiency and goals, and which maximizes benefit to the object, may be disrupted by new stated priorities for a variety of very good reasons. As example: When seeking examples for figures in this article, it was discovered that some books initially prepared for digitization (including pulled sewing from unstable or overtight structures for flatbed imaging, with a recommendation to return for conservation rebinding) were withheld from the imaging queue due to changed priorities for content delivery. Therefore, some entered a sort of limbo of staging, although available for limited reference access on demand, putting the order of unpaginated leaves and content at risk. Another example: Discovering that one out of a set of related field books had been assessed and sent for treatment based on content priorities of the cataloger, where multiples of the same condition problem exist adjacent. In the future, its sibling objects may be pulled to the reading room precisely because they were not digitized, but, as they were not captured in an item-level conservation assessment, remain vulnerable to damage in use. This case shows that non-condition-related selection criteria can disrupt goals to improve the collection holistically, creating significant differences in housing or condition between like objects. Today, the authors are reviewing these prepared, but still awaiting imaging, items to reduce some of these risks, add to the list of collections care established priorities, and provide ample opportunity for further work in this area. For more perspectives on large-scale digitization projects' influence on conservation project management and outcomes for objects, see also the position paper by conservators Biggs and Khan, 2015.

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Martín Ramírez's Creative Compulsions: The Composition, Construction and Conservation of His Monumental Collaged Drawings

Like many "outsider" artists who were not championed by the art establishment until late in their careers or well after their deaths, Martin Ramírez was, until recently, somewhat of a mysterious figure. The details of his biography were scant, and the 42 years that passed between his death and their coalescence in a 2015 biography by Victor Espinoza bred apocryphal tales of his artistic process (Espinoza 2015). Ramírez came to the United States from Mexico and became a migrant worker who found himself homeless on the streets of Los Angeles, only to be incarcerated in the state's mental hospitals for the last decades of his life. His isolation and misdiagnosis as a mute, catatonic schizophrenic fueled rumors that without access to art supplies, he was compelled to squeeze grapefruits to make ink from their juice; to macerate bread, mashed potatoes, and cereal to make adhesives; and to use small amounts of charcoal derived from matchsticks removed from garbage cans.

While it is true that Ramírez's circumstances necessitated ingenuity, such descriptions of his desperation detract from the technical skill, sophisticated visual lexicon, and thoughtful revisions that he employed in the production of some 400 extant drawings (as well as many more that were destroyed by hospital staff) over a period of three decades. Fashioned from papers that Ramírez removed from wastepaper baskets and magazines, from the cafeteria's paper placemats and napkins, and from paper bags of all sorts, the artist's collaged supports are works of art in their own right that possess a tactile three-dimensional quality. His imagery includes trains that pass through tunnels, men on horseback, Spanish colonial-style architecture, and towering Madonnas to name only a few.

In anticipation of the inaugural exhibition for the new Institute of Contemporary Art in Los Angeles (ICA LA) in September 2017, a large number of Ramírez's drawings housed in Chicago collections were examined, and those from the collection of Jim Nutt and Gladys Nilsson, who are noted artists in their own right, underwent more in-depth study and conservation treatment. Among them, a monumental 17.5-ft.-long drawing would become central to the exhibition after a major conservation intervention. The project began by learning as much as possible about the various materials Ramírez used to make this monumental drawing and others. The approach was to examine and treat, as necessary, as many drawings as possible before turning to the task of conserving the monumental drawing, referred to here as "the scroll" (fig. 1).

The artist's biography provides critical insight into the circumstances under which Ramírez made his art. During his incarceration at the DeWitt State Hospital in Auburn, California, Dr. Tarmo Pasto, an art professor who taught painting at nearby Sacramento State College, took an interest in Ramírez's work. Pasto, also a nonpracticing psychologist, sketched the layout of Ramírez's ward, the cramped confines that seemingly did not deter the artist from working so prolifically and often on a large scale (fig. 2). Ramírez would store countless rolled drawings under his bed and on top of the radiator until there were so many that they were removed and presumably discarded by hospital staff. Dr. Pasto gathered hundreds of the artist's drawings from 1948, the year Ramírez entered DeWitt, until 1960 (when Pasto retired from the college), and he sometimes supplied Ramírez with better quality papers and a few art supplies. "Better quality" included a sturdy butcher paper, which to Pasto "…would not tear easily," a pad of typing paper and some stationary, including one brand watermarked Hammermill Paper (fig. 3).

By 1968, when Jim Nutt and Gladys Nilsson first saw the collection amassed by Dr. Pasto, unrolling drawings on his driveway, and later after they were acquired by the couple, in their own home, they immediately realized that the rolls of drawings had deteriorated. For years, they had been stored in the physician's garage, some in a wooden crate, and others simply stacked in the rafters. Nutt vividly remembers that, in 1971:

> "All the work came to our house – these rolls with multiple drawings, like ten or twenty drawings in a roll, an assortment of big and small drawings. …we started unrolling them, and we realized that there were bugs inside [all of] the rolls."[1]

Clearly insects had taken their toll. The appearance of gnawed losses indicated that mice had also inflicted their damage (fig. 4).

Papers presented at the General Session, AIC's 46th Annual Meeting, May 29-June 2, 2018, Houston, Texas

Fig. 1. Martín Ramírez, *Untitled (Scroll),* ca. 1950. Crayon, graphite, colored pencil, ink and charcoal on pieced paper (recto); various pieced papers (verso). 45 × 211 in. (114.3 × 535.9 cm). Collection of Jim Nutt and Gladys Nilsson. Credit: Tom Van Eynde.

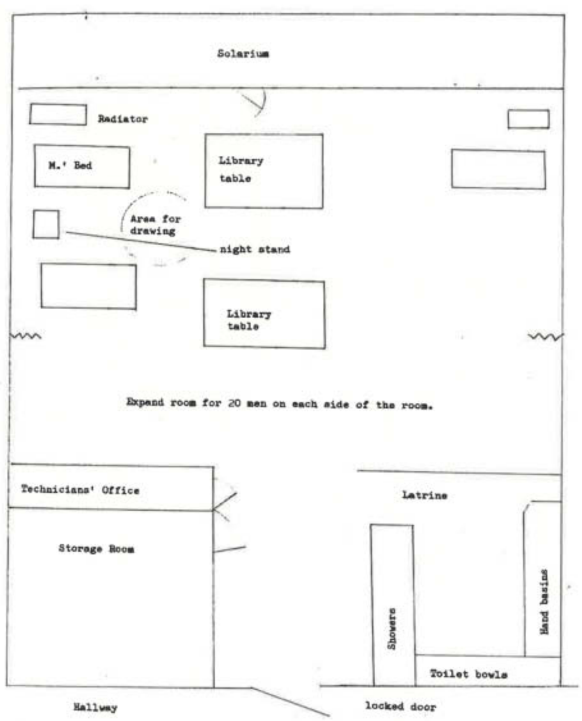

Fig. 2. Tarmo Pasto, sketch of Martín Ramírez's ward at DeWitt State Hospital. Collection of Matthew Pasto. Reproduced in Espinosa 2015, 117.

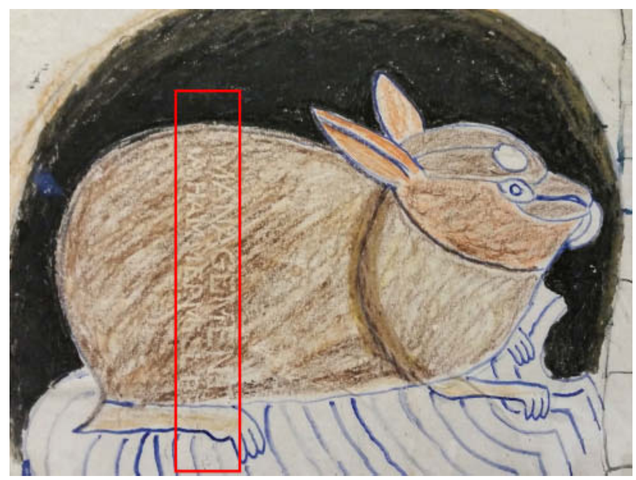

Fig. 3. Martín Ramírez, detail of watermark in *Untitled*, ca. 1950. Crayon, colored pencil, graphite, and tempera on pieced paper. 142 × 39 in. (360.7 × 99 cm). Private collection. Reproduced in Longhauser 2017, 72.

In order to establish a treatment protocol, as many drawings as possible were examined so that anomalies inherent or intentional to the drawings' aesthetic could be differentiated from damage that occurred after the drawings were removed from Ramírez's hospital ward. This was done in constant dialogue with Nutt, which was possible because conservation treatment was carried out in the Nutt/Nilsson studio. The hospitality of these custodians of many of Ramírez's drawings was matched by their great sense of responsibility toward their collection.

Nutt looked very closely at each drawing, focusing on every detail and nuance of line, and was ethically invested in conserving these drawings to accurately reflect the artist's intentions. Perhaps because Nutt is an artist with a profound interest in materials and process, he was able to zero in on specific passages in the drawings that he felt had been so visually undermined by their damage that stain reduction,

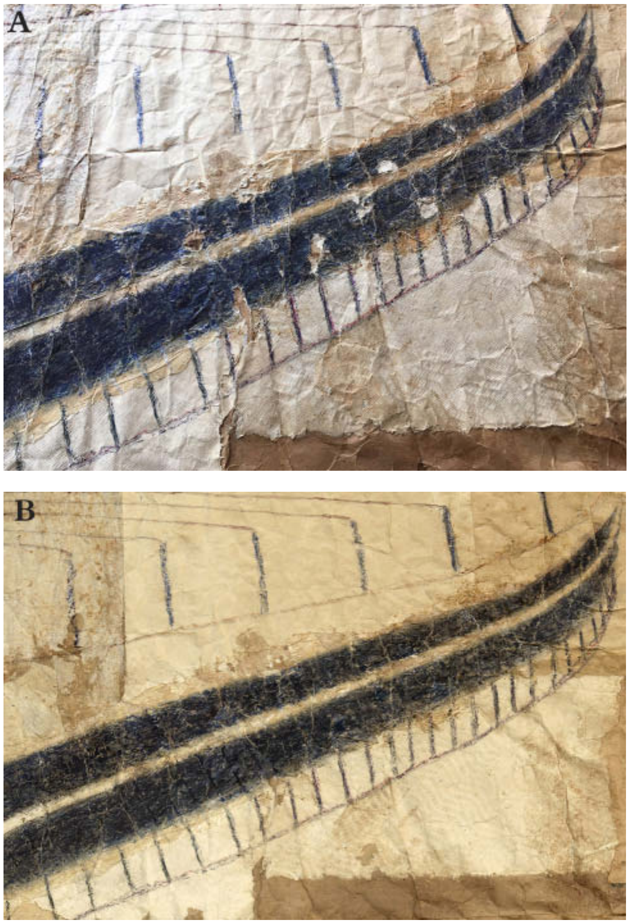

Fig. 4. Detail of *Untitled (Scroll),* showing insect and rodent damage (a) before treatment and (b) after treatment.

consolidation, infilling and toning of losses and inpainting were warranted. In conversation, Nutt would suggest the trajectory of an inpainted line, or the tone and surface texture of a fill. He had no problem telling the authors to try again if he felt that the tone of a particular fill was not just right or if the authors had neglected to inpaint a small loss that he found visually distracting. Nutt was very concerned with image compensation and encouraged reestablishment of the solidity of the repeated linear forms that Ramírez rendered so emphatically in his drawings—forms that had been undermined by flaking media and grazing pests.

As for the scroll itself, few people had seen it over the years—Nilsson estimates that she and Nutt had unrolled it perhaps three or four times at most—it was just too impractical. The scroll was too big, it was damaged, vulnerable, and there was loose, flaking media on the surface. And to their credit, they did not want to inadvertently cause more damage in the process. As the drawing was unrolled for this project, it could be ascertained that Ramírez worked a bit at a time, unrolling the drawing in his confined space, extending his narrative using a cache of his stock motifs from left to right. When Ramírez constructed the scroll, he used hundreds of pieces of paper in a vast array of sizes and shapes, some minute and others quite large, and in a multitude of colors and textures that he adhered in layers. A pasted element could be as small as the size of a pea. In a number of areas, collage elements had partially released from the desiccated, brittle adhesive holding them in place. Dates present on some of the papers on the verso indicate that the artist completed the scroll over the course of several months (Stratis 2017, 106). The far right section of the drawing was the most damaged, as one would expect since it was the most exposed and vulnerable to mishandling. The drawing remained unfinished as evidenced by a large swath of blank paper in the lower right, as if the artist would have continued endlessly had the drawing not been removed from the ward.

With little in the way of art-making materials at hand, Ramírez drew as his sole form of artistic expression. He did not paint in oils or make sculpture, although arguably his wrinkled, undulated, pieced-together supports attain a tangible dimensionality. Instead, he used wax crayons, colored pencils, graphite, charcoal, red and black writing inks, and simple watercolor sets. These inexpensive sets were often marketed as tempera paint, poster paint, school paint or watercolor—more accurately, they are opaque watercolors that appear matte when dry.

To better understand these materials, and with the hope of discrediting the fruit juice ink and oatmeal/mashed potato adhesive stories, research to learn more about the low-cost art supplies that were finding their way into primary school classrooms was carried out. This was happening in the 1940s and 1950s at the same time that arts education curricula were emerging and being taught systematically for the first time to elementary school students. Anyone who attended public school during this time may remember the paper, pencils, new box of crayons, little jar of paste, and scissors that appeared on each desk the first day of school every year (fig. 5). The paste had a very distinctive cloying aroma. Such adhesives were marketed as library paste, liquid paste, school paste, or mucilage—and were often supplied with small plastic brush applicators (fig. 6). It was these very same inexpensive materials that were being made available to encourage the making of arts and crafts within the wards of psychiatric hospitals. Espinoza documents that, at De Witt, Ramírez attended arts and crafts workshops. He may have attended sing-alongs too as evidenced by the song lyrics that he pasted onto the scroll (fig. 7).

To better understand some of the more visually puzzling materials in the scroll, analysis was undertaken to characterize several ink and adhesive samples from the Art Institute's 1950 drawing, *Cowboy* (fig. 8), as well as from the scroll. The investigation was inspired in part by an earlier study of the materials of another artist labeled an outsider, James Castle, which provided an unprecedented understanding of Castle's unconventional materials. It was hoped that, with a small and limited sample set, insight could be provided into a few of Ramirez's materials as well.

Fig. 5. Selection of crayons that would have been available to Ramírez.

Fig. 6. Selection of adhesives that would have been available to Ramírez.

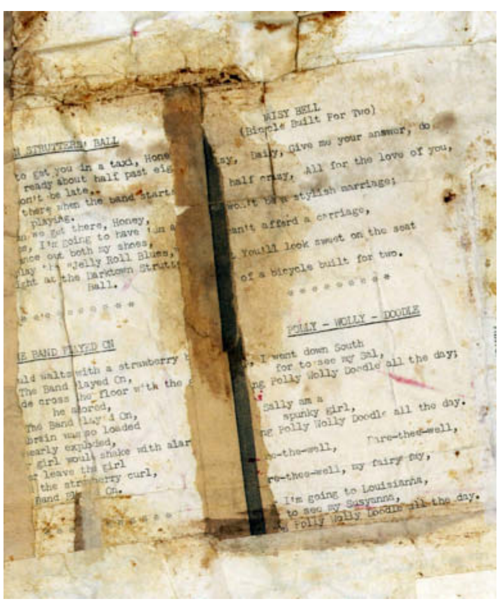

Fig. 7. Detail of *Untitled (Scroll)*, verso, showing song lyrics that Ramírez incorporated into the support.

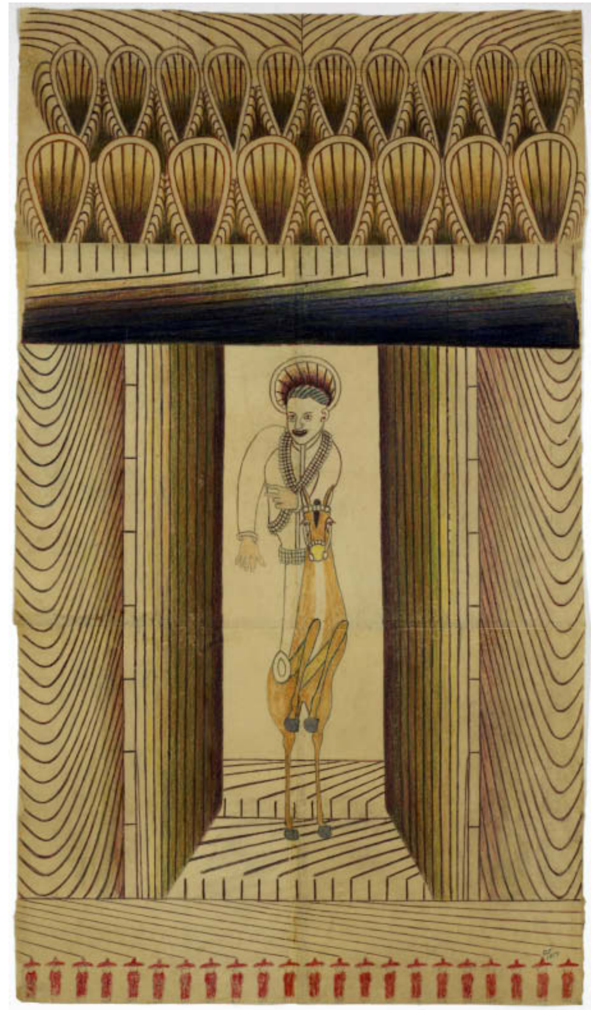

Fig. 8. Martín Ramírez, *Cowboy*, 1950. Wax crayons, colored pencils, and watercolor over graphite on beige wove paper, 156.0 × 86.3 cm. The Art Institute of Chicago; gift of Mr. and Mrs. Robert S. Hartman.

In drawings made over a number of years, two similar adhesives could be differentiated visually and under magnification time and time again. Minute samples were taken from the scroll and from the Art Institute's *Cowboy*. Although each sample looked slightly different, FTIR analysis indicates that both are starch-based. For comparative purposes, several historic reference samples of mucilage and library paste were also analyzed, and they proved to be starch-based as well. If, as suggested in the literature, the artist had masticated and mixed all manner of starch-based food with his saliva to form an adhesive, its appearance and consistency would vary greatly from artwork to artwork. However, this was not the case. The visual properties that were uniformly observed were more consistent with the use of commercial adhesives, products that were processed and refined in their manufacture to a degree that is simply not attainable by mastication or mixing by hand. Further evidence of this was found in *Cowboy*, in which the detection of chorine in the sample, along with its unusual translucency and the lack of grain structure under magnification, suggests the use of a bleached product known as "oxidized starch."[2] In another sample from *Cowboy*, a modified cellulose such as methyl cellulose was also identified. With that information in hand it was possible to rule out the use of oatmeal and mashed potatoes from the cafeteria for these adhesives.

Likewise, among the group of drawings studied for this project, there is no visual indication that the artist used juice that he extracted from fruit. Microscopic examination revealed that crayon strokes are broad and have a glossy, waxy appearance. They are hard, compact, and homogeneous. Colored pencil strokes are thin and equally compact—and, in fact, the detection of kaolinite, a common extender in colored pencils, by FTIR and EDS in several colored pencil samples from the scroll and *Cowboy* supports visual identification of this medium. Charcoal strokes appear splintery and particulate and disperse on the papers' surfaces; and finally, under magnification it was clear that the artist's drawing implements included brushes and the pointed tips of pen nibs.

One particular medium that stands out in so many drawings is a bright red ink that Ramírez applied with a brush, and perhaps matchsticks. Analysis of this material identified the organic red colorants eosin and lithol rubine.[3] Both are known for their bright red color and their susceptibility to fading. Eosin is readily soluble; our testing in anticipation of treatment confirmed that. And more to the point, colorants such as these cannot be extracted by squeezing fruit.

Coinciding with scientific analysis, conservation treatment progressed at a slow and steady pace over several months. First, the entire drawing was humidified and gently relaxed to reduce the pronounced waves of undulation. No attempt was made to flatten the scroll; the way in which Ramírez adhered the wrinkled, creased, and deformed papers to each other made it clear that this, like most of his drawings, were never intended to be flat (fig. 9). With the relaxed drawing open to its full length, torn and crumpled edges were unfolded and mended, lifting papers were set down, losses

Fig. 9. Raking light detail of *Untitled (Scroll),* showing natural undulations and cockling that are inherent to the pieced support.

Fig. 10a. Detail of *Untitled (Scroll),* showing the anthropomorphic smokestack as it appears today.

Fig. 10b. Detail of *Untitled (Scroll),* showing the artist's first attempt, which he later patched and redrew.

were filled and inpainted, and where wax crayon was applied over desiccated, cracking, and lifting flakes of media-laden adhesive, consolidation, followed by inpainting of areas of loss, was carried out.

As more became clear about Ramírez's artistic process, his manner of constructing his supports and the ways in which he incorporated his subject matter, interest intensified in trying to assess the degree to which intentionality played a role in the artist's process. Several patches, including one with a sketch of an anthropomorphic smokestack was particularly intriguing (fig. 10a). Knowing that the adhesive was water soluble, it was decided to humidify the patch and lift it temporarily to reveal the sketch below (fig. 10b). With the sketch removed, it became clear that Ramírez decided that his first attempt to draw the figure was much too small to carry enough visual weight in the overarching composition. Instead of erasing the form—a practice in which he rarely engaged—he simply adhered another piece of paper over his first attempt and redrew the form, this time much larger so that it could take pride of place in the composition. Upon seeing this, it was clear that this had been a deliberate aesthetic decision on the part of the artist who, in this moment, was clearly conscious of the visual impact of his actions.

Although the primary goal of this project was to examine and conserve a selection of Ramírez's drawings to ready them for the ICA LA exhibition, by studying the artist's materials and processes, misconceptions have been corrected and a fuller understanding of the nature of his materials, and the deterioration to which many have been subjected was established. Through Victor Espinoza's research, the artist's biography has been corrected, clarified, and expanded upon with new and important information. Continued close looking and technical investigation on the part of conservators and scientific analysis on the part of conservation scientists of Ramírez's drawings will surely continue to enhance that story.

ACKNOWLEDGMENTS

The authors express their gratitude to the following colleagues for their contributions to this project: Francesca Casadio, Inge Fiedler, Maria Kokorri, Mark Pascale, and Mardy Sears from the Art Institute of Chicago; Elsa Longhauser and Jamillah James from the Institute of Contemporary Art, LA; and especially to Gladys Nilsson and Jim Nutt.

NOTES

1. Excerpted from a conversation that took place on June 5, 2017 with Jim Nutt, Gladys Nilsson, Mark Pascale, and Mary Broadway (Pascale 2017).
2. Hypochlorite was among the chemical agents used to produce oxidized starches (Stratis 2017, 111, note 16).
3. Analysis of the red colorants was carried out using FTIR and Raman spectroscopy; the identification of eosin was supported by the detection of bromine using EDS (Stratis 2017, 111, note 20).

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The Colors of Desire: Examination of Colorants in *Beauties of the Yoshiwara*

INTRODUCTION

From the simple two- to three-color *benizuri-e* prints of the 1740s to the complex full color printed *nishiki-e* or brocade prints, Suzuki Harunobu's 1765 calendar prints are thought to have ushered full color printing into the world of Japanese woodblock prints. Still early in the development of full color printing, Harunobu's five volumes of *Beauties of the Yoshiwara* published during the final year of his life in 1770 can be seen not only as a masterpiece of his designs for book illustration (Toda 1931) but also as a compelling example of how artisan-printers might have developed a palette during the early years of full color printing. The frontispiece of each volume of *Beauties of the Yoshiwara* displays an image that sets its mood and poetic subject; *cherry blossoms (spring), cuckoo (summer)*, *moon (late summer/early autumn), falling leaves (autumn)*, *and snow (winter*). Within each volume, courtesans are shown engaged in activities, accompanied by their name, the brothel where they worked, and their poem contributing to the book's seasonal theme. The colorants found in the first edition of *Beauties of the Yoshiwara* were examined as part of an ongoing study into the colorants of Japanese woodblock prints at the Museum of Fine Arts, Boston (Derrick, Newman, and Wright 2017).

The color palette for woodblock printing during the Edo period has been conjectured based on historic sources and current evaluation of color tones, but few technical studies have been done to further investigate and define the exact materials (Kendo 1929). It is known, however, that the colors used were composed of both organic and inorganic materials, derived from plants (organic) and mineral compounds (inorganic). Each color lends its distinctive character to a printed image. For the most part, organic colorants appear transparent and inorganic pigments opaque.

Organic colorants thought to be commonly used are:

Yellow: gamboge (*tō-ō*), turmeric (*ukon*), Amur cork tree (*kihada*), gardenia (*kuchinashi*), Japanese pagoda tree buds (*enju*), mountain peach (*yama-momo*), silver grass/eulalia (*kariyasu*), and Toringo crabapple (*zumi*)
Blue: dayflower (*aobana*) and indigo (*ai*)
Red: safflower (*benibana*) and sappanwood (*suo*)

Inorganic pigments thought to be commonly used are:

Yellow: ochre (*ōdo*) and orpiment (*sekiō*)
Brown to Orange: iron oxide red (*bengara*), red lead (*tan*), and vermilion (*shu*)
White: calcium carbonate (*gofun*), white lead (*empaku*), and mica (*kira*)
Black: ink (*sumi*) made from soot and animal glue

ANALYTICAL METHODS

For this study, 66 out of the 166 courtesans depicted in the book were analyzed with multiple points analyzed per figure. Careful observation of how pages were printed in combination with nondestructive analysis of selected pages provided a snapshot view. Every illustration was surveyed using a stereo binocular microscope at 50× magnification in order to determine which colors were overprinted. The illustrations were also viewed under UVA radiation to reveal the characteristic fluorescence or absorption properties of the individual colors. X-ray fluorescence provided information on the chemical elements found in inorganic pigments.[1] The red and yellow organic colorants were indicated by excitation-emission matrix (EEM) fluorescence[2] and the blue colorants were identified by fiber-optic reflectance (FORS). FORS can be used to readily distinguish between dayflower and indigo, even in mixtures that appear green or purple. The parameters of the analysis methods were thoroughly vetted using printed references of traditional Japanese colors that were prepared in-house from solutions of authenticated materials onto Japanese *hōshō* paper sized with *dosa*, a mixture of alum and animal glue. Pure materials, as well as mixtures and overprinted colors were examined. These techniques, both visual and spectroscopic, provided beneficial but partial views of the whole. All data had to be viewed together in order to gain insights. Even so, these methods were not always sufficient to

Papers presented at the General Session, AIC's 46th Annual Meeting, May 29-June 2, 2018, Houston, Texas

answer all questions for the characterization of some materials, such as the plant-based yellows (flavonoids). Moreover, because of the potential for colorant mixtures, all analysis points on each image were examined by all methods.

RESULTS

The results of this study indicated that color variations and multiple hues were not only produced by altering proportions, but also by creating multiple colorant and pigment mixtures, including some with three or more components. Greens were overwhelmingly a mixture of indigo and orpiment with the printers showing an ability to print a wide range of green tones from the beginning. A few instances of indigo with gamboge alone or with added orpiment were found, as well as dayflower printed over turmeric to imitate a bronze patina on a vase. Yellows were most often a mixture of orpiment and turmeric. A soft beige tone that frequently appeared in volumes one and two was revealed to be a mixture of a flavonoid with calcium carbonate. Of the yellow colors available to printers during Harunobu's time, gamboge did not appear as often as expected on the pages examined.[3] Purples were consistently a mixture of safflower and dayflower, a combination that was preferred throughout the course of Japanese woodblock printing during the Edo period. Blues were dayflower and indigo, although indigo was never found as a single colorant and only as a mixture with another color. Dayflower is known as one of the most fugitive colorants and throughout the book it appears in numerous hues, some of which could have changed over time from their original appearance of blue to a yellow/tan color (Sasaki and Coombs 2005). It was also found during this study that discolored dayflower resulted in spectra similar to that of a flavonoid.

Throughout *Beauties of the Yoshiwara,* an impressive array of red to pink tones were employed. These reds and pinks were mostly madder and safflower. Although not mentioned as a "known" colorant in the historical literature, madder was frequently found. Both madder and safflower were used as a single color but also as a mixture. Sappanwood was present but only found as part of a mixture with the other reds. In some cases, this combination was used to print over orpiment to yield a deep red-orange. Madder was not detected as a component in any of the purple to brown colors that were analyzed but sappanwood was found in one instance as a mixture with dayflower to create what visually appears to be a dull brown with a faint purple cast. Also, the pinks and reds were noticeably brighter from volume three onward. Brown to orange-brown tones found in all volumes were comprised of iron oxide red. This inorganic pigment was routinely used alone but was also present in mixtures. Iron oxides were present in complex mixtures with red lead, orpiment, and turmeric. Red lead was never found printed by itself and no instances of the use of vermilion were found.

Overprinted colors were also observed throughout. Microscopic examination of overprinted areas often showed individual colors within the paper fiber interstices as well as along the edges of printed regions. Yellow was most often overprinted with reds and pinks to produce an overall orange tint. Assorted colors such as blue, purple, green, and brown, in addition to reds and pinks, were used to overprint and fashion elaborate patterns onto clothing. One of these overprintings found was an unusual and possibly unique shade of brown, which was identified as safflower over an indigo/orpiment green. This particular combination captures the look of glossy varnished wood.

CONCLUSION

The profusion of colors and innovative mixtures seen in the first two volumes appears to give way in the last three volumes to a comparatively restrained palette. These volumes can be viewed to anticipate the standardization that takes place as full color printing develops. During the years that followed Harunobu and as print production matured, the development of a standardized palette was likely advantageous for both efficiency and economy within the increasingly commercialized world of publishing. As research continues to expand our knowledge of the materials and techniques employed during the Edo period to produce woodblock prints, undoubtedly there will be more questions to answer and further mysteries to solve.

ACKNOWLEDGMENTS

The authors would like to thank Jacki Elgar, Pamela and Peter Voss, Head of Asian Conservation (MFA, Boston); Sarah Thompson, Curator of Japanese Art (MFA, Boston); Maskao Tanabe, Deputy Director and Chief Curator of the Chiba City Museum of Art. We would also like to thank Kaeley Ferguson and Marta Sliwa for their assistance in analyzing the prints.

NOTES

1. For this study, elevated elemental levels were attributed as follows: silicon (mica), calcium (calcium carbonate), iron (yellow ochre-hydrated iron oxide, or iron oxide red), lead (red lead or lead white), arsenic (orpiment—arsenic sulfide), and mercury (vermilion—mercuric sulfide). It is noted, however, that these attributed compounds are based on the previously listed set of expected inorganic pigments for Japanese prints in conjunction with the visually observed color for each region. It is possible that other pigments could also be present.

2. EEM fluorescence produced unique three-dimensional spectral patterns for most red (safflower, sappanwood, and madder) and yellow (turmeric, Amur cork tree, flavonoids, and gardenia) colorants. There are over 5,000 types of flavonoid compounds that occur in plants and most produce yellow or blue colors. The following yellow colorants are primarily composed of multiple flavonoid-type compounds: Japanese pagoda tree buds, mountain peach, silver grass/eulalia, and

Toringo crab apple. This group produced fluorescent patterns that were indistinguishable from each other, so, for this study, the presence of that pattern was generically called "flavonoid."

3. Gamboge may have been more frequently used but was only indicated by our analytical techniques when a yellow color was determined to be organic but did not fluoresce significantly.

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Tip: Local Cleaning with Gels: Acknowledging the Challenges and Successes

INTRODUCTION

In 2016, research was undertaken at the Smithsonian American Art Museum to evaluate and compare three polysaccharide gels: agarose, gellan gum, and xanthan gum. The aim of the study was to provide guidelines on their use in the specific case of local treatment for stained art on paper. A well-known risk of using gels locally is the creation of a wet/dry interface, or tideline. The following is a brief summary of some of the findings of this one-year research project. The full project will be detailed further in another publication. The goal is to provide some concrete hands-on tips for paper conservators with limited experience using gels, and to encourage them to start experimenting.

CONSIDER THE PARAMETERS

First, let us acknowledge that local cleaning with rigid gels can be challenging. Some conservators have developed the necessary experience to successfully perform such treatments and are able to achieve amazing results (Keynan and Hughes 2013; Couvert and Dupont 2013; Sullivan et al. 2014; Barbisan and Dupont 2017). But someone just getting started with rigid gels may want to think carefully about the following parameters.

- Concentration of the gel: this will affect the amount of moisture released into the substrate, as well as the suppleness of the gel. At higher concentrations, there is less risk of creating a tideline. However, the gel will conform less to the surface of the paper, which can result in uneven cleaning.
- Contact between the gel and the substrate: in some instances, it is safer to apply weight on top of the gel to ensure perfect contact. One needs to evaluate how much pressure is appropriate, to avoid creating an unwanted local deformation.
- Thickness of the gel: the thicker the gel, the more water and capillary action. However, cutting a thick block of gel to conform the shape of a stain can be challenging.
- Timing: the appropriate duration of cleaning needs to be determined through testing. Ideally, the gel should be left on the substrate as long as possible to get efficient cleaning, but not long enough to create a tideline.

Striking a balance between all of these parameters and adapting them to a particular scenario is key in designing a successful local treatment with rigid gels.

WHAT GEL? WHAT CONCENTRATION?

Previous research suggested agarose should be favored to perform local treatment (Wolbers 2013). Our experiments, comparing agarose, gellan gum, and xanthan gum, confirmed that statement. Agarose at concentrations from 6% to 10% (w/v) makes it easier to manage the risk of tideline formation (fig. 1). However, agarose does not possess the best cleaning efficiency when compared with other gels at similar concentrations (fig. 2). This can be compensated by the fact that agarose is a nonionic gel, which makes it possible to adjust its pH and conductivity and add chelating agents to increase cleaning efficiency (Stavroudis et al. 2005). Agarose also leaves a small quantity of residues behind compared to other gels (Sullivan et al. 2017). Additionally, areas treated with agarose showed a more regular cleaning when observed under the microscope (fig. 3).

MANAGING THE WET/DRY INTERFACE

Controlling the lateral spread of moisture during local treatment is critical and that control may be achieved through a particular application method. Wet/dry interfaces, sometimes invisible under normal light, have long-term detrimental consequences to the paper (Dupont 1996; Souguir, Dupont, and de la Rie 2008; Jeong, Dupont, and de la Rie 2012, 2014). Various application methods were tested: applying a film of gel, beveling the edges of the gel (Skelton, Rogge, and Bomford 2016), drying between applications, soaking the gel

Tips presented at the Book and Paper Group Session, AIC's 46th Annual Meeting, May 29-June 2, 2018, Houston, Texas

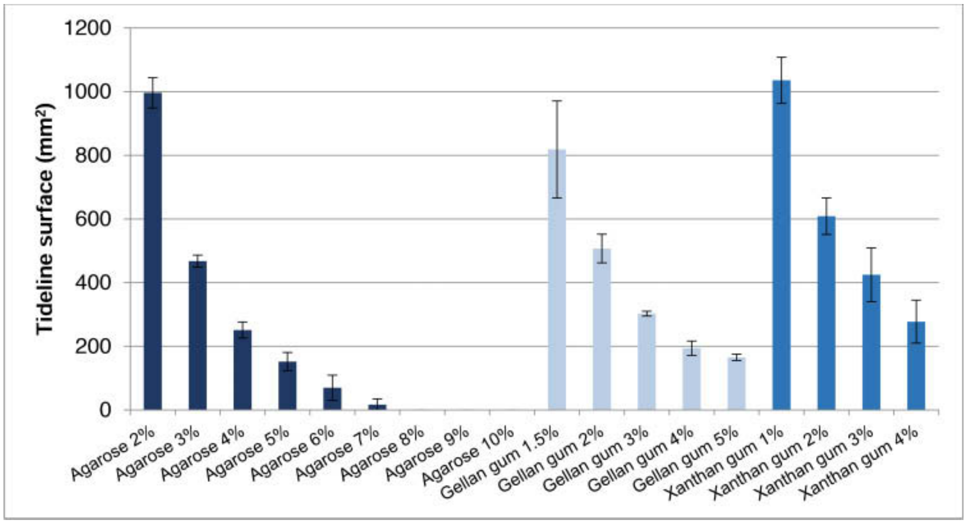

Fig. 1. Comparison of tideline surfaces after contact for 10 minutes between gel and sample. Samples made with Whatman paper (grade 1), toned with a solution of methylene blue (1.5 g/L). Time-lapse recorded with Nikon 800, data extracted with ImageJ software.

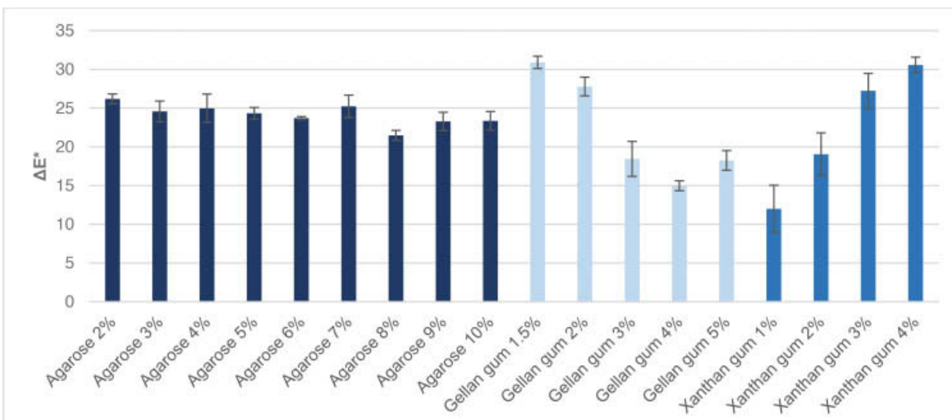

Fig. 2. Comparison of △E* values (CIELAB 1976, D65 illuminant, 10° observer) after cleaning for 2 hours. Readings taken with a spectrophotometer X-rite Exact. Samples made with Whatman paper (grade 1), toned with a solution of methylene blue (1.5 g/L).

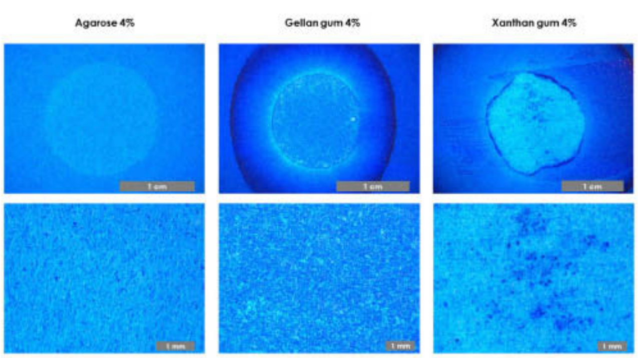

Fig. 3. Images taken under the microscope of samples cleaned with different gels for 2 hours (normal light). Samples made with Whatman paper (grade 1), toned with a solution of methylene blue (1.5 g/L).

in a water/ethanol solution, and humidifying the paper before treatment.

Using a film of gel proved helpful in managing the creation of a wet/dry interface and promoting better contact between the gel and the substrate. Humidifying the paper prior to local treatment seemed to soften the wet/dry interface, which was apparent in UV-induced visible fluorescence photographs (fig. 4). If appropriate for a particular object, prehumidification of the artwork with Gore-Tex or in a humidification chamber before undertaking local treatment with rigid gels is encouraged.

To produce films of agarose gels, one needs to pour the hot agarose on a polyester sheet, place another polyester sheet on top, followed by a board. Apply weight on top and let it cool (fig. 5). However, this method only works for small quantities

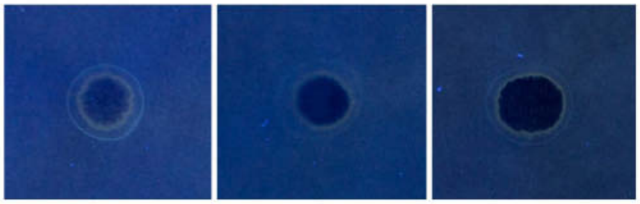

Fig. 4. After treatment UV-induced visible fluorescence photographs. From left to right: agarose film (9%) applied for 10 min; agarose film (9%) applied for 1 hour, after prehumidification of the sample for 1 hour; agarose film applied for 10 min, soaked in a water/ethanol solution (70/30) overnight.

of agarose (50 mL). For larger quantities, poor hot agarose in a baking sheet, tip, and rotate to spread.

FINAL TIPS AND RECOMMENDATIONS

- Closely monitor treatment, as tidelines may be created seconds after initial contact between the gel and the paper.
- Regularly check under UV radiation: wet/dry interfaces may not be visible under normal light in the moment, but they are always visible under UV radiation and will turn into discoloration long-term. They should be minimized as much as possible.
- Agarose films are more controllable. They are easier to handle, provide better contact with the substrate, and are easier to cut to the shape wanted.
- Use agarose between 6% and 10% and test which concentration is most appropriate for your project.
- Prehumidification appears to soften the wet/dry interface. It also promotes a more even cleaning, since the paper's fibers are already swollen.
- Drying between applications helps to avoid overwetting.
- Applying weight on top helps produce good contact, particularly for gels at high concentrations (fig. 6).
- Change your gel often. To promote diffusion, using a fresh gel every 10–20 min will speed up the cleaning.

Gels are an amazing addition to the paper conservator's tool kit. As with any new technique, they can be intimidating and require building experience before jumping into treatment. Using a step-by-step approach helps identify what works and what does not and hopefully will encourage hesitant paper conservators to start experimenting.

Fig. 5. Steps to make agarose film, from left to right: pour the hot agarose on a polyester sheet; place on top another polyester sheet and a board; apply weight on top (around 2 kg/4.4 lbs.).

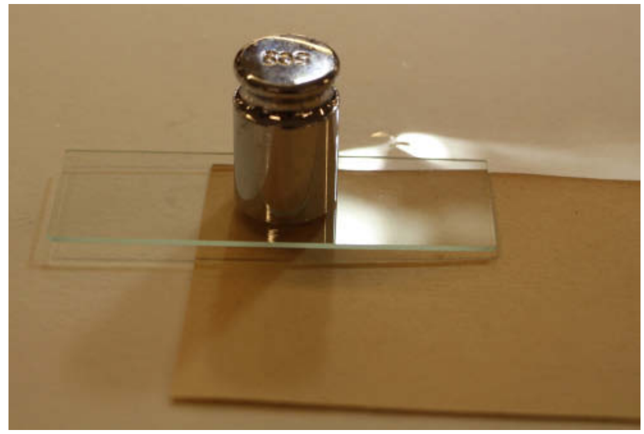

Fig. 6. Testing with microscope slide and 50 g calibration weight.

ACKNOWLEDGMENTS

The author would like to gratefully acknowledge the following individuals for their guidance and help: Catherine I. Maynor, Tiarna Doherty, and Amber Kerr (Smithsonian American Art Museum); Amy Hughes (National Gallery of Art); Michelle Sullivan (J. Paul Getty Museum); Nora Lockshin (Smithsonian Archives); Stephanie Lussier (Hirshhorn Museum and Sculpture Garden); Mary Ballard and Dawn Rogala (Museum Conservation Institute); Teresa Duncan (National Gallery of Art); Pam Young (Colonial Williamsburg Foundation); and Noah Smutz (Smithsonian Libraries).

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Tip: A Hot Tip! The Use of a Soldering Iron for Conducting Polyester Encapsulation of Paper Objects

INTRODUCTION

The encapsulation of paper objects in polyester sleeves has become standard practice by paper conservators. Encapsulation allows fragile paper artifacts to be handled, while greatly reducing the physical abuse incurred during handling. Currently, the two most popular methods of encapsulating polyester are heat-based edge welders and ultrasonic welders. These welders have proven to be very efficient for conservation labs that have large workflows that include encapsulations. Both systems have been proven to be very user-friendly. Both systems also produce clean, sharp, and strong welds. But while both systems have many benefits, they also have many limitations as well. Due to the high purchase cost for the edge welder and the even higher cost for the ultrasonic welder, the practice of conducting encapsulations has largely been limited to conservators working in institutional conservation labs. Both systems also generally require the use of a permanent location in a lab, potentially tying up often precious table space. Due to these limitations, it has been largely prohibitive to be able to conduct encapsulation at many small labs that have neither the budget or the space to maintain either system.

This talk will demonstrate how to use a traditional soldering iron to produce clean strong welds between two sheets of polyester. Soldering irons are readily available tools that can generally be purchased very inexpensively at virtually any hardware store, allowing both institutional conservation labs as well as small private practices to purchase them on tight budgets. They are small enough that they can be left in a drawer when not in use, therefore not taking up permanent table space in a lab. Soldering irons also travel easily, allowing for the possibility of conducting encapsulations on site. The use of soldering for encapsulation will also allow for rounded welds, as well as straight line welds of virtually any length. This talk will demonstrate the benefits of using a soldering iron to conduct encapsulation.

Tips presented at the Book and Paper Group Session, AIC's 46th Annual Meeting, May 29-June 2, 2018, Houston, Texas

BENFITS OF USING A SOLDERING IRON FOR WELDING POLYESTER FILM

Ultrasonic and heat-based edge welders are widely known and generally considered one of the more essential pieces of equipment in paper conservation labs. Both systems have been around for over 30 years and are well established. In conservation labs that already have one of these systems, the use of a soldering iron to weld polyester film should not be thought of as a substitute method for either of these machines, but rather should complement them. In situations where labs are not able to accommodate either system due to budget or space concerns, a soldering iron may allow for a conservator to conduct polyester encapsulations where it would not have been a possibility before.

There are several benefits to welding polyester films with a soldering iron. First, soldering irons are very small, often not much larger than your average pencil. This means it can be put away in a drawer when not in use and doesn't take up any permanent table space in a lab. Its size also allows for portability. A soldering iron can even be packed in a checked bag for travel, allowing for encapsulations to be conducted on site or anywhere where there is a table. There are even battery-powered soldering irons for when there might not be a power source available.

Soldering irons are very inexpensive and often can be purchased for as little as $20. This allows for encapsulations to be done by virtually anyone, once properly trained. It even allows for budget sensitive private practices, historical societies, libraries, museums, or archives to conduct polyester encapsulations where they may have thought it could not have been done before due to budget or space. In labs where doing an encapsulation is infrequent and a more expensive system may not be perceived as cost effective, a soldering iron may be the ideal substitute.

Welds with a soldering iron can be done at virtually any length where the only limitation is the length of the straight edge. The ability for the soldering iron tip to follow nonstraight edges also allows for round welds to be conducted on unusually shaped paper objects. Finally, the soldering iron allows easily

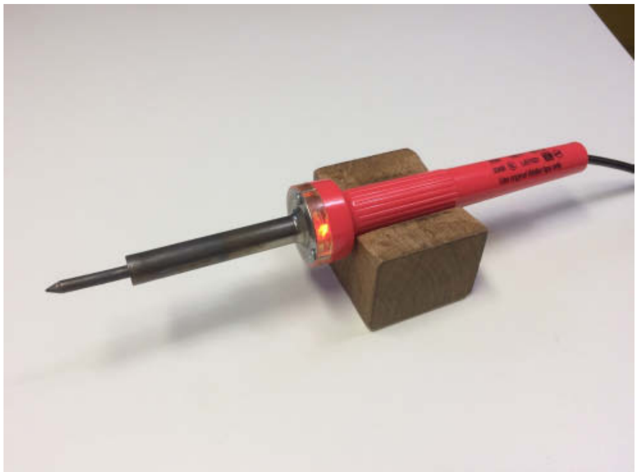

Fig. 1.

allows for "tack welds," which can be used to "float" double-sided paper objects between two sheets of polyester film.

WELDING THE POLYESTER FILM

Most soldering irons can be used to weld polyester film, but, for the purposes of this article, the soldering iron that was used was the Weller Model SP23LM 25 watt soldering iron (fig. 1). This soldering iron allows for the tips to be changed and can also be purchased online and at most hardware stores for about $20. To get the best welds, the optional pointed tip should be used and sanded down to as fine a tip as possible. The supplies require to weld polyester film, in addition to the soldering iron, are a good heavy straight edge and strips of museum board to weld on. For the easiest and most efficient encapsulations, it is recommended that 3-mm polyester film be used.

Welding polyester film using a soldering iron is easy. Simply put two sheets of polyester film on a strip of four-ply museum board and put a bag weight on top to prevent movement. Then line the straight edge up with were the weld should be. Run the soldering iron slowly down the straight edge several times until the soldering iron has melted all the way through the film into the board below (fig. 2). The weld will be completed when the film is stuck to the board and, upon close examination, the weld appears to have cut through the film (fig. 3). To remove the film from the museum board simply bend the film backward against the board (fig. 4). The film will make a slight cracking sound as it separates from the museum board. In the event the film doesn't come off, slide a thin microspatula under the film to remove it (fig. 5). After the first weld is completed, complete the other three sides to finish the encapsulation (fig. 6).

USING TACK WELDS TO FLOAT PAPER ARTIFACTS

A soldering iron can also be uses to create "tack" welds as a very discreet method of suspending a sheet of paper between

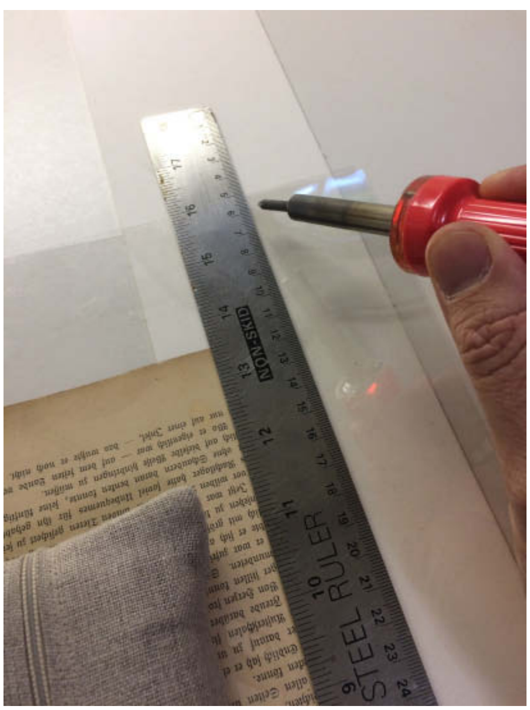

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 6.

two sheets of polyester film (fig. 7). This can then be used as an alternative method for the display of double-sided paper artifacts where the entire sheet of paper needs to be seen, giving the appearance that the paper is "floating." An additional benefit of this type of display is that no additional adhesives or hinges are introduced to the paper artifact.

The steps for doing a float display using tack welds are like the steps previously described for doing an encapsulation. The only additional required materials are the two sheets of museum board used for the window mats. The first step is to cut two identical window mats with windows that are larger than the paper object. The amount of open floated area of the opening is an aesthetic choice. Hinge both window mats

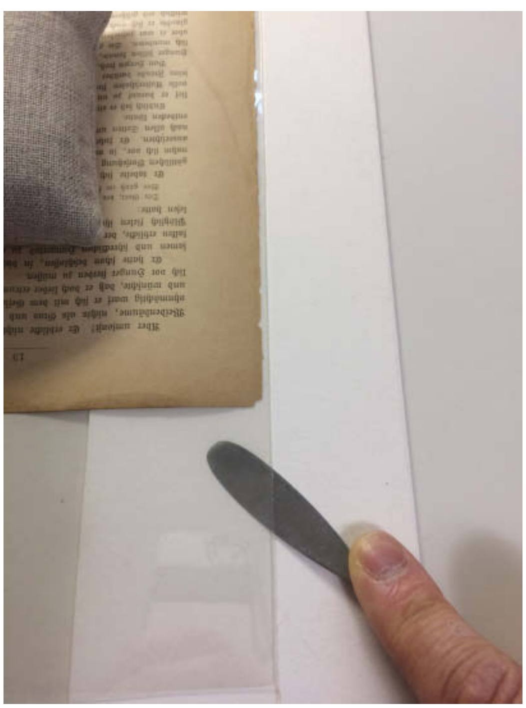

Fig. 5.

Fig. 7.

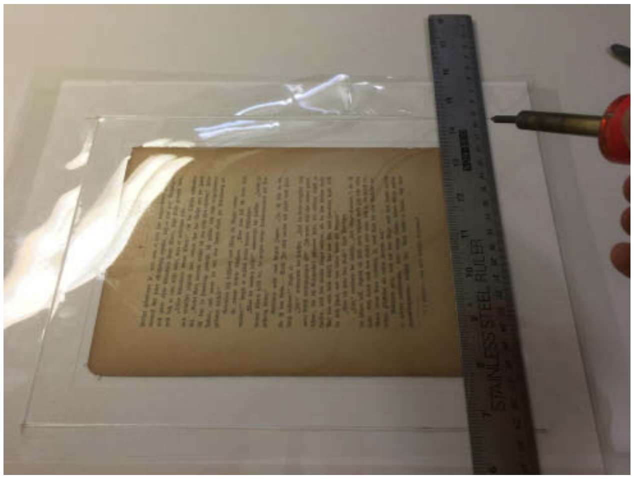

Fig. 8.

together and put off to the side along with the cutouts from the windows. Put the paper object between two sheets of polyester film and slip a piece of scrap museum board under one of the corners of the paper object. Using just the tip of the soldering iron, and holding the soldering iron perpendicular

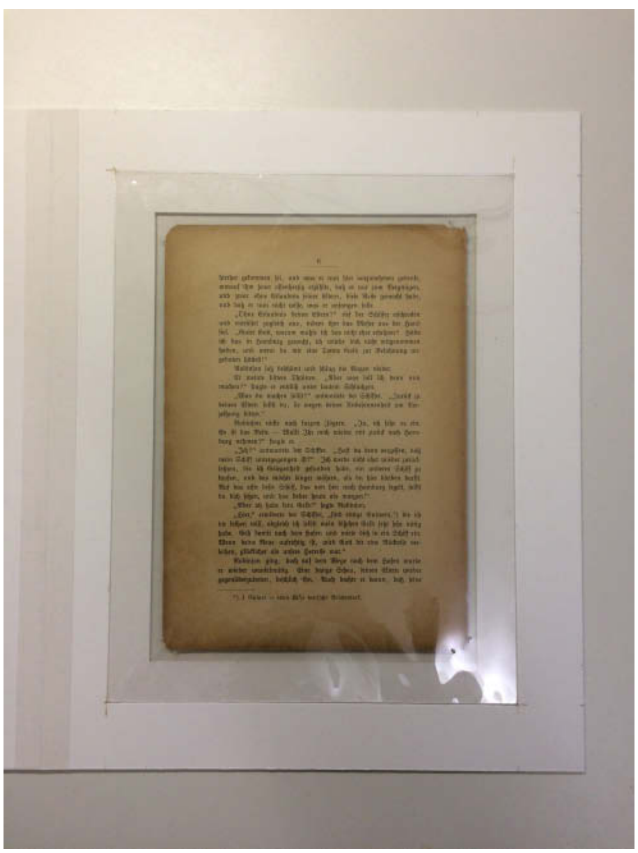

Fig. 9.

Fig. 10.

to the surface, touch the tip down along the edge of the paper object slightly off from the corner. Press down on the soldering iron for about one second and repeat along the corresponding edge of the same corner to "hold" the paper in place in that corner. Once the two tack welds are completed, slide a thin microspatula under the film to release the film from the museum board. Repeat the tack welds in the other remaining three corners. The paper should now be held in place, between the two sheets of polyester film, using eight tack welds. Open the hinged window mats with the inside face-up and place one of the cut outs back in one of the windows to support the center. Place the paper object, inside the film, on the window with the cut out and position it in the middle of the opening. Place a weight on the paper to prevent it from moving. Using a straight edge, weld all four sides of the film about one inch outside the beveled edge of the window. This will fuse the film to the museum board (fig. 8). Carefully bend the off-cut film back against itself to remove it. If it won't come off, carefully slide a microspatula under the weld to assist with removal. Once the off-cut film is removed, the window mat can be closed and put into frame with glazing on both sides of the window mat to allow for viewing of both the front and the back of the piece (figs. 9 and 10).

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Tip: Movable Pocket and Crossbar Hinge

The movable pocket and crossbar hinge was created by former Freer|Sackler Paper Conservator Martha Smith and further refined by Emily Jacobson and Amanda Malkin. The hinge consists of folded Japanese paper pasted to create a pocket that accommodates a polyester film crossbar (fig. 1). Gummed linen tape strips are then adhered across the crossbar to attach the hinged artwork to the back mat (fig. 2). The purpose of this style of hinge is to allow an artwork to be moved from one mat to another without having to remove the old hinges and apply new ones; simply cut the linen tape to release the crossbar from the back mat. This hinge is particularly useful for collections that are regularly moved from storage mats to exhibition mats, or where mat sizes frequently change.

Eliminating the need to remove and reapply hinges saves the object from possible skinning as well as unnecessary exposure to moisture, which can harm water-sensitive media or cause distortion in the paper support. This style of hinge also saves the time and energy involved in removing and applying new hinges every time an object needs to be rematted. Once the hinges are attached, rematting requires little handling or manipulation of an object, leaving the work to a capable technician or assistant rather than the conservator. All of the components—the hinges, crossbars, and linen tape strips—can be premade so that little preparation time is necessary to begin hinging.

At the Freer|Sackler, the bottom of the hinge is cut to create an "eyelash" attachment (fig. 3). The "eyelash" aspect of the hinge is valuable in that it allows only small points of contact with the object, reducing the amount of adhesive introduced, in addition to allowing the paper support to expand and contract without much restriction from the hinge.

When making this hinge, it is critical that the polyester crossbar fits snugly inside the pocket to prevent the hinged artwork from shifting up and down. Additionally, the linen tape must be placed as close to the sides of the hinge as possible to prevent the artwork from shifting side to side.

Finally, if the paper used to make the hinge is not thick enough, it is possible for the hinge to fold up on itself in the area between the crossbar and the artwork (fig. 4). This area is necessary to give room for the linen tape strips to safely secure the crossbars to the back mat. Therefore, this style of

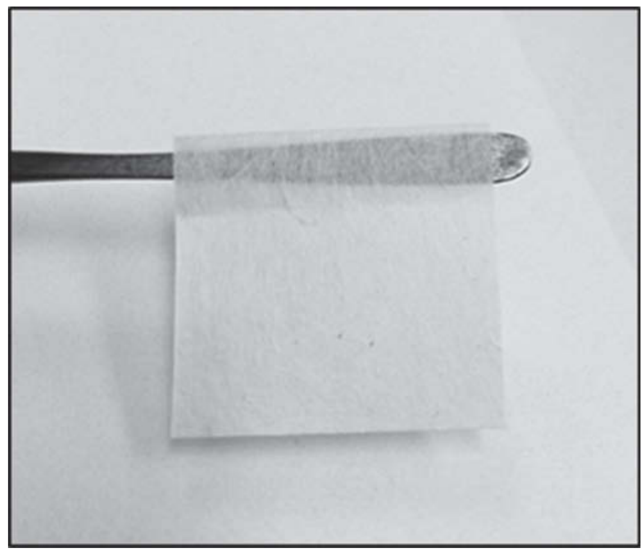

Fig. 1. Japanese paper pocket hinge with spatula inserted to show pocket.

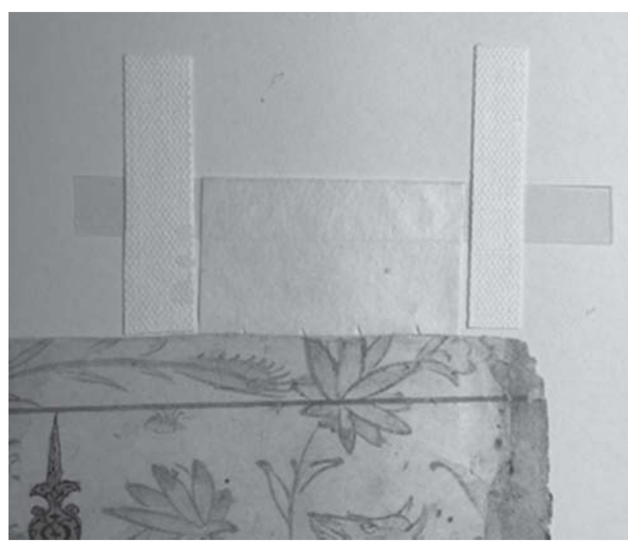

Fig. 2. Pocket hinge with polyester film crossbar held to back mat with linen tape strips.

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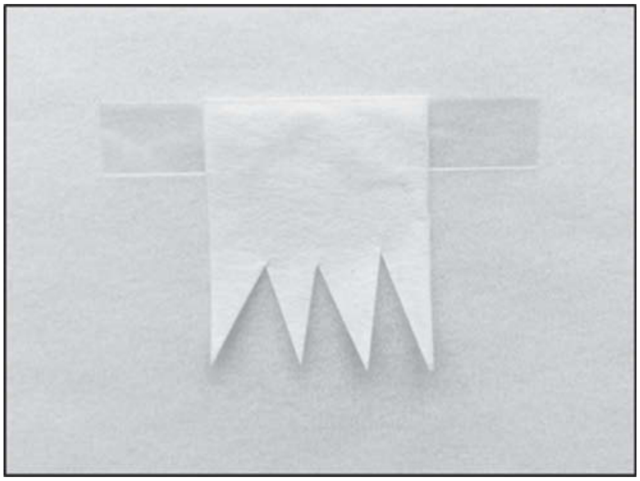

Fig. 3. Pocket hinge with "eyelash" attachment.

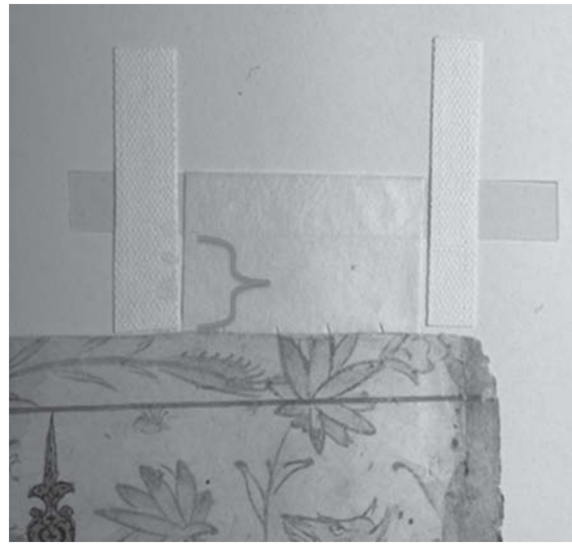

Fig. 4. Marked area indicates the space needed to allow full overlap of linen tape over the crossbars. Depending on the thickness of the Japanese paper used, the hinge can fold up on itself in this area.

hinge may not be appropriate for artworks travelling on loan where the chance of movement is greater.

FURTHER READING

For instructions on making batches of the movable pocket and crossbar hinge, go to https://www.freersackler.si.edu/research/conservation-scientific-research/paper-photographs/resources/.

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Tip: Gellan Gum Tips

INTRODUCTION

Since attending the 2016 workshop led by the Canadian Conservation Institute and Library and Archives Canada, the conservation staff at Northwestern has been experimenting with gellan gum. While many publications feature gellan gum used in overall treatments, it can also be quite versatile for local treatments, and it has become part of the daily toolkit for things such as humidification and flattening and softening of adhesive residues.

REACTIVATION OF PRECOATED TISSUES

Staff routinely use gellan gum for reactivation of adhesive on precoated tissues. Using previously prepared tissues coated in a methyl cellulose and wheat starch paste mixture, tissue pieces are cut to size and laid adhesive side up on 3% gellan gum (fig. 1).

Several strips of tissue can be laid out to hydrate at the same time. The adhesive swells uniformly in less than a minute. The adhesive does not dry out or overmoisten, even if left on the gellan gum for a long time.

Using the gellan gum and precoated tissue combination provides a very low moisture mending option. The moisture level is low enough to pass the bathophenantroline iron gall ink indicator test (fig. 2).

Conversely, it is also possible to lay the tissue in place on the object, and then dab it with gellan gum in situ to reactivate the adhesive (fig. 3). This technique is a little more difficult to control, but can be used when a moist tissue is too floppy or awkward to get into position or when a previously applied tissue is incompletely adhered or shiny.

CLEANING PLASTIC

Gellan gum can be used to surface clean dirt, drips, and splashes off of plastic film (fig. 4). The surface dirt can be hard to capture due to static electricity, but it will stick to the gellan gum. The smaller splashes can be picked up directly by the gellan gum, although softening followed by swabs may be needed for the more stubborn drips. Gellan gum seems to be completely scratch-free, unless grit becomes embedded in it.

CASTING WITH SPUN POLYESTER TO EASE HANDLING

It can be difficult to handle large sheets of gellan gum for overall treatments. While 3% seems most useful for local, everyday use, a wetter concentration of 1% or 2% may be preferred for overall washing. The wetter the gel, the more difficult it is to move as a sheet.

When spun polyester is laid into the hot gellan gum, it is easier to handle. The spun polyester is laid on top of the liquid gellan gum and becomes embedded in it, providing physical support (fig. 5). If the spun polyester is laid in the tray before the gellan is poured in, the tray side of the gellan is irregular, but if the spun polyester is laid on top, the tray side is smooth.

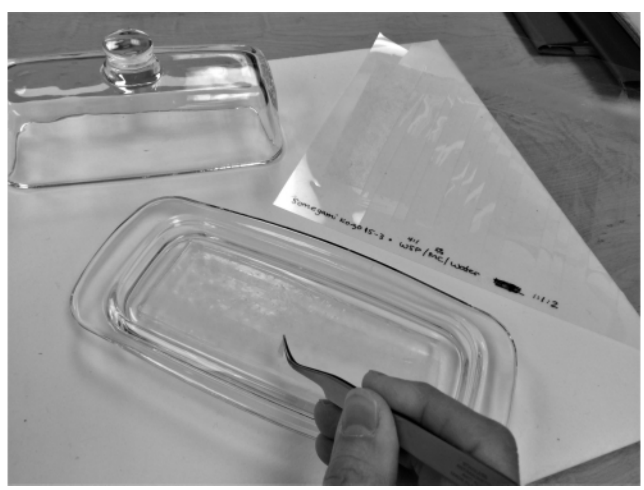

Fig. 1. A butter dish makes a convenient container for holding a sheet of gellan gum. Strips of water-sensitive adhesive precoated tissue lay on the gellan gum to reactivate the adhesive.

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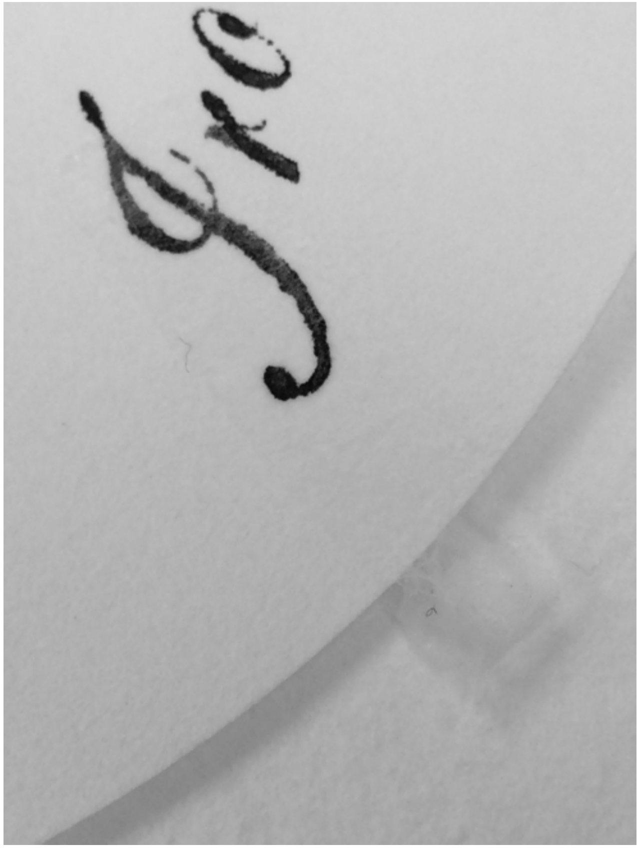

Fig. 2. This paper is impregnated with the bathophenantroline indicator and would turn pink if iron(II) were mobilized by adequate moisture. This example utilized precoated tissue that was laid on gellan gum to reactivate prior to placing the tissue.

Fig. 3. Dry precoated tissue is laid in place and touched with gellan gum to reactivate the adhesive.

Use spun polyester larger than the tray in one dimension to form a tab on one side for lifting the gellan gum without disturbing the surface. A knife or scissors are needed to cut it, and it is no longer crystal clear (fig. 6).

WASHING

Gellan gum is able to draw stains out of objects. It becomes discolored when this happens, but if dirty gellan gum is placed in clean water for a few minutes, it appears colorless again. Obviously, there will be some residues of the staining left in the gellan gum, but in some cases it may be acceptable to clean and reuse the gellan gum while working on the same treatment.

DRYING

Gellan gum keeps for about 2 weeks in the refrigerator before growing mold. If unused, it can be dried for long-term storage (fig. 7). This process seems to work best with thin 3% sheets and can be used for fairly large pieces or precut into smaller ones. In a dry environment, sheets will dry overnight, however it may take longer in moderate humidity or with thicker sheets. It forms a rigid, wrinkled film even if held flat while drying. Once dry, gellan gum seems to have a very long

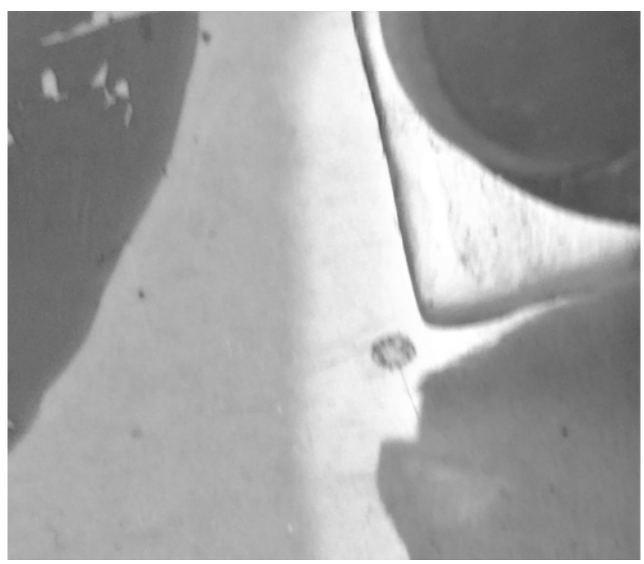

Fig. 4. Gellan gum is used to clean drip marks from plastic without abrasion.

Fig. 5. Leave a tab of spun polyester at one side to ease lifting so that the gellan gum is not pinched or damaged.

Fig. 6. The gellan gum is perfectly smooth on the tray side and large sheets are easily handled.

shelf life and can be easily stored in a file folder or toolkit and safely transported on an airplane.

REHYDRATING

Rehydrating dried pieces of gellan gum is easy—just submerge it in some water. It takes about 5–10 minutes for thin sheets to rehydrate. Regardless of how wrinkled it became while drying, it becomes flat again once rehydrated. It is never quite as smooth as the freshly made gellan gum, but it is useful for local applications.

Although people are already using gellan gum with aqueous solutions like ammonium hydroxide and the Modular Cleaning System, it can absorb more of those solutions if dried out first. It may not absorb all components at the same rate and may throw off some calculations.

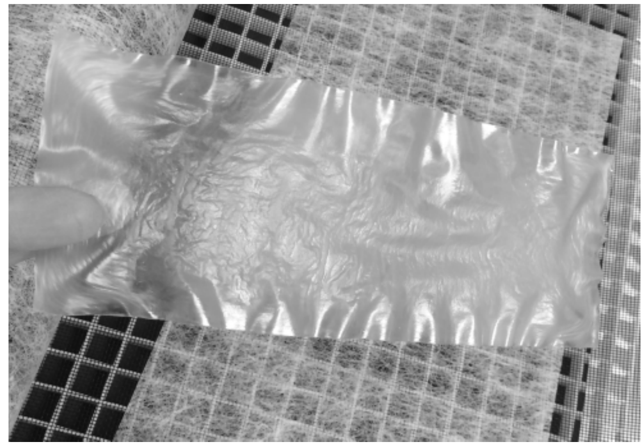

Fig. 7. A thin sheet of 3% gellan gum dried overnight on a drying rack sandwiched between spun polyester and window screening.

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Tip: Mending Paper with the Lightest Available Japanese Tissue

INTRODUCTION

Mending and lining damaged paper with precoated tissue (Baker 1990) has been a useful conservation technique for almost 30 years, and many publications since have investigated the materials used to prepare it (notably, Pataki 2009). Over the last 10 years, the conservators, technicians, and interns of Harvard Library's Weissman Preservation Center (WPC) have been putting this literature into practice while continually refining the recipes, preparation, and use of precoated tissues on paper, parchment, and textiles. The most commonly used precoated mending tissues at the WPC are machine-made kozo tissues weighing 5g/m^2 or 3.5g/m^2. Recently, the WPC staff purchased a roll of the lightest tissue intended for conservation on the market—1.6g/m^2—and found it to have excellent application as a precoated mending tissue with unmatched invisibility (fig. 1). For example, once precoated with an adhesive such as Klucel G, this tissue is ideal for reinforcing weak areas in paper caused by iron gall ink corrosion without obscuring the writing and for mending tears in transparent papers with minimal show-through. The tissue is the NAJ (National Archives of Japan) Toned *Tengucho* manufactured by Hidaka and is also offered in four other weights by Hiromi Paper of California.

PREPARATION

Transforming this diaphanous material into a useful mending tissue by precoating it with an adhesive is no more (or less!) difficult than for heavier weight tissues. At the WPC, precoated tissue preparation is a group activity and begins with labelling Mylar D support sheets measuring 8 ½ × 11 in. with tissue grammage, type, vendor, and date using a permanent pen. Next, the tissue can be efficiently cut from the roll in approximately 8 × 10 in. sheets by folding the tissue onto itself repeatedly, creasing sharply with a bone folder as one progresses, and cutting along the folds with a Japanese paper knife. In this way, a few cuts yield many similar-sized sheets.

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For an aqueous adhesive coating, the WPC uses a dilute mixture of wheat starch paste and methyl cellulose. Approximately 8 mL of adhesive is needed per sheet of precoated tissue. Cooked Aytex P wheat starch paste is strained and diluted to "pourable yogurt" consistency with deionized water and mixed with an equal volume of 2.5% A4M methyl cellulose. This mixture is then diluted with the same volume of deionized water to arrive at the final, ready-to-use consistency.

For a nonaqueous adhesive coating (ethanol activated), the WPC prepares a quantity of 5% Klucel G in deionized water (weight/volume). Again, approximately 8 mL of adhesive is required per sheet of tissue. For example, to make 20 sheets of 8 × 10 in. mending tissue, 160 mL of adhesive is needed (8 mL × 20 = 160 mL). Weigh out 8 g of Klucel G powder and slowly mix this into about half the water. When all the powder has been added, fill the container to the 160-mL mark. Let mixture sit overnight to allow the powder to fully gel and for air bubbles to disperse.

ASSEMBLY

Paste out a continuous and even layer of adhesive mixture onto a labelled Mylar sheet with a Japanese pasting brush presoaked in deionized water. Spray a generous mist of deionized water over the coated Mylar until the adhesive is glossy and margins look frosted with water droplets. Drop the dry tissue sheet onto the Mylar by holding tissue from diagonally opposite corners in a "hammock" shape and allow the bottom of the hammock to touch the adhesive first in the center (fig. 2). If done correctly, the rest of the sheet will roll itself down and out to the edges completely. Avoid touching or tamping the tissue as this will push adhesive through to the front of the tissue. Set aside on a flat surface to dry overnight.

MENDING

In most circumstances, both the aqueous and nonaqueous versions of this precoated tissue are best applied by wetting it up first and then placing it on the object to avoid

Fig. 1. Strip of 1.6g tissue precoated with 5% Klucel G on a dollar bill. Note hole in tissue caused by tweezers at the edge.

creating tidelines or blurring soluble media. Cut mending strips (1/8 × 3/4 in. is often a useful size) and small shapes by cutting cleanly through the precoated tissue and partially into the Mylar support sheet using a scalpel blade. With the tip of the blade, scrape up a corner of the mending strip up and peel up the strip using a curved-tip tweezers (fig. 3). This tissue coated with Klucel G is particularly reluctant

Fig. 2. A liberal spray of water on the adhesive coating just prior to dropping the tissue minimizes the chance of wrinkles.

Fig. 3. Lifting a precut mending strip from Mylar support with tweezers: more difficult than it looks.

to come away from the Mylar. Keeping hold of the strip with the tweezers, lay it into the wetting fluid puddled on a dark-colored glazed tile for a second. Then place tissue on object. Tamp down with a brush or lightly burnish down through smooth Hollytex or blotter. Dry under a blotter square, plexi plaque, and weight.

For the aqueous version, it is recommended to add ethanol to the deionized water to create a drier wetting fluid (up to 50/50 mix) to keep this fine tissue from collapsing upon itself before it is placed on the object. Should this happen (and it does!), discard and use a new strip. Because the nonaqueous tissue is wetted in straight ethanol, there is less sagging and manipulation is easier.

STORAGE

At the WPC, staff file sheets of precoated tissue in vertical hanging file folders. In theory, these sheets should keep indefinitely, and staff are currently using some weights of tissue prepared years ago. The sheets are organized by increasing grammage. Until a lighter and more useful paper appears, the 1.6g/m^2 tissue is at the front!

ACKNOWLEDGMENTS

The author would like to thank his colleagues at the Weissman Preservation Center both present and past for their continual effort in refining the preparation and use of precoated mending tissues for conservation.

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Pataki, A. 2009. Remoistenable tissue preparation and its practical aspects. *Restaurator.* 30 (1/2): 50-69.

SOURCES OF MATERIALS

NAJ Toned Tengucho (Hidaka) 1.6g/m2 rolls (19” × 5 m)
Hiromi Paper Inc.

Aytex P wheat starch paste, A4M methyl cellulose, and Klucel G hydroxypropylcellulose
Talas

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Tip: Single-Day Treatment of Extremely Fractured, Varnished, Fabric-Lined Map Sections

At the New York Public Library (NYPL), there are a number of maps that were previously backed with fabric on the verso and varnished on the recto. This combination of fabric on one side and varnish on the other can sometimes cause cracks to form in the paper. For the handful of maps in the worst condition (fig. 1), pieces of the paper layer become loose and then detached. Because of the cracking and flaking of the paper layer, these maps are too fragile to wash. Once the fabric backing is removed, the result is a collection of loose pieces that cannot be moved until a new backing is applied.

Stephanie Porto described the treatment of similar maps in the 2016 *The Book and Paper Group Annual*. The following treatment is a variation that makes the best use of limited time, enabled by that fact that at some time in the past, many of the maps in NYPL's collection were cut into halves, quarters, or sixths so that the individual sections were small enough to be stored flat in drawers. The map sections vary in size, about 23 × 28 in. As a result, the sections are small enough to fit into the fume hood and on the suction table, something that would not be possible with many full-sized maps.

To prep for treatment, loose pieces for which the locations can be determined are set down using methyl cellulose or wheat starch paste. The surface is carefully surface cleaned, and the media is tested for solubility in water and ethanol.

The map section is placed between two layers of nonwoven polyester and into a shallow ethanol bath (fig. 2). The surface is blotted with wads of cotton through the nonwoven polyester.[1] The cotton can be squeezed out and reused. The ethanol may need to be refreshed. Eventually, the cotton will come off clean, and the map is ready to wash.

The map section is transferred facedown on the nonwoven polyester to the suction table, where two layers of damp Evolon[2] have already been placed. As with most suction table treatments, plastic sheeting is placed around the object to concentrate the suction. The map section is sprayed with conditioned water repeatedly for about 20 minutes. At that point, the fabric can be peeled from the verso gradually, spraying to keep the fabric damp (fig. 3).

For these maps, there are usually two or three layers of fabric and sometimes strips of paper or paper tape to peel off.

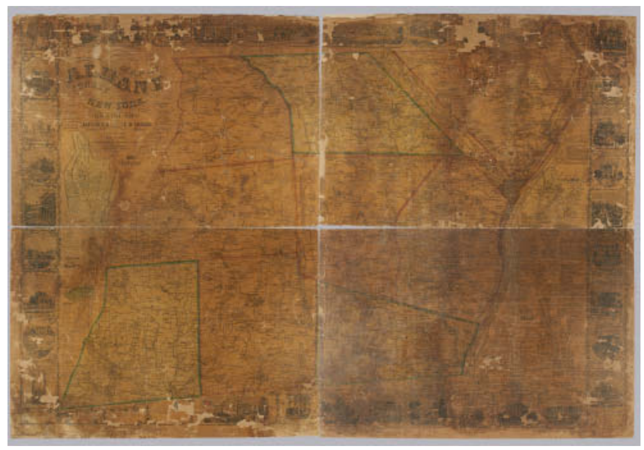

Fig. 1. Before treatment. Gould & Moore, *Map of Albany County, New York,* 1834, NYPL Map Division 16-5980.

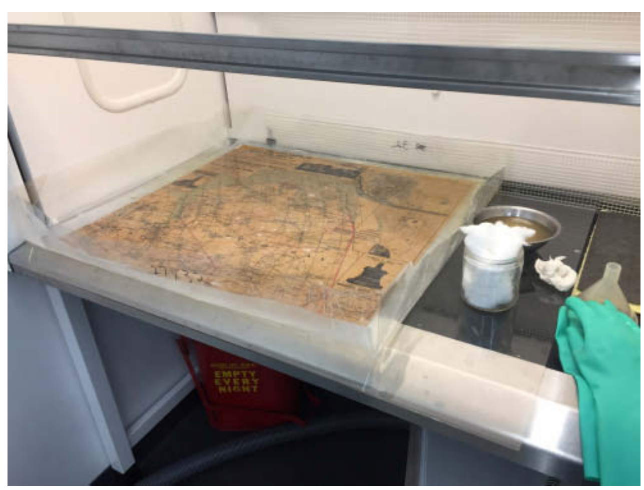

Fig. 2. Ethanol bath inside fume hood. One quarter of J.B. Beers & Co., *Kings and Queens Counties, New York,* 1886, NYPL Map Division 16-5970.

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Fig. 3. Peeling the final layer of fabric. Detail of one quarter of J.B. Beers & Co., *Kings and Queens Counties, New York,* 1886, NYPL Map Division 16-5970.

The suction holds all of the fractured map pieces in place while peeling. When all of the fabric is finally removed, old adhesive is reduced from the verso by scraping with a spatula.

Before lining, the plastic sheeting is removed from around the edges. The nonwoven polyester and two layers of Evolon

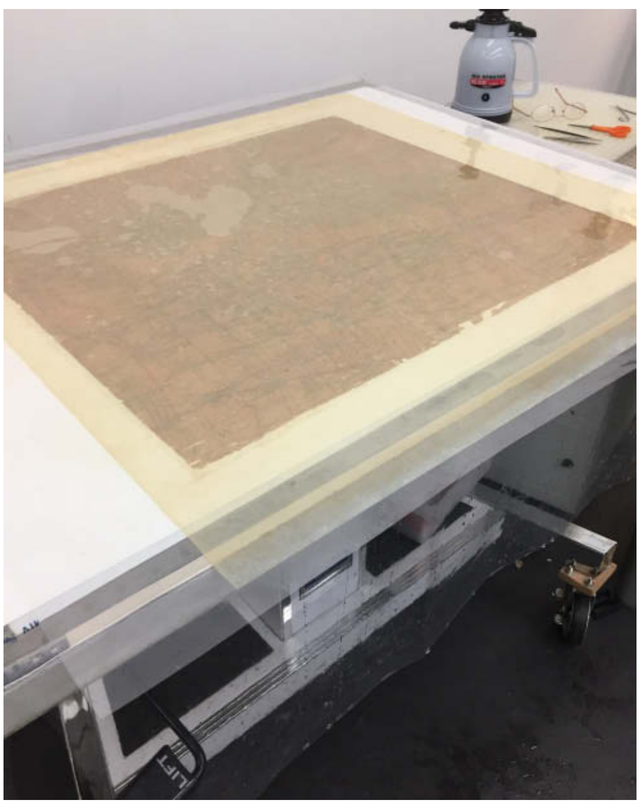

Fig. 4. Lining directly on suction table. One quarter of J.B. Beers & Co., *Kings and Queens Counties, New York,* 1886, NYPL Map Division 16-5970.

Fig. 5. After treatment. Gould & Moore, *Map of Albany County, New York,* 1834, NYPL Map Division 16-5980.

Fig. 6. (a) Before treatment and (b) after treatment. Olmstead, Vaux, & Co., *General Plan of Riverside,* 1869, NYPL Map Division 15-5830.

are left under the object on the suction table. The pasted-out lining paper is laid across the verso, applying pressure so that it fully adheres (fig. 4). Once lined, the map can safely be removed from the suction table and turned faceup so that fragments that may have shifted during treatment can be aligned, then dried for an hour or two between fresh, dry nonwoven polyester and Evolon under a weight. After an hour, the map is transferred to a blotter stack for drying. For these maps, losses are not filled and stains are not reduced so that more maps can be treated within the limited number of treatment hours allotted per year for the collection. After drying, the goals of treatment are met: the map is securely adhered to its backing and the information is more readable (figs. 5 and 6).

ACKNOWLEDGMENTS

The author would like to thank her colleagues Jessica Keister (NYPL) and Grace Owen-Weiss (NYPL) for helping to devise this treatment and for lending a hand whenever needed, Heather Hodge (current student at Buffalo State) for making lots of paste, and Marina Ruiz Molina (Metropolitan Museum of Art) for telling her about Evolon and passing on a sample.

NOTES

1. This varnish removal method was taught to me by photograph conservator Jessica Keister, who learned it at the Conservation Center for Art and Historic Artifacts in Philadelphia.

2. At NYPL, we have been finding many uses for Evolon (Molina and Hughes 2016). We buy it in rolls and cut it to useful sizes. It can be used for many of the same things that blotter is used for, such as to line tables or drying racks, and wash or dry objects. Grace Owen-Weiss has also developed a method of toning paper by coating Evolon with acrylic paint and pressing the paper to be toned onto the Evolon. Evolon can be washed and reused, similar to Tek-Wipe. Varnish stains can be removed by soaking in ethanol. Water-based stains can be removed by soaking in hot water or placing in a washing machine.

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SOURCES OF MATERIALS

Evolon nonwoven microfiber paper
Talas

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Tip: Using a Compact Hanging Screen and Magnets for Temporary Installation of Oversized Unframed Works on Paper

Conservators search for solutions to temporarily hang oversized unframed artworks to meet demands such as condition checks, imaging, and curatorial reviews. The paper conservators at the Museum of Fine Arts, Houston (MFAH) recently devised a system to secure oversized artworks (fig. 1) to a rolling hanging screen in their storage vault (fig. 2) with rare earth magnets. The use of magnets for temporary installation is often used by conservators. However, the advantage of using the rolling screen is that the art-handling team can remain stationary, placing magnets while a team member rolls out the rack during the installation process. This method is easily executed, with lesser handling of the artwork. It is also less physically demanding for the art handlers.

The first step is to mark out the installation position on the screen—low-tack blue tape is useful for this application. Use the solid metal ribs for attaching the artwork, particularly at the top edge, which bears the most weight (fig. 3). Prior to installing the artwork, place magnets on the screen just outside of the marked area (fig. 4). Magnets of various strengths and shapes can be used based on the object's needs. Space the magnets 9–12 in. apart (fig. 5). Fewer magnets can be used at the sides and the bottom if the artwork does not have tight curls. Start with the rolling rack partially retracted; align the artwork using the positional markings; open the roll slightly to place magnets at the top and bottom right corners, as well as the right edge (fig. 6). Once the artwork is secured, a team member can slowly extend the rolling rack. As the rack is extended, installers continue to place magnets along the margins of the artwork. Let the rolling rack do the "walking"—installers can remain stationary as the artwork unfolds. Reverse the process for deinstallation.

Tips to keep in mind when using this installation method:

- If using this method for photography, choose a rack at the end of the room to allow enough distance for the

Fig. 1. Rolled oversized work on paper.

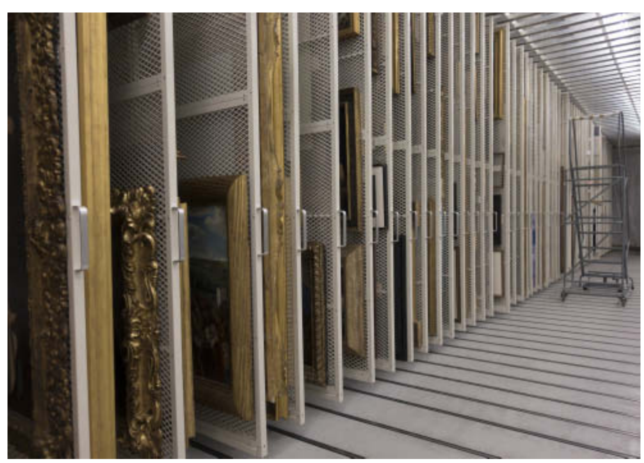

Fig. 2. Rolling art storage racks at MFAH.

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Fig. 3. Installation position marked on the screen.

Fig. 4. Magnets on the screen just outside of the marked area.

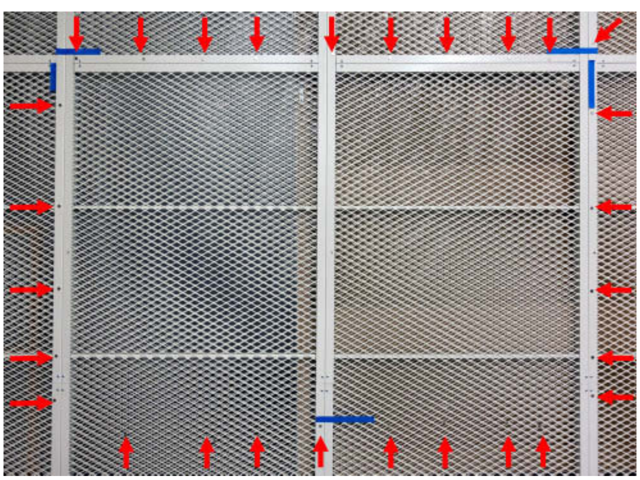

Fig. 5. Spacing of the magnets.

Fig. 6. Installation.

camera and lighting setup. It is also helpful to place a floor marker where the rolling rack should stop—this helps with centering the work as well as camera positioning.

- Use the solid portion of the rack instead of the mesh if possible.
- When shorthanded, installers can also extend the screen in situ by pushing on the mesh section of the screen.
- Communication is crucial to ensure the rack unrolling speed is in sync with the placement of the magnets.
- For larger works, more people will be needed. A stepladder will also be necessary.
- When removing magnets (particularly when the work has a strong curl), remove center magnets on the edge first to avoid uncontrolled magnet release (i.e., flying magnets hitting the installer).
- This type of rolling rack system can be incorporated into the design of a photography studio or conservation lab.
- This type of temporary installation is easy to set up. However, it is beneficial to gather all interested parties. For example, cover condition check, conservation imaging, and curatorial review in the same session. This method of installation has also been used for behind the scenes outreach activity with a donor.

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Tip: Minor Treatment for Chinese Folding Fans

BACKGROUND

The physical condition of Chinese folding fans can be quite poor because of the heavily applied sizing, coating, and finishing used in the production process. Additionally, their folding function can also result in severe tearing and cracking to the paper support.

A major treatment for Chinese folding fans could address these condition issues and replace the damaged lining; however, it would involve disassembly and reassembly, which is very time consuming and labor intensive. Furthermore, major treatment could adversely affect the undamaged side of the fan. This article includes an explanation of the structure of the Chinese folding fan and offers a tip to mend the tears on the paper-based folding fans without disassembly. It is hoped this tip will be useful for conservators working on similar cases.

INTRODUCTION

It is said in China that the process of making folding fans takes 72 steps to finish and includes rib preparation and leaf preparation. The ribs are usually made of bamboo. After the bamboo has been cut into standard sizes, steamed and dried, the bamboo sticks are paired (guards and ribs). The guards are carved and polished with wax. The ribs are also carved very thin at their tips and sanded. A horn rivet is used to join the guards and ribs together. The leaf is made of sized Xuan paper that is laminated, and may be decorated with mica, gold flake, or pigment coating. The Xuan paper is cut into the fan leaf shape, then moistened. To prepare the leaf, the fan leaf shape Xuan paper is laid on top of a plastic sheet with a template indicating where the ribs are to be placed underneath, then starch paste is applied evenly overall. Paper strips are placed along the marks of template. Another layer of Xuan paper is added. The paper strips create "pockets" or nonadhered areas within the fan leaf, which allows the ribs to slide between the layers of Xuan paper. After laminating the leaf and letting it dry, the leaf is ready to paint. The painted leaf is folded and trimmed, then paper or silk is applied along the top edge for both aesthetics and protection. At this stage, the leaf is ready to combine with the ribs. First, the rib (pockets) areas have to opened up carefully with a bamboo spatula, then the ribs are inserted into these areas, two edges of leaf pasted onto the guards, and the extra leaf trimmed. (The Production of Folding Fans 2017)

The rib pockets can become loose as the fan is used. The ribs then move more within the pocket area causing damage to the Xuan paper layers. Another issue is that Xuan paper decorated with gold flakes or mica/pigment coating is usually heavily sized with a high concentration of alum gelatin. These coatings and the acidic agents released from the bamboo ribs can cause the paper to become brittle and yellow over time. All these characteristics of the folding fan result in the leaf tearing along the edges of ribs and can create further damage such as losses. Therefore, some folding fan paintings or calligraphies that we see today have been altered into other mounting formats such as an album or scroll. For restoration of folding fans, preserving its original format involves disassembling and remounting; it takes an excessive amount of time and labor and also might adversely affect the undamaged side of the fan.

In 2016, three folding fans were acquired for a special Chinese exhibition, *China's 8 Brokens: Puzzles of the Treasured Past* at Museum of Fine Arts, Boston. These folding fans all arrived in similar condition with tears and splits along the ribs (figs.1 and 2). To keep these fans in their original format and address the condition issues, minor treatment was designed and undertaken.

TREATMENT

This section describes the minor treatment for three folding fans (MFA accession nos. 2013.581, 2013.580, and 2017.14) to mend the tears and splits.

The folding fans were photographed before treatment to document conditions under normal light and transmitted light. They were surface cleaned front and back with kneaded eraser as needed. Reinforcement strips were set underneath the tears as support. First, a long piece of mat board folded

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Fig. 1. Cracks, slips, and losses were seen at the lower portion on the front of 2013.581 before treatment.

Fig. 2. Cracks, slips, and losses were seen at the lower portion on the back of 2013.581 before treatment.

into a V shape was prepared as a support platform during treatment (fig. 3). Mylar or a fine bamboo spatula were used to open up the paper layers around the areas with no ribs, and the paper (or silk, if that is the original material) strip was pasted on the Mylar. The end of both the Mylar strip and paper (silk) strip were trimmed into a rounded shape, so that they could be easily inserted (fig. 4). After pasting a mending strip with Mylar underneath (fig. 5), both the paper (silk) and Mylar strip were inserted in between the paper layers along the ribs and set into place (fig. 6). A fine-tipped bamboo spatula was used to push the paper strip further to adjust if needed (fig. 7). The paper (silk) strips adhered to the paper

Fig. 3. A long piece of V-shaped mat board was placed underneath as a solid support during treatment.

Fig. 6. Placing the paper strip and carrier in between the painting and rib.

Fig. 4. Using a Mylar strip to get through the space between painting and ribs.

Fig. 7. Once the paper strip and carrier could not be pushed any further, use the bamboo spatula's tip to push paper in more.

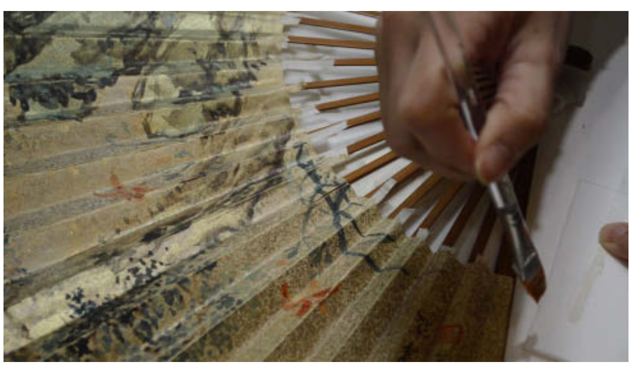

Fig. 5. Pasting paper strips with the Mylar strip underneath as a carrier.

layers and the Mylar carrier was removed. The paper (silk) strips underneath the surface were smoothed to make sure they had good contact. After the strips were dry, any extra papers were trimmed off. Color compensation was done to the repairs as needed. After treatment, these fans could be folded and opened according to their function, and also could be stored folded (fig. 8).

Fig. 8. After treatment, these fans could be folded and opened according to their function, and also could be stored folded in the box.

Fig. 9. The front of 2013.581 after treatment.

Fig. 10. The back of 2013.581 after treatment.

CONCLUSION

The minor treatment described above addressed the structural issues on the Chinese folding fans to prevent them from further damage during handling. These mending strips also allowed conservators to color compensate losses addressing aesthetic issues (figs. 9 and 10). In comparison with a major treatment involving disassembly and remounting, this minor treatment is less time consuming with highly acceptable results. This treatment supports the concept of less is more.

ACKNOWLEDGMENTS

I would like to thank the following MFA colleagues. I am also grateful for the supervision from Jing Gao, Cornelius Van der Starr Conservator of Chinese Paintings. Thank you to Jacki Elgar, head of the Asian Conservation Studio; Katrina Newbury; and Saundra B. Lane, associate conservator, for their generous support and encouragement.

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Tip: Enhancing Watermark Images: A Photoshop Method

BUILDING THE DATABASE

A recent research project at the Library of Congress focused on building a watermark database using a part of the Tissandier Collection, which contains approximately 8,000 items including letters, documents, maps, drawings and watercolors.[1] The material was collected by the French brothers Albert and Gaston Tissandier, noted balloonists and writers. The collection documents the early history of aeronautics with an emphasis on balloon flight in France and other European countries, with the majority of items spanning the years 1780–1910.

The aim of the research project was to provide a comprehensive and complete database of watermarks identified in the collection of handmade and early machine-made papers using a simple, cost effective, and reproducible method of recording the designs legibly (fig. 1). Ultimately, these enhanced images enable identification of provenance and/or dating of historic papers.

DIGITAL PROCESSING WITH PHOTOSHOP

The method uses transmitted light photography (fig. 2) followed by manipulations in Adobe Photoshop to record the watermarks. The process is efficient, quick, and does not require expensive equipment. Moreover, it directly generates digital data and allows future additional manipulations.

The challenge of producing a clearly legible image is the high contrast between the dark areas of the writing ink and the transparency of the watermark that appears weak in comparison. Reducing the contrast makes the watermark appear more legible. By manipulating a digital transmitted light image using Photoshop, the media that frequently obscures a watermark can be diminished and the legibility of the watermark image can significantly improve. Subsequently, the contrast within the watermark image alone can be maximized, enhancing contours and legibility. The method consists of two processing steps in Photoshop.

Tips presented at the Book and Paper Group Session, AIC's 46th Annual Meeting, May 29-June 2, 2018, Houston, Texas

STEP ONE: MEDIA REDUCTION

First, create a copy of the background. On this copy, select the darkest pixels in the image, which are typically the writing or printing media, using the Color Range tool under the Select tab (fig. 3). In most cases, select the Shadows settings from the first drop-down menu. Sometimes, other selections like Sampled Colors, Skin Tones, or specific colors may be a more suitable match for the media. Determining which selection is appropriate is made by trial and error and, eventually, with practice. Next, erase the selected media. Finally, create a new layer below and fill it with a midtone selected from the image. The midtone will blend in with the erased areas to "retouch" the loss.

STEP TWO: WATERMARK ENHANCEMENT

The second step is increasing the contrast to the maximum (fig. 4). Adjust the contrast in the image by selecting Adjustments > Levels under the Image tab. Select the lightest pixel, (typically inside the watermark) and the darkest pixel in the image (usually located on a fold or edge).

ADVANTAGES AND DRAWBACKS

The method described is simple and reproducible (fig. 5). It is easily accessible to a wide variety of users and can be adapted for other types of collections. Furthermore, this systematic approach allows reproducibility and fast recording.

The method follows typical conservation practices with regard to reversibility of the process and application of a custom-made approach. The principle of reversibility is respected by always creating copies of original images and multiple layers so the original image is never lost through subsequent manipulations. Also, as in retouching a real artefact, finding a midtone that can unify the color of the paper is challenging, especially after the second step. Nearly all of the parameters can be easily tailored to suit a specific watermark image, including the level of retouching by changing the midtone color, as well as adapting the hardness of the edge and size of the filling tools in specific areas in the lower layer.

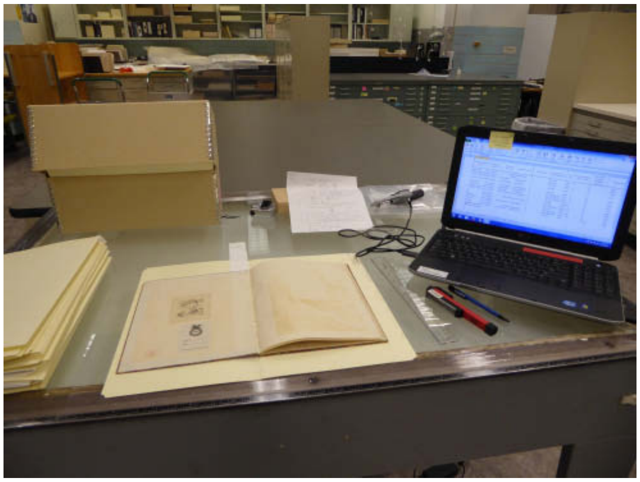

Fig. 1. Recording data on the light table.

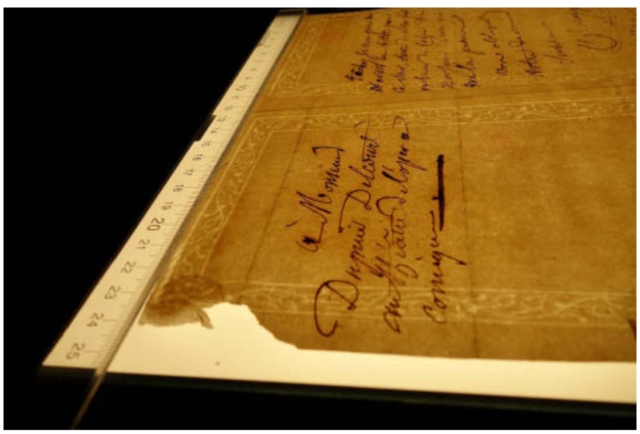

Fig. 2. Transmitted light photography.

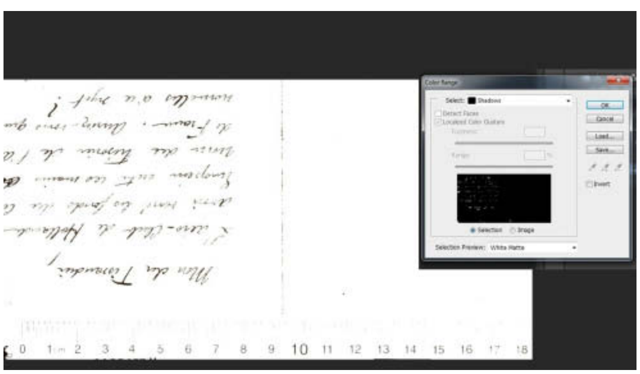

Fig. 3. Step 1 of the digital processing—selecting the media area.

Nevertheless, this method does not come without drawbacks. Enhancing the contrast by broadly selecting the darkest and lightest areas can become a problem when applying the method to a heavyweight paper, a large surface area covered by media such as engraving or watercolor, or if the original image is very dark from the beginning. In these cases, the

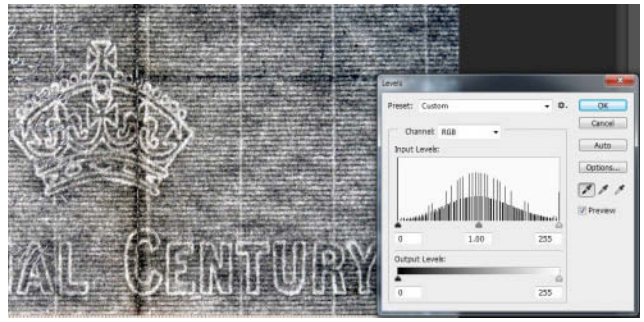

Fig. 4. Step 2 of the digital processing—enhancing the level of the contrast.

Fig. 5. Example of watermark enhancement.

selection will be harder to make and details can be lost during the digital manipulations. Moreover, the enhancement operation for one watermark may take around 5–10 minutes but digital processing of a large collection with low quality photographs or complex media can be very time-consuming.

This Photoshop method provides the first step to a new way of recording and deciphering watermarks. More information can be found on the Library of Congress website (Valero and Oey 2018) and detailed instructions are available on the Book and Paper Group Wiki (Valero 2018). It is hoped that, with widespread use, the method can be improved and perfected.

ACKNOWLEDGMENTS

I would like to thank Julie Biggs, Sylvia Albro, Elmer Eusman, Karen Femia, Mary Oey, Andrew Robb, and Chelsea Fairley from the Library of Congress for their comments, availability, and support. I would also thank the Foundation of the American Institute for Conservation of Historic & Artistic Works for their support.

NOTE

1. The Tissandier Collection on the history of aeronautics was purchased in 1930 and resides in the Manuscript Division at the Library of

Congress (MSS42994). The Tissandier collection also contains original documents from the Montgolfier brothers, Joseph and Etienne, pioneer developers of hot air balloon and heirs of a French family well-known for their prosperous papermaking business in the southeast of France.

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Tip: *Shimbari* at the Book Conservator's Bench

Shimbari is a Japanese term for a method of clamping using flexible sticks. Traditionally made of bamboo, *shimbari* sticks are placed between the area in treatment and a rigid frame. This system allows for extremely precise pressure that can be applied in a wide range of strengths in any direction.

This system is used most often in furniture conservation, especially for the treatment of lacquered or veneered items that require many minute points of pressure around a three-dimensional area. When treating objects as large and irregular as furniture, conservators often construct custom *shimbari* frames to provide the system's counterpressure.

For book conservators, however, a sewing frame can be employed as a *shimbari* frame (fig. 1). Sewing frames benefit from their adjustable crossbars, which can be shifted as needed for different angles or pressure strengths. Since the crossbar of the typical sewing frame is not secured, but rather rests on the thread nuts of the uprights, it will need to be clamped in place to provide counterpressure against the *shimbari*. The object in treatment can be held in place with a cradle or finishing press, if necessary.

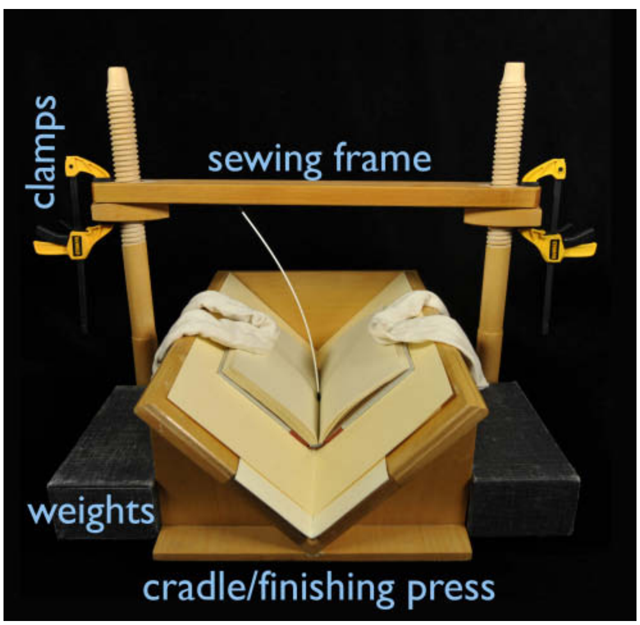

Fig. 1. Tools to use when employing a sewing frame for *shimbari*.

While traditional *shimbari* sticks are made of bamboo, fiberglass rods make for a stronger, more flexible alternative (fig. 2). The addition of a vinyl endcap provides gentle contact and friction to hold the *shimbari* in place.

With *shimbari*, pressure can be applied to virtually any area of a book: the gutter of a tight binding, narrow spines (fig. 3), headcaps, and even board edges. Multiple *shimbari* sticks can be used in conjunction to achieve pressure in different directions (fig. 4).

The *shimbari* sticks can also make an effective clamping system to support stiff or delicate leaves during digitization (fig. 5) and while sewing on the frame.

Shimbari makes for an affordable addition to the toolkit, running at roughly $2 per stick. Both the fiberglass rods and vinyl endcaps can be purchased from kite-making suppliers, such as Goodwinds, LLC. The rods come in a wide range of

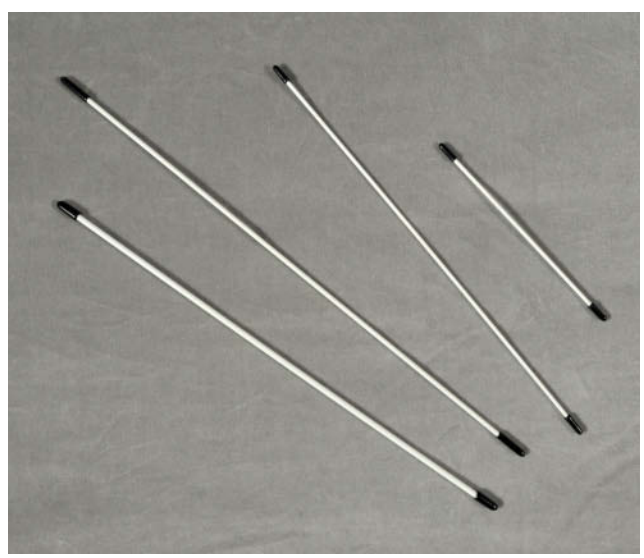

Fig. 2. A set of *shimbari* sticks.

Tips presented at the Book and Paper Group Session, AIC's 46th Annual Meeting, May 29-June 2, 2018, Houston, Texas

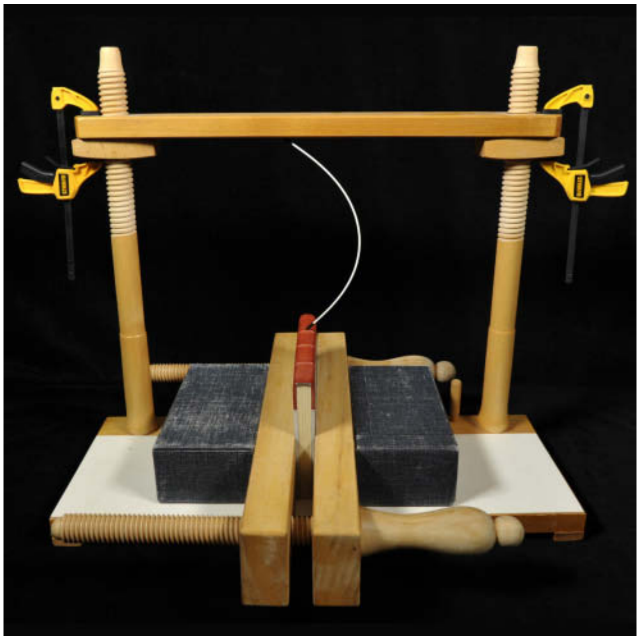

Fig. 3. *Shimbari* applying pressure to a narrow book spine.

Fig. 4. Three *shimbari* sticks applying pressure in multiple directions inside a book gutter.

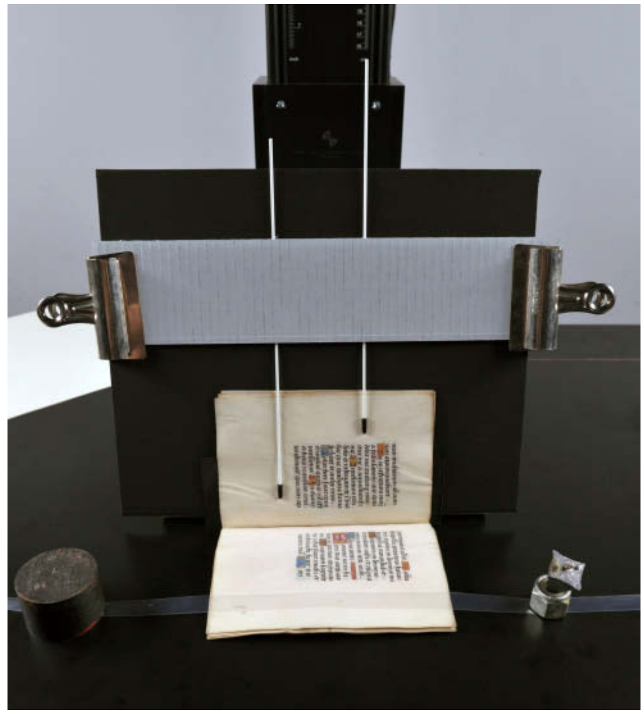

Fig. 5. *Shimbari* used to support a manuscript during its digitization process.

thicknesses, but the narrowest options (0.062 in. and 0.08 in.) work best.

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Archives Conservation Discussion Group/Electronic Media Group 2018 Preserving the Protest: Collection and Care of Social Movement Archives

INTRODUCTION

In recent years, there has been renewed activism and mobilization worldwide as a means of generating social or political change. The United States alone has seen record attendance at marches, vigils, and protests addressing racial injustice, civil rights, health care, immigration, climate change, gun violence, free speech, and education.

Objects created and used for these social and political actions are often ephemeral, presenting conservation challenges because they can be complex, composite objects, often made with inexpensive, repurposed, or disposable materials. In addition, the way these objects are used can leave them vulnerable to deterioration. For example, many activists intentionally leave signs or other objects behind as a means of continued protest. These items can be exposed to a wide range of environmental conditions and may sustain damage before they enter collections.

Though repositories have been collecting works associated with activism for many years, born-digital content has become a significant part of documenting contemporary resistance movements. Streaming video, social media posts, oral histories, podcasts, and performances allow activist communities to tell their stories in their own words. Acquiring, preserving, and making these primary source materials accessible requires innovative approaches.

This joint open discussion took place on June 2, 2018, during AIC's 46th Annual Meeting, May 29–June 2, 2018, Houston, Texas. The moderators organized and led the discussion and recorded notes. Readers are reminded that the moderators do not necessarily endorse all comments recorded and that, although every effort was made to record proceedings accurately, further evaluation or research is advised before putting treatment observations into practice.

SUMMARY OF PRESENTATIONS

CHER SCHNEIDER
CAUGHT UP IN THE CURRENT

Since the 2016 Presidential election, there have been widespread protest demonstrations in the United States. The archival community quickly realized that events like these needed to be proactively documented.

The University of Illinois Archives was inspired to participate in documenting the local March for Science held at the Children's Science Museum in Champaign-Urbana on April 22, 2017. Archivist Bethany Anderson realized that the University Archives needed to collect several different types of documentation in order to tell the whole story of the local march. Digital materials, ephemera, and brief oral histories were collected. Additionally, the archives used social media and web archiving tools to capture events simultaneously on campus. Twitter was chosen to document the local event for ease and expediency of sharing information using the hashtag #cumarchforscience.

Earlier the same year during the Women's March, a team of volunteers had asked the protesters to donate their posters, but only a handful of posters were given. As a result, archivists tried a more proactive approach during the March for Science by advertising on social media. A simple web form was created where people could share their thoughts and upload photographs, which could be matched up with later donations.

Getting in touch with the organizers of the march proved to be the best means of acquiring collection items. Many of the poster donors wanted additional information about the archival process and how their material would be made accessible in the future. These conversations were not only vital to the archival efforts, they provided important cataloging information about the creators' motivations and inspirations. They also offered an opportunity for outreach about preservation and the archival process.

The University Archives did not have a procedure for collecting protest ephemera. The collection was brought to conservation in a large cardboard box in the exact position that they had been donated on the day of the march. The box contained a pile of jumbled posters that were folded, torn, and partially visible. Some of the posters were stuck together.

After examining the posters and convening several meetings, a spreadsheet was created that included identifying information, barcodes, conservation notes, and metadata that would be controlled by the collection's owner, the University of Illinois Archives. The posters were arranged by size, materials, and media. Certain themes emerged, which allowed for sub-categories for future searches. The spreadsheet is crucial for storage and future access to this collection, as it links data and will be used for retrieval.

Many of the posters consisted of poor-quality materials, materials on hand, or commercially produced art and craft supplies such as corrugated cardboard, wood-pulp poster board, used retail signs, Styrofoam food containers, office paper, and textiles. Media consisted of poster paint, felt tip pens, graphite, crayons, and inkjet ink—very unstable media which is dye based, light sensitive, water soluble, flaking, or friable. There were many collage elements and three-dimensional applications in the form of paper letters, self-adhesive appliqués, paper cutouts, inkjet prints, iron-on textiles, and even nitrile gloves and specimen tubes. Many of the attachments were adhered with spray, water-based or heat-activated adhesives, rivets, sewing thread, and pressure-sensitive tape. Some of the three-dimensional elements were broken, loose, or delaminating prior to coming to conservation.

No conservation would be conducted on these posters for several reasons: they were in relatively good condition, the archivists wanted evidence of construction and use, the damage was not a risk to these suspected low-use items, and they were slated to be digitized.

Because most of the posters were of similar sizes, prefabricated metal-edge and corrugated clamshell boxes were used for permanent storage. To save space, posters were stacked within the boxes, allowing for reduced storage volume and efficient retrieval. Posters with collage elements or sensitive media were placed into polyester L sleeves within the boxes. Loose fragments were saved in polyethylene bags, which were labeled and placed into the boxes.

The two-step approach to preservation included digitization and long-term storage in the high-density cold storage unit. The posters could not be stored at the main library due to space limitations. Other oversized, low-use objects from Special Collections were recently moved to another library facility, so this was a logical choice and the best solution for these protest materials.

Once items had been organized, cataloged, and boxed, they were digitized and transferred to permanent storage. The most important part of the digitization process was creating the highest quality digital surrogate for preservation and access, without bringing harm to the newly acquired collection. The reward in digitally preserving political posters is realizing that patrons may one day use these items to learn about this historical political movement.

Many of the March for Science posters were too large to digitize in a single photograph, so they were shot in two or more images and stitched together. Capture took about two and a half hours for 120 posters and an additional three hours to stitch the photographs together. The preservation master files for this collection are saved as a 16-bit Adobe RGB uncompressed TIFF files, and access files are a derivative 8-bit JPEG 2000.

Legibility was an issue with some of the posters, due to high contrast materials, especially bright white and neon poster boards, where reflected light can cause loss of legibility in the image. The flat surface also makes focusing a challenge, as the poster board is smooth and shiny, and causes texture and highlight loss during imaging. Therefore, digitization chose a slower shutter speed and smaller aperture along with lowering the white point. They found this crucial to avoiding overexposure, tonal saturation, and texture loss.

The digitization department determined that it was necessary to capture digital images using raking light and angle shots to best represent the three-dimensionalities of the posters. These details also helped to provide scale for the posters. Extra attention was paid to double-sided items. Some of the posters had edited information and remnants of attachments. Because several of the posters had signatures, this became a copyright concern. Signatures were digitally blocked to allow for full access.

The project sought to preserve the posters' authenticity and context of creation, as well as to enhance access to the physical ephemera. The subtleties of materiality can easily become lost in the digital surrogates, so it was necessary to consider how much descriptive information was necessary for cataloging.

Details emerged in how the creators used materials to communicate their political message. The information from the oral histories will fill in the gap, and a nontraditional approach will allow for continued collection of metadata by the donating authors. The University of Illinois Library is committed to providing full access to this collection in its original form. The posters can be requested through University Archives. They will be retrieved from the high-density storage facility and brought to a reading room by request. The limited digital format can be found through the university's holdings database, and their preservation master files are in the repository and can be requested for review.

Modifying collection forms can help to address ambiguous concerns for future protest accessions. Space, money, time, and staffing are limited and should be considered when developing a preservation strategy. Open collaboration and communication is imperative from start to finish. An updateable content management system is necessary. Safely creating a high quality representative preservation master file is key. A proactive, ethical, and inclusive collecting strategy is crucial to creating trust in the community, which in turn will engender more donations for the archives.

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DANIEL BURGE

THE HISTORY, EVOLUTION, AND GROWTH OF DIGITAL PRINTING TECHNOLOGIES AND MATERIALS CORRELATED WITH MAJOR POLITICAL AND SOCIAL MOVEMENTS AND EVENTS OVER THE LAST THREE DECADES

The digital print era began in 1984 when two important products came onto the market: the inkjet and laser desktop printers. Both devices used black ink or toner, as they were intended for producing documents and not for creating images. This form of hard copy began to be produced in large quantities in offices and homes, entering into personal papers, corporate records, and governmental archives. Throughout the 1980s, new technologies were introduced and each played an important part in the evolution of these new materials, including the dye sublimation printer (1986), the color inkjet printer (1987), and the digital photocopier (1987).

In a watershed moment in 1990, singer/songwriter Graham Nash used an inkjet printer to create fine art prints of his photographic works for his two shows in the United States and Japan. He used an Iris continuous inkjet printer, which was originally designed for proofing offset printing, to print his black-and-white photographs. There were a variety of new advances in 1993, including wide format inkjet, black pigment inks, and the digital press. By this point, users had home desktop printers and office printers. However, commercial printing companies started buying even larger versions of this equipment, called digital presses, to meet their customers' needs. The first of these presses used the electrophotographic process. The advantage of this print method over traditional print systems was that they could print one object at a time or instantly print many unique objects one after another. By contrast, on an offset printer, it is necessary to make the printing plates, have staff that can ink the plates, and then run make-ready copies, all of which takes time. In offset printing, every single impression must be the same, creating long runs of each page which are eventually collated and bound. Digital presses can produce variable data, which means that each object can be printed independently. With these devices, every page can be printed one at a time in sequence to produce a single book and bind it immediately.

In 2007, inkjet printing entered the commercial market. This process uses even larger devices and was intended to compete directly with offset lithography. These inkjet printers also use variable data to produce different impressions of each object, though their size and speed prevents printing singular objects. There were some difficulties getting this technology to market, as it takes a lot of computing power to run a machine that fast and make every impression different, as well as having paper that can handle that much water, because the ink is aqueous.

Since 1984, many objects printed using technologies such as desktop printers, office printers, and commercial printers have entered into museum, archival, and library collections. At a minimum, internal administrative records are almost always printed using one of these techniques. In 2008, an Image Permanence Institute survey found that 80% of institutions had some forms of digital prints in their collections, including dye sublimation, inkjet, and electrophotography. This number is likely underestimated for several reasons: many people underestimate how long this technology has been in use and often expect a digital look, such as pixelation. In addition, the "poster child" for digital print has been the digitally printed photograph. If it looks like a photograph but is identified as inkjet, it is often called a "digital print." However, a digitally printed book is rarely considered a digital print. In fact, many short run publications, especially periodicals, may be printed using digital technology. The terminology used to describe different digital print types is often misunderstood and inconsistent. Misidentification or misnaming in records is therefore a big problem.

Digitally printed materials will dominate 21st-century collections such as those in the National September 11 Memorial and Museum. Almost everything in their collection that is printed is digital hard copy, such as objects recovered from the sites themselves, as well as items that were created immediately after the attacks, including printed posters of the missing and memorials to the deceased. Many of these items are unique in that damage is part of the object's story, but the objects also have forensic evidence associated with them. Since 9/11, there are also works created that comment on those events, whether artworks or short run publications.

During the last 34 years of digital printing, a variety of social movements have emerged. These range from ActUp, which came about at the beginning of the AIDS epidemic in the 1980s, to more modern movements such as Black Lives Matter today. Anything that has been created and collected from any of these movements has the potential to be a digital hardcopy. Most of the printers used to create protest materials are also low-end home printers, rather than the high-quality printers used in fine art print shops. Additionally, the objects are usually exposed to outdoor conditions.

An important point to consider is that there can be manifest damage, which is when an object is brought into a collection, and it is already obvious something has happened to it. There can also be latent damage, which means that decay is not immediately visible, but may appear as time passes while the object is in storage. This is especially true if the work has been exposed for extended periods to light, atmospheric pollutants, high humidity, water, dirt, improper handling, or mold, as well as if the materials are collected but not processed right away. Digital prints are sensitive to all of these factors. However, in many cases, the damage is part of the object's story.

The evolution of digital print materials has also affected these prints' stability and permanence. Image Permanence Institute experiments have documented the effects of water, light, and pollutants on examples of these prints from the 1980s. Many people believe that digital print evolution has consistently led to improvements in print durability. The truth is that the types of damage these prints experience has changed over time, with early examples being sensitive to light and moisture, and more recent examples being more sensitive to pollution and abrasion. Newer prints need just as much thoughtful care as older ones.

Digital printing is not new. It is ubiquitous in collections, but underappreciated and poorly understood. It is diverse and evolving. Conservators need a new preservation awareness and new skills for identification and care of these objects, and education and training are key. For additional information or workshops, please see the Image Permanence Institute website, as well as the Digital Print Preservation Portal (Image Permanence Institute 2018).

Daniel Burge, Senior Research Scientist, Image Permanence Institute

ROY CANIZARO AND KIM R. DU BOISE
MOLDY OLDIES: SAVING HISTORIC AUDIO TAPES WITH DIGITIZATION AND ORGANIC PARTICLE MASKS

This project was the emergency mitigation of mold on 35 10.5-in. reels of 1/4″ audio tape and the final conservation efforts to save the information recorded on them. The tapes, which date from 1983 to 1992, were owned by the Honors College of University of Southern Mississippi and are now accessioned by and housed in the University Archives.

These recordings represent the political, social, creative, educational, and technological issues and projects of their time. Some of the topics addressed during the presentations were those of civil rights, women's rights, and the earliest attempts to create electronic music. Others addressed political issues such as apartheid, international trade, and foreign relationships. The speakers on the tapes included Dr. Jesse Jackson, Betty Friedan, Sir Harold Wilson, Prime Minister of England, and Mark Mathabane, South African author of *Kaffir Boy*. It was vitally important to the Honors College and University Archives that the content of these tapes be saved and made accessible to researchers and the public.

Fig. 1. Kim Du Boise checking the mold condition on tape and box. Credit: Roy Canizaro.

The tapes were found in a locked closet that had unknown leakage for several years. They arrived at the PhotoArts Imaging Professionals' lab with no containment of the mold on the reels or tape, and were inside what appeared to be their original boxes. The coating of active mold averaged approximately 1-mm thick and was thicker on several audio tapes. Staff quickly put on their personal protective equipment, sprayed the tapes with a 91% isopropanol solution to help render the mold inactive, and placed them into small, translucent shredder bags which were sealed with blue tape. Isopropanol (91%) is an effective solution for rendering the mold dormant until further efforts at removal can be started. The shredder bags are strong, create a semi-anoxic microenvironment, and allow viewing of the contents' condition (fig. 1).

Once the initial emergency stabilization work had been completed, the curator asked for an estimate to mitigate the mold intrusion, clean and stabilize the audio tapes, digitize the contents, and put the original tapes/reels into archival storage containers, transferring the original data from the contaminated boxes. The curator discovered the university's foundation had a fund for departmental project grants and was determined to write for one. It took approximately two full weeks of inspection, written and photographic documentation, guessing whether the runtimes noted on the boxes were correct, and respraying the tapes and boxes so that the mold remained dormant in its microenvironment. It was also not possible to be sure the tapes' contents matched the information on the boxes until the actual playing.

The project was put on hold awaiting a grant application for the conservation and reformatting of the tapes. This took three to four months before work could begin on the project, rather than continuing to keep the tapes isolated in a section of the lab. At that point, part of the facility became a temporary isolation chamber to contain the mold, while staff started planning for the materials and workflow. The tapes with the now dormant mold were taken out of their boxes and transferred to gallon zip top freezer bags to maintain the anoxic conditions and make their progress more visible. Prior to placing them into the bags, they were sprayed with a 70:30 ethanol : distilled water mixture to kill the remaining mold. Once the information was transcribed, staff properly disposed of the boxes and shredder bags.

Over this period, the audio tapes were treated with ultraviolet radiation of standard commercial quality. This type of bulb emits an average UV wavelength between 350–380 nm, which is enough to affect the mold and keep it dormant without exposure levels that would cause further tape degradation issues. The treatment times were usually limited to two to five hours from a distance of about 18 in. The treatment was chosen because it limits the amount of liquid used after the mold was under control.

When the grant for the conservation came through, a cleaning station was set up on the counter at one end of the lab, directly under the exhaust fan. The fan draws and exchanges the air five to six times per hour; it was on constantly during any procedure that required handling the tapes. The fan was intended to draw out any dormant, dead, or dying mold that could be removed. It was possible that even the stabilization and cleaning steps could damage the metal layer. All steps, including the removal of the mold from the metal-based tape, were carefully handled to make these recordings as stable as possible so the information could be salvaged and digitized.

Roy Canizaro, the time-based media conservator, designed the tape cleaning setup. He used two 8-in. spooling arms that held the reels set approximately 4 ft. apart. The area was covered with plastic-backed pads that could be cleaned or discarded. The generally recommended cleaning material is nonwoven polyester webbing. Due to the damaged binder and flaking magnetic layer, he used Kimwipes because they are thinner, smooth-textured papers, and did not affect the tape but efficiently removed the dead mold structures. The dry paper material was not always effective at removing all of the mold the first time, so a Kimwipe dampened with the 70% ethanol mixture was used to take off the rest of the mold on a second pass (fig. 2).

The tapes had to be taken off the original reel and respooled on to a clean reel after dry cleaning. Two 10.5-in. reels were used for respooling. This allowed the second conservator time to clean mold off the original reels. Tapes were

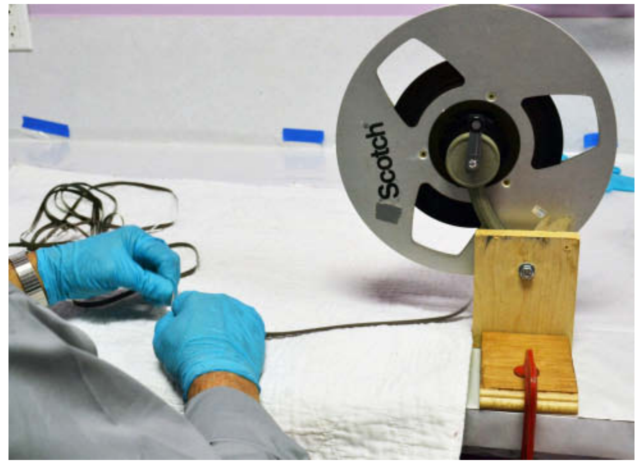

Fig. 2. Dry cleaning audio tape to remove dead mold colonies treated by the ethanol mixture. Credit: Kim Du Boise.

sprayed with the 70% ethanol mixture, which was made in pint batches and then put into spray bottles. This was used to clean the reels of mold that had grown into the recesses and insides of the hubs, as well as the screws that held the reels to them. The water had rusted some of the screws and holes, and a black mold had found its way into the hard, plastic hubs and between them and the side reels.

Kimwipes, cotton swabs of various sizes, and steel brushes were used to clean the reels, depending on how contaminated or damaged it was. The disassembly, cleaning, and reassembly of an empty reel averaged 25–30 minutes. As a final step before reformatting, the tapes were spooled onto cleaned reels and housed in Stil inert polypropylene boxes that have antistatic properties and are vented to stabilize humidity (fig. 3).

Due to the condition of the tapes and the advanced invasion of the mold, there might only be one chance at digital capture. From all indications, the binder on the tapes, if not the metal composition of the magnetic layer, had been compromised by the moisture intrusion and mold. The tape binder layer had deteriorated in many places allowing the magnetic metal layer to flake (fig. 4). This required disassembly of the tape deck heads for cleaning after playing every tape.

Once the tapes were cleaned and ready for digitization, they had to have heads and tails attached to many of them. The tapes were played on a 10.5-in. reel-to-reel player that had one of the capture devices attached to it. This device was attached to a laptop containing the software used to reformat the information to the required file format requested by the client, often in MP3 or MP4 format.

The contents of the tapes did not match the labels on the boxes or announcer's notes inside. One tape was not a speaker, but a concert from the University of Southern Mississippi Symphony. On another tape, the speaker had the microphone turned down when they began to speak and it was difficult to bring out their voice, which was less than a whisper. The

Fig. 3. Cleaned reels and tapes, respooled with new heads and tails in Stil hard case archival boxes made to stand vertically on a shelf or in a box. Note that the box comes with securing hub and secondary hub for larger core reels. Credit: Kim Du Boise.

Fig. 4. 10-in. reel-to-reel player/recorder with head protectant shield removed for flaking magnetic layer to exit the machine. Note the flaked materials on the table. Credit: Roy Canizaro.

archives had brought the tapes directly from the damaged area, and they were not yet accessioned, so staff had to make a list for them to provide a record of what was at the lab.

When working on a large multistep project that had suffered accidental damage, it is most important to document the timeline and the total hours the project steps consume. Knowing what is ahead made it easier to estimate the work performed for the grant budget. Understanding the importance of documenting treatments and results can never be emphasized enough. Spreadsheets are used to document every step, treatment, enhancement, or issue found, and these are essential to the final report given to the client.

Kim R. Du Boise, President & Senior Photograph Conservator of PhotoArts Imaging Professionals, LLC., and Roy Canizaro, VP and Electronic and Time-based Media Conservator for PhotoArts Imaging Professionals, LLC

WHITNEY BAKER
PRESERVING ARTIFACTS OF FREE SPEECH: SIMPLE SOLUTIONS FOR BUTTONS, T-SHIRTS, AND BUMPER STICKERS

Established in 1965, the Wilcox Collection of Contemporary Political Movements at the University of Kansas (KU) Libraries features United States left- and right-wing political materials from the 1960s to the present. The KU Libraries are still adding to this collection. It is one of the most highly used and one of the library's most nationally significant collections, as it encompasses the full spectrum of American political thought. The collection contains a wide variety of paper, ephemeral materials, leaflets, broadsides, and posters.

While paper-based materials are handled according to KU Libraries' preservation guidelines, many repositories are finding more nonpaper objects coming in with archival collections. As a result, there is a need to find ways to stabilize or safely house these materials. Because KU has a graduate level Museum Studies program, conservators at KU Libraries have hired many of these students to focus on housing solutions for these unusual objects and reduce archival backlogs.

Conservation Services tries to use and adapt archival housing materials it has on hand for archival processes. Because this collection is large and still actively collected, there is not a large budget for custom housing solutions. The housings should be straightforward and easy to use, incorporating pictures of the objects and the way they are housed on both the outside and inside of the boxes. The hope is to ensure that curators can handle these objects safely when they use them in teaching and exhibits.

The "more product, less process" approach (Greene and Meissner 2005) used by many archival processing units means that there is often not a lot of granularity in finding aids. Unless an inventory of single items is created, most researchers aren't going to know what is in the collection. The Museum Studies students are helpful at creating inventories—something lab staff might otherwise not have time to do.

Both the Wilcox Collection and the University Archives have thousands of political buttons that are used for instructional purposes. Conservators worked out a process to individually house those buttons that the curators feel are significant, so they are able to find particular buttons quickly.

Conservation Services has many 15.25 × 11.5 × 3 in. boxes that were designed to be used for slide storage and come with six long, skinny boxes inside, measuring approximately 2 × 2.5 × 11 in. each. Both the skinny boxes and their lids are used as trays for button storage within the larger slide boxes. Since large groups of buttons can be heavy, these relatively small boxes can contain many buttons without being difficult to carry. Each button is housed with a 20-point support that is stamped with archival information; the button and support are placed in a clear polyethylene bag (fig. 5). This storage solution can also be adapted to larger items, with adjustments to the size of the box, bag, and support. For example, oversized buttons are housed similarly, but using the "card-file" size archival box. This method of storage also does not affect the pin back, which can potentially damage the metal if the button is pinned to a support. Also within the collection are thousands of t-shirts from various student and political groups. They are stored rolled onto a tissue/batting core and stored in flat archival boxes, usually 20 × 24 in. The aim is to safely get as many t-shirts into a box as possible, as the collections have thousands of t-shirts and lack adequate space to store them flat. Each t-shirt is photographed and its image is placed on the box lid inside a pocket as well as on the outside of the box. That way, researchers can view the picture before or instead of unrolling the item. Conservators try to make it as easy as possible for the researcher to find the information they need.

Bumper stickers also frequently come in with many archival collections, and these have been discussed previously at previous AIC meetings (Baker 2012). These are housed in alkaline folders within a standard sized archival storage box. If the sticker has condition problems, such as sticky adhesive or ink, shrunken vinyl, or peeling backing, it is placed individually onto a sheet of silicone release paper within the alkaline folder (fig. 6). While Mylar might seem like a possible solution for these items, the polymer-based inks used to print modern bumper stickers can sometimes stick to the polyester.

Whitney Baker, Head, Conservation Services, University of Kansas Libraries

DAN ERDMAN
MAKING SOCIAL MOVEMENTS ACCESSIBLE AT MEDIA BURN ARCHIVE

Media Burn is a small independent video archive in Chicago. It began operations in 2003 when founder Tom Weinberg, who had produced several documentaries and television

Fig. 5. Buttons housed in polyethylene bags, placed within slide trays in a slide storage box. Credit: Whitney Baker.

Fig. 6. Bumper sticker within folded piece of silicone release paper, placed within a standard alkaline folder. Credit: Whitney Baker.

shows for public broadcast, decided that he wanted his collection of tapes, including finished programs, production elements, and various bits of video ephemera, to survive into posterity. Since that time, Media Burn has been digitizing and cataloging video. Currently there are over 7,000 tapes online, all of which are available for free (Media Burn Archive 2018). Weinberg has deep connections with the greater video production community and as a result, Media Burn has added the work of many artists, documentarians, and other video makers to their collections.

Many early video works are political in theme and the Media Burn collection reflects that. Many videos in the collection depict protests of one form or another. "Protest video" as a phrase may not be as straightforward as it seems; searching that term on the Media Burn site returns 22 pages of results. To make these materials more accessible to viewers, Media Burn works closely with the producers of the footage to provide necessary contextual information. Three brief case studies illustrate the ways in which video producers helped Media Burn ensure the fullest possible access to their materials.

Collaboration with producers can be an important means of clarifying the nature of an event, particularly in a media environment in which everyday news has seemingly undergone spin and revision before reaching its conclusion. Producers are in some ways better equipped to take on this role of clarifying than third-party eyewitnesses, as producers can often point to their own images as supporting evidence. Independent filmmaker Bill Stamets was present at the aborted Chicago rally for then-candidate Donald Trump in April 2016. Stamets did not intend to make anything in particular of the material he shot that evening. He also did not, and could not have, anticipated that this event would be shut down before the featured speaker could take the stage, nor that the mainstream news coverage would attribute this cancellation to violent incidents in the hall itself. Stamets submitted his footage to Media Burn some weeks after the event and only after this particular narrative of violence had fully made the rounds. Originally shot in brief increments on his iPad, ranging from 3 seconds to 4.5 minutes, he edited these into a longer complete piece and supplemented them with a written observation on what he saw at the event. Specifically, Stamets observed that his footage runs counter to the conventional journalistic wisdom of the event as an outbreak of mass mayhem, and his account also suggests that the speech was cancelled not because of a threat of violence, but because the majority of the crowd had no intention of acting as cheerleaders for Trump.

Many of Media Burn's videos are programs created for broadcast on independent or public television and in addition to the final videos, producers often provide production elements, including raw camera original footage of the event. It is not always a priority for moving image archives to make raw footage accessible, but Media Burn has always regarded camera original video as essential to the understanding of the work. Not only does it give the viewer a sense of the choices the producer made in the structuring of the video piece but it can also reveal details that were not regarded as important at that time. An example of the potential for raw footage to cast a wider light on such an event can be found in an episode of *The 90s*, a program that Tom Weinberg created for public television. This particular episode was focused on the 1992 presidential primaries. The clip shown is a short scene of a demonstration by Chicago homeless people outside a fundraiser for George H. W. Bush. The clip makes a straightforward political rhetorical point, contrasting the people protesting outside with the comfortable, well-fed donors inside. But the raw footage, which is also streamable, reveals that the protest by the homeless was only one of many outside the building that evening, including one by Haitians demonstrating against U.S. foreign policy and another against the extradition of IRA fighter Joe Doherty. This footage illustrates the range of communities and activist organizations that had an axe to grind against the administration of that time. One can see the ways in which different groups made their case; the homeless group set up an impromptu soup line in front of the hall, while the others waved signs and chanted. It also reveals the sort of treatment each of these groups received by the police.

"Activist video" can mean something much broader than simply the documenting of a protest. It can also refer to video that was created for use as part of a specific piece of political agitation. An especially salient example from the Media Burn collection is Communications for Change, an initiative begun by Tedwilliam Theodore, who thought that the medium could be used by activists of all types, from documentarians to neighborhood associations. These actions from the very early 1970s often resulted in the creation of footage that was not meant to be shown to a wide audience, but only in particular circumstances. For example, one particular piece of footage does not seem like either a protest or a typical piece of agitprop. In the clip, a woman is standing in a pothole poking at it with a cane to see how deep it goes. The context of this, not necessarily obvious to the viewer, can be found in some of the documents included on the site provided by the producers. In a lengthy reminiscence about his time with Communications for Change, Theodore remembers this as "The Pothole Action." Community members took the initiative not only to demonstrate the extent to which neighborhood infrastructure was crumbling but in fact to capture it on tape. This was not necessarily created for public consumption—it was not supposed to get on the news or get a local PBS affiliate—but to illustrate the problem to the city. Once this was screened for development officials, aldermen, and whichever department was responsible for potholes, the hole was repaired almost immediately, according to Theodore. For him, this is not only a demonstration of the tactical potential of protest or video, or protest *and* video, but of the way in which both could empower communities and individuals generally. As he wrote, the woman in this footage "used the video camera's presence to generate an event, an action which got results, increased her stature in the community, and created a feeling of accomplishment and power in those who participated. And most importantly, a dynamic situation was created to move apathetic individuals" (Media Burn Archive 2018).

Media Burn has primarily worked with video producers; all three of these examples have focused on collaboration with video production professionals, or semiprofessionals, who are video-makers first and activists second. They are, to one degree or another, removed from the actions being documented. Media Burn hopes to create more connections with communities and interest groups who might be undertaking these actions themselves and to take advantage of the momentum for community archiving and collaboration currently taking place in the media archive world.

Dan Erdman, Video Archivist, Media Burn Archive

DISCUSSION SUMMARY

After the last presentation, the moderator opened up the floor for questions, comments, and answers. The contents of the discussion are summarized and paraphrased in the following.

Commenter: Comment for Baker. We recently received a few hundred metal buttons and we did the exact same thing—stored them in plastic bags in slide boxes. We sat down and talked to our curators to identify about 20 or so that would be representative of that collection and made a tray to house them that could be easily shown and taken to classes.

Commenter: Question for Schneider. Can you speak more about the decision to blur out the creators' names when you digitized the posters?

Schneider: The archivist who made that decision was concerned about ownership and unsure about copyright, and blurring the creators' names seemed like the safest way to make the content quickly accessible. The names are blurred for online access but not in the original catalog record. The donors did sign a release, which allowed digitization and web access, but the signature is considered a separate matter. For now, we decided to blur the signature, though that may change in the future.

Commenter: Question for Canizaro. After cleaning the moldy audio tape, what kind of preparation was done for digitization?

Canizaro: Other than cleaning we did no other preparation; we took them straight up to the digital lab for transfer. Their condition was so bad that we only had one shot to capture the audio. If we had done any other preparations on them, we probably would have lost more of the magnetic materials. The binder layer was deteriorating badly from the conditions where they were found and the necessary use of alcohols and dry cleaning treatments to get rid of the mold.

After each pass of the tape, I really had to work to clean the machines afterwards. I could only run one tape in a session, clean the machine; then run another tape and clean the machine. After playing, there was really nothing left on the tape in some areas.

Commenter: Question for Canizaro. Is there a specific reason that you didn't consider baking the tape?

Canizaro: Yes—it wasn't "Sticky Tape Syndrome," it was pure and simple failure of the binder layer that holds the magnetic metal layer to the tape. The tape was on a polyester back, not an acetate back, which is where sticky syndrome occurs in cellulose acetate tape. The reason to bake a tape is so it will hopefully run through the machine better. This is not always the case though. These tapes were from the 1980s–1990s when Ampex made only polyester support tape; it was a simple failure of binder breakdown due to the wet boxes, excessive moisture from the leaky closet, and mold growth. Baking the tape after cleaning the mold would have probably only accelerated the binder failure.

Commenter: Question for Schneider. If you were asked to gather documentation for another march, how would you prepare?

Schneider: Make sure that we advertised as much as possible on social media and any other venues; recommend conservation be more involved in the process from the beginning; determine a better way of collecting items so that they do not get damaged or start sticking together right away.

Commenter: Questions for the whole panel. What is your biggest learning experience working with activist communities? What advice would you give for a repository or association starting this process?

Erdman: Working directly with community organizers and community groups is something that needs to be done more going forward. As for advising any organization in the future, collect materials from video producers and the people responsible for putting forth the message; if those are not the same people, try to get as much from both as can be responsibly maintained.

Schneider: We would like to be more organized. We were really surprised by the response—the organizers of the protest were happy to hear about us, to learn about archiving, and wanted to be a part of the preservation of the protest so they could make announcements about it to participants. That kind of collective approach really helps. The organizers got many more people to donate and do the oral histories. Even the protestors were interested in preservation and archiving and were excited to share their stories. It became this whole story that was told in many different ways. We plan to share some of our documentation and forms to show others what we are doing.

Moderator: Maybe information like this could be on the AIC Wiki.

Burge: Given the fact there is often no control over when these protests erupt, who is going to them, what they are going to say, what materials they are going to bring and what they are going to do with those materials afterwards, you cannot really be prescriptive about what types of materials will be included. Since what you are getting is always a surprise, the ability to identify a variety of things in terms of their composition and condition as effectively as possible is important. With the digital hard copy, it is really about adding it to the already existing knowledge that conservators have in their specialties because digital lives between specialties.

Canizaro: One of the things we are trying to overcome is working with small universities that do not have funding—who often have protest cartoons and other ephemera in their archives that they did not know they had. They have movies, audio tape, video tape, of all sorts of things. In fact, the University of Southern Mississippi has a large collection of materials about the Freedom Summer that they are trying to get funding for us to digitize and put on the internet. So, you have small universities who want to work with people to get things done but do not have funding. We are always trying to help them find some grants or patrons.

Commenter: Regarding storage—lack of storage, cost of storage—where we draw the line with what we accept and what we refuse?

Schneider: Storage was something we talked a lot about. Storage and space will disappear quickly. Continuing this process, they may have to be selective about what gets collected and to collect what represents the overall voice rather than collecting everything.

ACKNOWLEDGMENTS

The co-chairs of ACDG and EMG would like to thank BPG Program Chair Debra Cuoco for her assistance in planning and organizing this session. They also wish to express their gratitude to the panelists for sharing their experiences, and to the audience members who participated in the discussion.

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ANGELA ANDRES, SONYA BARRON, AND JESSAMY GLOOR
DISCUSSION GROUP CO-CHAIRS

Library Collections Conservation Discussion Group 2018 Matters at Hand: The Evolution of Staffing and Prioritization in Library Conservation Labs

INTRODUCTION

Conversations with BPG colleagues at the 2017 AIC annual meeting in Chicago and in the following months revealed a common interest in how library conservation practice is changing in the 21st century. Through in-person, phone, and email exchanges, fellow conservators, and preservation administrators shared their observations and concerns about adapting to shifting institutional priorities. These include prioritizing treatment of certain types of materials over others, responding to and meeting broader institutional goals, and the challenges such changes present to traditional models of staffing and divisions of labor in library conservation labs. A panel of speakers from a variety of libraries and archives offered short presentations exploring both the day-to-day issues and the big picture implications surrounding these concerns. A discussion with the audience followed the presentations to allow for questions, comments, and sharing of experiences.

PRESENTATION SUMMARIES

ELLEN CUNNINGHAM-KRUPPA
PREVENTION AND PROMOTION ROUND-UP

In recent years, new approaches to managing the Preservation and Conservation Division of the Harry Ransom Humanities Research Center at the University of Texas at Austin have concentrated operations and provided ladders of professional advancement for conservators and technicians. A series of organizational and workflow "tune-ups" were undertaken in the division over the past couple of years with two main objectives: to create more time for treatment for conservators and to designate appropriate job titles that speak to work responsibilities, reporting structures, and advancement opportunities. These objectives were ultimately achieved by an organic process whereby decisions and changes were made when opportunities presented themselves.

Division staff began by tracking their time spent on various work activities; it became clear that conservators' time was stretched among a variety of responsibilities well beyond treatment. While this situation is not unusual for institutions, division staff wished to carve out more time for treatment and collections-focused work. To this end, they rethought how the work being done was prioritized, and where in the division the work resided. One idea was to re-envision the tasks that technicians undertook (at the time, technicians primarily made housings) and to concentrate preventive activities under a larger preventive umbrella. When the speaker assumed her role in the division, two conservators divided the responsibilities of environmental monitoring and integrated pest management (IPM); under the new arrangement, these activities are consolidated and technicians, rather than conservators, oversee them.

A number of staffing changes offered opportunities to rethink how work was accomplished in the division, and whether job titles and salary levels were appropriate to the work at hand. Over the course of one and a half years, two longtime Ransom Center conservators retired, one from the book lab and one from the photo lab; another full-time housing technician resigned and moved to a new job elsewhere. Around the same time, the speaker sought to hire a new head of the paper lab, a position that had been vacant for about a year. The division also gained a full-time postgraduate fellow position for 3 years thanks to a generous gift from a donor. All this shifting allowed the division to re-envision workflows and structure. The director of the Ransom Center committed to raising staff salaries and reducing compression, devoting funds

This joint open discussion took place on June 2, 2018, during AIC's 46th Annual Meeting, May 29-June 2, 2018, Houston, Texas. The moderators organized and led the discussion and recorded notes. Readers are reminded that the moderators do not necessarily endorse all comments recorded and that, although every effort was made to record proceedings accurately, further evaluation or research is advised before putting treatment observations into practice.

to raising the lowest salaries in the center to the level of a living wage in Austin, and to making conservators' salaries more competitive. Funds for these changes were found through new commitments of funding combined with lapsed salary savings and/or nonreplacement of positions. With difficulty, division leadership determined not to refill a second book conservator position, reasoning that those funds could be put to effective use for selected division positions and a new critical hire.

These events—a retirement, a resignation, a donor gift, and the willingness of a division technician to undertake an expanded range of work—combined to allow the achievement of the two primary goals the division had set for themselves. Prior to this undertaking, the book lab was staffed by one senior book conservator and one book conservator; the paper lab by two paper conservators, including one lead conservator, and the photograph lab had a similar arrangement. Staff in the preservation unit included one full-time technical staff assistant III and one .75 FTE technical staff assistant III, plus one .25 FTE work-study employee, all reporting to the speaker. Under the new arrangement, the title of senior conservator was created for the head of each lab to establish a clear, albeit short, ladder of opportunity for advancement. The biggest changes happened in the preservation unit, which is now staffed by a full-time senior preservation technician, a .75 FTE preservation technician, and a .5 FTE preservation technician, in addition to a two-year special project position and a work-study position. The new arrangement and job titles now more accurately reflect the responsibilities of each role, and collections care activities such as housing, IPM, environmental monitoring, inspection of incoming collections, and supplies ordering are centralized.

Ellen Cunningham-Kruppa, University of Texas at Austin

WERNER HAUN
FROM DIY TO COLLABORATION AND INNOVATION: OBSERVATIONS ON THE EVOLUTION OF COLLECTIONS CONSERVATION

Collections conservation work has changed through the years from activities focused on the repair and maintenance of general collections to more complex treatments for all types of collections. This shift has been made possible by developments in automation and through collaboration with commercial binders and vendors. Innovations and improvements have advanced the quality and variety of products and services, allowing libraries and archives to outsource much of the routine work and to devote staff resources to a broader range of collections-focused work.

The speaker recalled starting out in his career as one of 14 student workers in the lab at Southern Illinois University. The lab had one conservator, and the student employees worked 20 to 25 hours a week. Treatment focused on general collections; damaged materials were identified through circulation, minor repairs were performed, serials placed in temporary bindings, and the like. Production methods were employed to get the work done, and pre-cut supplies were used to increase efficiency. An ultrasonic welder provided the only automation. At that time, preservation quality materials were harder to come by, and special collections treatments were few and minimal.

Throughout the years since then, preservation librarians, conservators, related organizations and institutions have worked increasingly with vendors to develop new products such as standard boxes, custom polyester sleeves, pamphlet binders, and folders. Custom boxes and portfolios have long been a part of commercial library binding programs, but with new automated systems custom boxes can be made at lower cost. Library binding has moved away from a primary focus in the early years on simple binding strength through the use of oversewing and heavy buckram. The later development of NISO and other standards enabled binders to offer more and better options for bindings and the retention of original material, and libraries in turn began to rely more heavily upon binders for preservation of collections.

Technology has also changed conservation and collections care work, particularly as the increasing online availability of library resources once available only in print leads to a reduction in the types of materials that once formed the bulk of many collections care programs. Better availability of products, better binding, and new technology have allowed labs to expand beyond programs focused only on basic repair. Now a conservator at the Yale University Library lab, the speaker oversees a collections care unit that also includes two technicians and one to two student employees. Their approach to collections conservation is more holistic than the high-volume production model from the speaker's days as a student worker. The lines between general and special collections conservation have blurred, as conservation staff look for opportunities to employ production style methods for all collections, but with more sympathetic materials and treatment protocols. Students only work 10 hours a week; their work is strictly defined by union rules and mainly consists of tip-ins, pockets, opening leaves, and measuring materials for boxes. Some practices, such as using precut supplies, have remained in place, and items in need of treatment are still identified through circulation. The speaker observed that treatments are more complex now than in his early career; more sympathetic materials are used, and effort is made to save more original material and evidence of provenance. The speaker encouraged the audience to work with vendors to explore their options for creating new products, such as developing "semistandard" enclosures. Such projects can be more affordable than one might imagine, and can lead to streamlined work and more lab time for staff.

Werner Haun, Yale University Library

LAURA MCCANN AND JESSICA PACE

PRESERVATION LIBRARIAN TO PREVENTIVE CONSERVATOR: SHIFTING PRIORITIES IN COLLECTION CARE AT NYU LIBRARIES

Over the past 10 years, New York University (NYU) Libraries' Barbara Goldsmith Preservation and Conservation Department changed the focus of its collections care program from general collections to special collections to adapt to shifting institutional needs. In response, the position of preservation librarian evolved into that of preventive conservator, a newly emerging specialization.

Since the 1990s, NYU's archival collections grew exponentially in both size and complexity, both in terms of the types of objects acquired and the types of environments from which they came. Collecting areas were added and expanded, leading to growth by thousands of linear feet per year. Several general collections changes happened concurrently. A decrease in print monograph circulations, increase in electronic resources, the use of high-density offsite storage along with de-duping, which eliminated many high-need volumes from general collections, all changed the way some items are used. For example, recalls of fragile books from offsite storage can be designated as in-library-use only, so they do not require the same level of repair as items that circulate, which must be backpack and book-drop ready. In addition, despite regular training for staff to identify preservation needs at the point of circulation, a decrease has been observed in the number of items selected in this way.

These reductions in the need for general collections conservation, coupled with the increased demand for archival and special collections conservation, without additional resources to support their care, forced the preservation department to adapt. Several years ago, the department had a classic preservation librarian position that required a master's degree in library studies (MLS), had a general collection focus and strong supervisory component, and reported to the head of the department. In 2008, that position became vacant and the department head sought to rework the position to address a problem that was evident in the archival collections, where preservation issues were being discovered far down the line rather than at the point of, or before, acquisition. Under the new title of preservation archivist, the position would be responsible for administering a newly created archives preservation program. The MLS requirement was eliminated, with the incumbent reporting to the department head but with no direct reports, and focusing only on archival collections (no rare books). The position was first held by an archivist with preservation experience, and later by a conservator with an MLS and coursework in archives. When the position became vacant once again, the department head and conservation librarian again reviewed the department's and library's needs, and considered how to approach recruitment. Feedback from library stakeholders indicated that they appreciated the materials knowledge of a conservator in the position, and that colleagues working with rare books collections also wished to benefit from the expertise of this role. The decision was made to recruit a conservator again, changing the title to preventive conservator to better reflect the skill set and expanded responsibilities of the position.

As the first person to hold the new preventive conservator position, Ms. Pace entered the role with a very different background from her NYU conservation colleagues. An academic research library presents a distinct set of challenges to those of her previous workplaces, which included fine art and science museums. The significantly larger scale of collecting in libraries necessitates a different approach to collections care and management. A library's mission to support users, education, and research means that collections are more accessible to a much wider range of users than in museums. However, the speaker's museum background offered notable benefits in the preventive conservator position. Her experience in housing works of art and her knowledge of a wide range of objects and materials was put to immediate use when she was asked to coordinate the creation of custom housings for objects being sent to offsite art storage, where they would be held during a special collections renovation project. The speaker's experience in technical analysis and examination of materials has proved to be another asset, as she works to introduce low-tech testing methods such as Oddy and spot testing to enable better evaluation of housing and exhibition materials. By working closely with staff across many departments and holding frequent consultations, the speaker has learned to adapt training materials to address the individual needs of different stakeholder and user groups, offering trainings annually and by request. A collaborative approach and clear communication have been key to the speaker's success in this new role.

Laura McCann, New York University Libraries
Jessica Pace, New York University Libraries

ASHLEIGH SCHIESZER

TEAMING UP ON TREATMENTS

Conservators can act as project managers during large special collection projects using a team of skilled technicians. To illustrate the collaborative working style at the Preservation Lab, the speaker discussed the conservation of a 1930s scrapbook. The scrapbook was created by Althea Hurst, who traveled with three other female African American educators from Cincinnati to Europe in 1938. The purpose of the women's travels was to share firsthand experience with students and serve as an inspiration for learning. What resulted was an interactive scrapbook filled with rare ephemeral components. The pages are inscribed with handwritten notes, and letters in the scrapbook document a rapidly changing Europe.

To begin the project, the team first defined the mission, treatment scope, and workflow, from which all else fell into place. The mission was to improve accessibility, both digitally and for physical use. The experiential importance of the tactile components was considered as important as the intellectual content. Thus, the overarching goal was to preserve the interactive nature and original organization of the binding. The presenter referenced Jennifer Hain Teper's presentation, "Managing Expectations in Conservation Scrapbook Approaches," from the previous day, which would define this as a level-five scrapbook treatment.

Team roles were defined early and were shaped by considering staff skill and natural inclination. One conservation technician had previous encapsulation experience, which easily translated into creating encapsulated pages. After some additional instruction in specialized welding techniques and training on strategies for retaining original placement, he was soon working independently to create complicated multicomponent pages. Similarly, a conservation technician with experience creating replicas for exhibits was the specialist for making replacements for any scrapbook pieces, such as clay-coated pamphlets, that would be too risky to remove from the original scrapbook.

A rough survey categorized treatment needs for every page. Printouts of the survey were cut into slips that traveled with individual pages, as pages were batch processed by one team member and passed on to the next. Notes written directly on the slips of paper served both as a communication plan and a tracking system. Carts held groups of pages, which physically traveled from one treatment stage to the next, eliminating time wasted on figuring out what treatment had already been completed. Some treatment decisions, such as which repair paper to use, were made collectively to ensure consistency.

It was difficult to find a way to incorporate the original covers into the new encapsulated binding without causing irreversible damage. While the technicians were tackling other parts of the treatment, the presenter was able to spend her time problem-solving. After some trial and error, the speaker was able to weld polyester sleeves to Vivak to include attached components, as well as use the clear sheet as a backing for a sink mat package to hold the cover.

In the end, the team was proud to meet the needs of numerous clients. A team of three people spent 55 total hours for treatment to improve handling and legibility for digital services. After digitization, 126 hours of treatment was invested by a team of four staff and one student to meet the needs of public library staff. The entire project from start to finish took a full calendar year, with a grand total of 183 hours. Even though the project took much longer than it usually would because it was a learning opportunity for the staff, only 43 treatment hours were invested by the conservator, and the project could be worked in alongside the usual lab workload. The use of students and technicians significantly reduced the overall cost by using the best person for each job.

The increased visibility brought users to the main public library, both locally and from Italy, including a six-page spread in the Italian magazine *Internazionale*. At the end, the team held an in-house workshop to archive all their inventive encapsulated page solutions as bound albums. Since then, the lab has undertaken treatment of over a dozen scrapbooks. Having tackled such a complex binding as their first encapsulated endeavor, the technicians have discovered that they're part of a team armed with skills to problem solve any scrapbook that comes their way.

Ashleigh Schieszer, Public Library of Cincinnati and Hamilton County/University of Cincinnati Library

LAUREN TELEPAK
SHIFTING CONSERVATION STRATEGIES IN HARVARD LIBRARY PRESERVATION SERVICES

In 2016, the Harvard Library created a new digital strategy document declaring, "First and foremost, the Harvard Library is a digital library." The document explains that regardless of the strength of Harvard's physical holdings, the vast majority of library users are accessing the collections electronically. For example, the document cited data from 2015 with over 600,000 loans of physical items for the entire year, while users accessed e-resources over 6,000,000 times in just one month of that same year. The library is in a hybrid information landscape and recognizes that the term "library collection" no longer refers only to groups of curated materials owned by one organization and assembled in a single location. A library collection now includes a distributed network of content and services. As a result, the library's vision for collecting is to focus on coordinating collections and content development, both locally and at 73 individual libraries and with external partners, to create a more cohesive collection to meet the needs of scholars and students.

This approach has led to a shift in collection development strategies, such as creating more shared collections with external partners. The hope is that coordinating collection purchases will cause less duplication in collective holdings, creating more diversity in the overall collections. The libraries also plan to focus on acquiring what they call "special and distinctive" collections and on developing deeper digital collections. Bibliographers are focusing on building digital collections in the spirit of the mantra "digital first and digital only." Whenever possible, special and distinctive collections are to be digitized, helping further develop the digital collection.

The overall impact of moving toward a shared collection is still unknown, but the conservation department has been trying to find ways to shift procedures and staffing to meet future needs. Within conservation, the decrease in physical collections circulation has not yet resulted in a corresponding decrease in general collections conservation treatment, but it is unclear what this trend may mean long-term. An increased focus on special and digital collections will probably increase the frequency of digitization projects, and thus increase the associated special collections conservation work needed to support these projects.

Over the past few years, conservation strategies have shifted to focus on finding opportunities for the special and general collections labs to collaborate more on large-scale treatments and for staff to develop broader skill sets. A reorganization in 2011 brought all of preservation into one group, and in 2014 all conservation staff were unified under the direction of one chief conservator. One such new collaborative effort is the Colonial North America digitization project, a privately funded multiyear project to digitize Harvard's manuscripts and archives related to 17th- and 18th-century North America. When completed, it is estimated to include over 450,000 images of items from collections across campus. For this project, the preservation services team tried a cross-training experiment. The original plan had been to hire a limited-term, full-time special collections conservation technician to assist with the treatment of the manuscripts. Instead, the staff turned the project into a professional development opportunity for the general collections conservation staff, who generally treat 19th- to 21st-century bound materials. The opportunity was offered to a few technicians as 3- to 4-month rotations, to avoid boredom and burnout. Many staff members were interested in the project, and five technicians were selected. During the rotations, the technicians worked two and a half days on the project and shared a bench at the Weissman Preservation Center.

To prepare the technicians for the rotation, the Weissman staff organized a half-day workshop including an overview of the project and description of the technicians' role in it. The workshop included demonstrations of treatment techniques and discussion of decision-making criteria, and provided the staff with an opportunity to try new treatment techniques on expendable materials. Two half-day workshops were also held for the general collections technicians who were interested but hadn't been selected for the project. The techniques shared included use of precoated tissues, which have now become popular with the general collections staff.

Overall, the experiment was a success. Staff contributions allowed the deadlines to be met, and feedback from staff and managers was positive. Technicians appreciated the opportunity to work with older and manuscript materials, and to hone their paper repair skills. Staff reported increased treatment confidence and improved collegiality between the labs. The rotations have been such a success that the labs are now in their second round of rotations, with 3-month rotations of 5 days a week.

The staff have since undertaken other cross-training opportunities. Weissman technicians have completed rotations in the general collections labs, learning how to make enclosures using a batch technique. A collections conservator also spent some time at the Weissman practicing special collections treatment. There is now the opportunity for graduate interns at the Weissman to do a rotation through the general collections lab, working on batch treatments. Looking forward, they hope to find projects that provide opportunities for conservators to develop supervisory skills.

As preservation services staff and managers move forward into this hybrid information landscape, the speaker hopes that cross-training opportunities like the Colonial North America project will help staff diversify their skillsets and will provide the department with a pool of skilled staff who can be strategically deployed across campus to work on projects as needed.

Lauren Telepak, Harvard Library

SONYA BARRON
DOING MORE WITH WHAT YOU'VE GOT AND DOING IT DIFFERENTLY!

Changes occurring at larger universities equally affect the smaller Iowa State University (ISU) Library, and changes are felt rapidly. ISU is a science and technology school with a mission of connecting research to practice, supported by specific core collecting areas in the library. The ISU Library conservation lab consists only of the speaker and two technicians. Despite a significant increase in enrollment, financial support for library services has not increased accordingly. ISU Library would like to provide faculty and students with additional services such as technology spaces, group study areas, and more special collections exhibits. Although space is needed for these, the building's footprint cannot increase, and storage is nearly full. Therefore, stack space is being reduced. The library uses GreenGlass software to help identify what to eliminate based on use, collecting area, and whether it can be accessed through other sources. Similarly, the library is cutting down on physical journals, keeping only titles relevant to the core collecting areas while relying on other libraries for loans. The library's extremely decisive collections development librarian reviews damaged materials before they reach preservation and discards anything he judges to be no longer needed.

As a result, there has been a dramatic reduction in traditional preservation tasks such as library binding, marking, and book repair. It is more cost-effective to purchase shelf-ready materials than to process them in-house, and this reduction in workstream is combined with a decrease in general collections acquisitions. As a result, ISU Library is left with two full-time staff members with 40-plus years of combined experience in preservation services, but with only enough work for one part-time person.

On the other hand, there is now more work with special collections for digital projects, grant projects, and in-house exhibits. This transition was abrupt as the library's small size means change happens quickly. Preservation services staff had to adapt quickly to meet new needs or face potential layoffs. State budget cuts of 12 million dollars over the past 2 years made adding positions impossible. In addition, staff cannot be moved from one area to another, due to labor union regulations. Similarly, promoting staff is difficult because of the university staff infrastructure. Many employees stay at ISU Library their whole careers and may have decades of experience in one specific area. It can be difficult to retrain or change behavior with these long-term employees, and this can be exacerbated by rapidly changing technology and generation gaps between management and staff. The management approach in the past has been to just wait for employees to retire. However, the library is changing right now, so staff tasks need to change now too.

Before tackling the transition from general to special collections work, the preservation technicians needed more training so that they could perform low to medium complexity work on special collections. Training was done in-house by the presenter, since training could be tailored specifically to the needs of ISU's collections and would not require staff to travel. The presenter offered the technicians detailed guidance on mending with precoated tissues, which have been very useful. The technicians were also trained in more straightforward tape removal and humidification and flattening. These techniques were applied to archival materials selected for digitization and exhibits. The speaker noted that there are also intangible qualities staff needed to possess for this type of work, such as sensitivity, respect for material culture, and the desire to preserve history.

The library is working on a Council on Library and Information Resources (CLIR) grant called *avIAn*, Avian Archives of Iowa Online, to make thousands of items related to birdwatching and the birds of Iowa digitally available. This grant creates work for preservation staff but does not come with funds to support preservation. The speaker's department accommodated the increase in work by transferring general collections book repair from professional staff to student employees, freeing up staff for grant-related work. The library also puts on special collections exhibits in the Reading Room, and each physical exhibit becomes an online exhibit. One preservation assistant creates custom-fit mounts from mat board, and the whole lab helps with stabilization treatments. In the case of digitizing especially fragile materials, one of the preservation assistants does the photography since he already knows how to handle the materials and how to judge the level of damage that's present. The library uses MeisterTask project management software to keep the workflow moving smoothly between departments.

In summary, the work environment at Iowa State University Library has become more collaborative and relies heavily on computer technology. Library work is now less about getting through as many repairs as possible and more about minimal carefully executed repairs and envisioning the big picture of how the work connects the library materials to the community. The speaker emphasized that this is very much a journey, not just for her lab but for the conservation community as a whole.

Sonya Barron, Iowa State University

DISCUSSION SUMMARY

After the presentations, the moderator opened up the floor for questions and comments. The contents of the discussion are summarized and paraphrased below.

The discussion began with a question about MeisterTask project management software, which Sonya Barron had mentioned in her talk. Throughout the discussion period, several panelists and commenters expressed interest in experimenting with a variety of project management software tools. Confluence and Jira were mentioned as commonly used platforms for organizing tasks and projects and for staying in communication with multiple stakeholders. Many people were interested in using project management tools to facilitate workflows for cross-departmental activities such as exhibits and digitization.

Managing staff, budgets, and workflows in response to change was a recurrent theme in the discussion. For labs shifting their focus from general to special collections treatment work, no major changes in supply budgets were reported, aside from buying considerably less book cloth. Responses differed on the subject of additional compensation for preservation staff making the transition to new special collections-focused duties. Some institutions are treating the move as a lateral one, while others are attempting to offer a salary increase and/or advancement of rank. Ashleigh Schieszer expressed hope of promoting two technician positions into higher-level positions based on the volume of specialized treatments that are coming through the lab. Others shared the challenges of modifying their workflows and prioritizing staff time in response to the changing landscape of their workplaces. An audience member asked Ms. Barron how her lab adapted after her institution was awarded a CLIR grant for a large digitization project that did not include funds for preservation; did they negotiate priorities, or simply do more? Ms. Barron explained that they opted to transfer general collections book repair from professional staff to student employees, enabling the lab to keep up with special collections stabilization treatments for the grant without adding staff positions.

Several commenters addressed the related topics of declining circulation and reductions in print collections that had been raised in some panelists' talks. One audience member observed that, at her institution, circulation statistics continue to be relatively high, perhaps reflecting a user-driven rather than a mission-driven reality of collections care. Others raised concerns about the existing models for weeding collections, particularly the problematic issue of identifying the "best" copy, or the copy of record, which may lack original features. Cooperative collecting and borrowing initiatives were discussed as well, with one commenter pointing out how such agreements can affect preservation in seemingly contradictory ways. Physical collections may be reduced, but libraries that have agreed to be the lone holder of particular materials are responsible for committing to the care of those collections. Another commenter raised the question of "medium-rare" materials, admitting reluctance about use of the term, and noted that her institution's alternate designation, "in-house use only," still raises issues of space, handling, and mediated access. Werner Haun responded that while "medium-rare" is not an official designation at Yale University, they do restrict access to items recalled from offsite storage. Manuscript reading room staff provide access to these materials and assume the resulting responsibility.

The topic of education of future library conservators was raised by one commenter who asked how conservation education might be affected by the types of changes being reported by speakers and audience members. Laura McCann and Ellen Cunningham-Kruppa both noted that the demand for rare books conservation has risen in recent years due to increased use for research and class instruction, so rare book conservation skills are as necessary and valuable as ever. Other panelists agreed that conservators today must possess both specialized treatment skills and preventive conservation/preservation management skills. Jessica Pace stressed that conservators of all specializations need to be open and flexible to best serve the needs of the specific institutions employing them.

The discussion also touched on differences in staffing models between institutions' preservation departments. Following a comment from a conservator whose department includes a dedicated cataloger, Ms. Cunningham-Kruppa recalled the past practice of placing cataloging positions within preservation departments to support large-scale reformatting projects of brittle materials. Cunningham-Kruppa also noted that present-day preservation departments often have metadata librarians working with them on digital reformatting projects. Lauren Telepak and Mr. Haun mentioned cataloging positions in their digital reformatting and imaging services departments, while Ms. McCann explained that some staff at NYU Libraries' preservation department have cataloging privileges. Ms. Schieszer said that her lab currently adds preservation notes to item records but is in the process of gaining cataloging privileges for one staff member to add material notes to subject fields. Audience members mentioned other types of allied positions, such as registrars and imaging services liaisons.

The subject of using trainings as tools for adapting to change was much discussed. Panelists touched on both outreach education for library staff and internal training for preservation department staff. Asked about the trainings she provides for staff, Ms. Pace explained that she tailors training sessions to the individual needs of the participants, noting that processing archivists interact with collections differently than reading room staff. Ms. Pace emphasized the value of having frequent one-on-one conversations with staff and the importance of updating trainings regularly. Several participants mentioned their use of LibGuides for sharing of training and reference materials such as disaster plans. Ms. McCann pointed to LibGuides as a useful platform for offering access to training sessions, with promising potential for sharing narrated video content. Some institutions chose to offer open access to their training sessions, while others have used LibGuides for internal use only.

Several commenters and panelists talked about how changes in institutional missions of libraries are driving change in preservation strategies, and the ways that conservators engage with their library communities. One commenter shared that her department is in the process of strategic planning, conducting focus groups across the libraries with the goal of gathering institutionwide input about priorities that will help them to more effectively garner support for preservation. Ms. Schieszer stressed the high value of visibility that exhibit and digitization projects provide, promoting conservation work to curators, administrators, and visitors. Open houses and annual special events at the lab promote visibility of preservation within the libraries and build professional relationships. Other panelists reiterated the importance of cultivating goodwill and strong ties. Ms. Cunningham-Kruppa recommended conservators and preservation professionals make themselves indispensable to the institution and its mission. She has found success in staying well connected and integrated throughout the entire library and keeping an active profile to demonstrate that preservation pervades every aspect of an organization. Ms. Pace similarly emphasized the value of maintaining personal relationships and following up on requests, and Mr. Haun encouraged participation in job-related lectures on campus and library social groups and committees.

ACKNOWLEDGMENTS

The co-chairs wish to extend their thanks to the panelists for generously sharing their insights and experiences. Thanks are also due to Deb Cuoco, BPG Program Chair; Jennifer Hunt Johnson, BPG Assistant Program Chair; and Whitney Baker, BPG Chair, for their support in the development of this program. Finally, the co-chairs wish to thank all of those colleagues who attended the session and participated in the discussion.

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HENRY HEBERT AND MARIEKA KAYE

Pre-Meeting Symposium: The Current Use of Leather in Book Conservation

INTRODUCTION

When confronted with the treatment of a damaged leather binding, conservators have many choices about which materials to use. The traditional approach is to repair "like with like," selecting a tanned skin of the appropriate animal and dyeing it to match. In the past 20 years, many techniques that make use of alternative materials such as paper or cast acrylic media have been described in the conservation literature. With so many options available, how are conservators choosing which materials to employ?

This symposium offered an opportunity for wider dialogue about the materials used to repair leather bindings and a chance to ask questions or relate lessons learned at the bench. Speakers presented on all aspects of this material, from manufacturing, evaluation of "vintage" repair techniques, decision-making, and use of new materials.

SUMMARY OF PRESENTATIONS

DAVID LANNING
A VIRTUAL TOUR OF THE J HEWIT & SONS TANNER AND THE LEATHER MANUFACTURING PROCESS

J Hewit & Sons has been in business for over 200 years, producing leather from goat, calf, and sheep skins. Many of the skins are sourced outside the United Kingdom, from Scandinavia, New Zealand, or the Indian subcontinent. Skins arrive at J Hewit & Sons in one of three different states: wet-salted, pickled, or native tanned.

Animal skins are made up of many layers of tissue, containing hair and glands for the secretion of oils and sweat. The leather manufacturing process involves several steps to remove or alter these components prior to tanning, including washing in large drums, liming with sodium sulfide or hydrosulphide to remove hair and inter-fiber proteins, and mechanically defleshing to promote penetration of chemicals.

There are many different types of tanning agents, including vegetable, mineral, aldehydes, and synthetic. These tannins can be used alone or in combination. Good quality bookbinding leathers should be vegetable tanned with slower acting pyrogallol tans. J Hewit & Sons predominantly uses sumac and tara tannins.

After sorting by quality, the leathers may go through several steps to be finished. They are first wet shaved to an appropriate thickness and then dyed in drums. At the same time, the skins may also undergo retanning, archival tanning with aluminum, or fat liquoring to replace lost oils. After drying, skins may be sprayed with additional dye or pigment, glazed, pressed, or embossed with a false grain using a large hydraulic press as a final finishing step.

Throughout the presentation, videos and images of each of these processes were shown. Additional details of the leather manufacturing process are available through J Hewit & Son's biannual newsletter, *Skin Deep.*

Q: Have you seen any trends recently in the use of your leathers? Are conservators buying less?

Lanning: There has been a lot more demand for our archival, aluminum retanned leather recently. Business is steady, though. The managing director's son is currently studying chemistry and intends to follow in his father's footsteps.

Q: Have you done any fold endurance testing?

Lanning: Yes. The Craft Project carried out 10 years ago included many specialized leather testing techniques, which had a big impact on our processes. The aluminum retannage that Hewit's is using now was influenced by this study and the report can be found on our website (Barlee 2014).

Q: Why isn't sheepskin a good bookbinding leather?

Lanning: The naturally high fat content in sheepskin creates voids with its removal during processing and it is prone to

Summary of symposium, AIC's 46th Annual Meeting, May 29-June 2, 2018, Houston, Texas

tear or delaminate. The climate actually has a big effect on the animal whilst it is alive, so Hewit's is acquiring sheepskins from warmer climates. But it still isn't recommended for durable bookbinding leather.

Q: You mentioned that a lot of the machines that you use are quite old. Are machines like those still manufactured?

Lanning: Most of our machines are well over 70 years old! Today, there are companies in China, India, and Italy that manufacture tannery equipment.

Q: Is there a detrimental effect of the alcohol in consolidant recipes? It appears to be pulling the moisture out of the skin and maybe that is making the problem worse. Isopropyl alcohol appears to be moving the dyes less than ethanol, so maybe it's the lesser of two evils.

Lanning: Yes, that is true. In fact, we recommend against the use of spirit-based dyes for that very reason. Traditionally, we would try to rehydrate the skins with some sort of oil, but I know that is a point of contention among conservators.

Sarah Reidell: There has been a lot of great research about the effects of consolidants in AIC posters recently (Mahony and Pearlstein 2014; Knight 2016). SC6000 has waxy components that don't age well. Cellugel is at least hydroxypropylcellulose but contains an added fragrance. I suggest just making it yourself, rather than purchasing it.

Q: I have some naturally aged skins in my personal collection and some are terribly degraded. Do you think that is due to the tannage used? Or other factors? Also, do you have naturally aged skins at Hewit's?

Lanning: Dye can obscure evidence of the type of tannage used. With an undyed skin, you can often see discoloration along the edges from oxidation, if the skin has been tanned with catechol (poor quality) tans. Hewit's has some naturally aged skins at least 80 years old.

Q: Have there been changes in the processing or manufacture of alum-tawed skins in the last 30 years? Some older skins that we have in our lab tear very easily.

Lanning: There shouldn't have been a significant change in manufacturing, but alum-tawed skins do need to be conditioned if it is very dry in your space. You may want to humidify them a bit and see if there is a change.

David Lanning, Hewit & Sons, Ltd

DAWN WALUS
A BRIEF HISTORY OF (A) TIME: REFLECTIONS ON 53 YEARS OF LEATHER CONSERVATION AT THE BOSTON ATHENAEUM

Founded in 1807, the Boston Athenaeum is one of the oldest independent libraries and cultural institutions in the United States. The collection contains books, paintings, sculpture, works on paper, and decorative arts. The history of conservation at the institution can be described in two major periods: 1807–1962, "before conservation," and 1963–present. Before the establishment of a conservation program, many books were sent to commercial binders for binding and rebinding, often in half or quarter leather with decorative paper over boards. The building did not see proper environmental controls until the last renovation in 2003, so the collections were regularly exposed to excessive heat, air pollution, and coal dust from the heating system, which probably contributed to the deterioration of collections.

In the 1950s, a former elevator operator was put to work applying a product called Liquick Leather to damaged or deteriorated leather bindings. Liquick Leather is a scientifically formulated plastic designed to retain its flexibility for many years. The instructions suggest cleaning the binding before application with carbon tetrachloride, a substance with known toxic effects. The product was applied to leather-bound books, as well as parchment and cloth bindings. It was usually applied only to the spine and was sometimes toned. Today, the coating is often brittle and occasionally adjacent Liquick-treated books stick together. Images of books with Liquick Leather coatings from the circulating and special collections were shown.

The first conservator at Athenæum, George M. Cunha, made major changes. Discrete collections were prioritized for treatment with a new emphasis on more thoughtful repairs. One of the first priorities was the King's Chapel collection. It is the oldest colonial library in Boston and features 17th-century theological works bound in leather. An image of the only incunabula in the collection was shown. It had been rebound in 1821 in a style more appropriate for the 19th century than the 15th century, and rebacked sometime prior to 1963. Of the treatment, Cunha writes, "I have never seen a better example of butchery on such a costly book." This serves as evidence of a shift from rebinding as repair to a more intentional approach, with consideration of the binding and its significance. For the highest value materials, Cunha tipped descriptions of the treatment inside the back of the book. A common treatment of the time was to clean and treat leather bindings with castile soap, potassium lactate, and British Museum leather dressing. Cunha experimented with accelerated decay testing of leathers available at the time, and those samples still exist.

In the modern era, treatment decisions are made more selectively. During the presentation, several recent treatments, including rebacking in leather, rebacking with toned Japanese or Korean tissues, and full rebinding in leather were discussed.

Former von Clemm Fellow Lauren Calcote conducted research on the identification and removal of Liquick Leather. Using FTIR, the product was identified as polyvinyl acetate (PVA) and was successfully reversed with acetone, except in cases where the leather was severely deteriorated (Calcote 2016). Associate Conservator Evan Knight compared the visual effects of Klucel-G in various solvents at various concentrations as well as application by brush and by spray (Knight 2016). A solution of Klucel-G in isopropanol is the current protocol for leather consolidation.

A recent shelf-cleaning project on a collection of large leather volumes was also described. The bindings were covered in dust and soot and the leather was flaking and powdery. The cleaning was undertaken after learning of a staff member's allergies, which worsened after working in close proximity to the collections. Since treatment, the staff member reported that the allergy symptoms have not returned. This serves as a reminder that the materials we work with can cause harm and that small-scale efforts can make a difference.

Q: Is Liquick Leather still produced?

Walus: Yes, but under different names.

Q: Did Captain Cunha record notes in all or most of the books treated during his tenure?

Walus: No, he just concentrated on the highest priority and valuable collections. There are lots of notes in those books, but most of it is very generic information. There are no specific notations about the source of materials, for example.

Dawn Walus, Boston Athenaeum

WILLIAM MINTER, KATIE WAGNER, KRISTI WRIGHT, HOLLY HERRO, LAURA MCNULTY
UNDERSTANDING THE MATERIAL PROPERTIES OF LEATHER, OLD AND NEW

Leather is an ideal material for covering books and members of the book trade have been discussing the quality of leather since the early 19th century. A bookbinder determines quality from training, experience, and interaction with the product, but how do you identify the quality of the tannage? There is an anecdote that T. J. Cobden-Sanderson actually tasted leather to judge the acidity. For the modern conservator, however, simple testing may be possible using the equipment available in a standard conservation lab. A leather discussion group, consisting of the members of this panel, was formed 2 years ago to investigate questions about leather quality and use within the bookbinding and conservation community.

Historical tanning processes, from ancient to medieval, were described in the presentation, comparing the methods and materials used to the ones described in David Lanning's presentation. Also included was an overview of scientific research into the mechanisms of leather degradation beginning in the 1800s, proceeding through the Printing Industries Research Association (PIRA) test (Plenderleith 1967), and followed by the establishment of production standards. Binders disliked the working properties of the early leathers produced adhering to the standards and, thus, the more recent STEP, Environment, and CRAFT Projects emerged in Europe, which aimed to improve those properties (Larsen, Vest, and Kejser 1994; Larsen 1996; Barlee 2014).

Members of the panel have been conducting an ongoing survey on how bookbinders and conservators interact with leather. An email questionnaire was developed to ask how individuals select leather for purchase, what qualities they think contribute to longevity or workability, their preferred type of tanning, and if they have noticed changes in the quality of products available on the market. Some early results were described. Many survey participants select skins by color, grain, thickness, and workability. Binders would prefer to purchase leather made with specific tanning agents but would like samples of the material before buying. Responses from tanners indicated that they would be open to changing production methods if there were sufficient demand.

The group has been performing tests in an attempt to correlate skin stability with the tanning process used. A number of modern and historic leather samples have been collected and are currently being tested for moldability, wettability, shrinkage temperature, pH, and response to a modified PIRA test. Additional testing efforts currently underway at the Smithsonian were also described, including how proteins are altered during tanning and insight into protein degradation over time.

There are many other avenues of cross-disciplinary leather research with zoo archeologists or archaeological conservators, particularly since the breeding and diet of livestock has significant effects on the quality and thickness of the animal skin. The composition of herds and agricultural practices have changed significantly since colonial times.

Q: What size of sample is required for testing of the leather?

Minter: A set of five 2″ × 2″ squares has been required for our testing, but most labs that will do testing just need one square that size. Bigger sample sizes and a larger quantity of samples is of course better.

Q: Why are American conservators so "behind the ball" on research into leather?

Minter: Good question! It may be because, without naming names, a lot of institutions who have the resources to conduct research aren't using leather in their treatments.

Herro: The results from the questionnaires and discussions with longtime book conservators in the US suggest that there is little awareness of European efforts in testing and discussion of production standards.

Audience comment: Maybe research isn't happening because there isn't much of a leather trade in the US, and thus no need to preserve industry jobs. CCI has lost a number of scientists focused on proteinaceous materials in the last few years, but hopefully that will be turning around soon.

William Minter, Pennsylvania State University Libraries
Katie Wagner, Smithsonian Libraries
Kristi Wright, National Library of Medicine
Holly Herro, National Library of Medicine
Laura McNulty, National Library of Medicine

JAMES REID-CUNNINGHAM
LOVE IT OR HATE IT: TANNED LEATHER IN INSTITUTIONAL CONSERVATION PROGRAMS COMPARED TO PRIVATE PRACTICE

Trends in the choice of material used to repair leather bindings have shifted in conservation labs serving cultural institutions. Leather was once the primary material used but, over time, library conservators began using Japanese paper almost exclusively as a repair material. Comparing private practice to working in an institution, very few clients are interested in minimal intervention; no one wants to just put their broken binding in a box. While the "less is more" approach is acceptable in a lab serving a research library, a client will typically adopt the opposite view. The private practice conservator must balance what the book needs and what the client wants, and often what the client wants is leather.

A great deal of the presentation focused on reversibility. The full method of preparing a leather-bound book for rebacking with new leather has many steps. The process is difficult and can be quite invasive to the original binding; however, one must ask the question, "Invasive compared to what?" Adding a Japanese paper repair adhered over the leather tends to fail by shearing off the grain layer of the original leather. While PVA is commonly stigmatized due to nonreversibility, even water-soluble adhesives are nearly impossible to reverse without affecting the original leather, simply because of the amount of moisture required. In reality, few repairs to a leather binding are actually reversible.

Many of the leather rebacks that we encounter as conservators were completed by skilled binders apprenticed in the book trade, but some were done quickly to avoid the high cost of rebinding in leather. As a result, poor repairs were executed. But conservation professionals should not give up on a repair technique just because it was executed poorly in the past. Great care can be taken to add structural components under the leather reback, including board reattachment or reinforcement through strong textile extended linings, rebuilding broken sewing supports, or board tacketing.

Many books may have no binding left or require a new binding. In those cases, rebinding in a period style requires using tanned leather because it was the most common covering material during many historical periods.

Models of training for professionals in the field have also dramatically changed. The historical model of training bookbinders included apprenticeships for many years. At present, book conservators have to learn many skills in a short period of time and, as a result, less time is spent on craft. Basic skills handling traditional materials appear to be on the decline. It may be that program-trained conservators tend to end up in institutional labs, while bench-trained conservators end up in private practice.

Q: A lot of design bindings and artists' books are bound with chrome-tanned leather. Should chrome-tanned leather be used to repair those bindings?

Reid-Cunningham: I'm not sure if there is a reason that a repair requires vegetable-tanned leather. It's just easier to pare. The appearance of colors and surfaces of mineral-tanned skins are often very different than vegetable-tanned skins, so it could be appropriate to use in those cases.

Q: How do you manage the client's expectations about how the finished treatment will look when repairing with an alternative material like Japanese paper?

Reid-Cunningham: I keep samples on hand to demonstrate how the repair will blend with the appearance of the original. Conservator Christian Scheidemann once said that the goal of conservation isn't to make the object look new, the goal is to make it look like a healthy 40-year-old.

Q: Have you noticed a correlation between the better quality archival leathers and the difficulty of paring?

Reid-Cunningham: Newer archival skins are much easier to pare, cover, and tool than they used to be. The first aluminum-retanned leathers produced in the 1980s were very stretchy.

James Reid-Cunningham, Cambridge, Massachusetts

EMILIE DEMERS

MATERIALS USED FOR THE APPLICATION OF JAPANESE PAPER REPAIRS IN THE CONSERVATION OF LEATHER BOUND BOOKS

Books have historical importance both in the text and the materials used for their construction. A binding can provide a great deal of information about the context of its production, such as the geographical location, the socioeconomic status of the owner, the bookbinder's skill, and common binding practices for the period. Skills in preparing leather for bookbinding allow for a better comprehension of the materials and how they behave under various conditions, which is crucial in book conservation. Although the art of bookbinding and leather preparation is important and still considered in conservation, the large numbers of books in need of conservation treatment have spurred development of many new techniques to create strong and stable repairs that do not require the use of leather. Japanese paper, which is both cost effective and time efficient, has proved to be an effective substitute. As part of its use in a leather binding repair, Japanese paper may be coated with various materials to change the color, surface texture, or sheen. The effects that these coatings have on the physical strength of Japanese paper are unknown.

To investigate this question, a selection of materials were tested on Kurotani #3 Japanese paper from the Japanese Paper Place: Burnt Sienna Golden acrylic paint, Cellugel (hydroxypropylcellulose and isopropanol), SC6000 an emulsion of mixed waxes and acrylic polymers in aqueous isopropanol, and Jade 403 polyvinyl acetate. Samples were made with up to four of these layered coatings, applied by brush.

To observe how these materials affect the physical strength of Japanese paper, a fold endurance test was performed. To test the viability of these coatings over time, two-thirds of the samples underwent up to two rounds of accelerated aging prior to fold endurance testing. One hundred twenty samples were adhered to board with Lascaux 498 adhesive and an ESPEC humidity cabinet LHL-112 was used to age them at 30°C and 65%RH for 18 days. Sixty of those samples were aged again at 35°C and 65%RH for 21 days. A Tinius Olsen model 4C012A tester was used to conduct the fold endurance test.

The results from the fold endurance testing show that, without accelerated aging, each of these coatings increases fold endurance. After one round of aging, the strength of toned Japanese paper without additional coatings was increased, while the fold endurance of all other samples was reduced. After two rounds of aging, all the samples decrease in strength; however, the toned Japanese paper coated with Cellugel and SC6000 had close to the same strength as the unaged sample with the same coatings applied.

Emilie Demers, Graduate, Queen's University

SARAH REIDELL

REPLICATING ORIGINAL LEATHER SURFACES WITH TEXTURED REPAIRS

Sarah Reidell and Grace Owen-Weiss co-created and published a technique for creating textured repair materials in the 2010 Library Collections Conservation Discussion Group (Haun and Beenk 2010, Owen and Reidell 2011). Now referred to as "textured fills," these materials are composed of a thin layer of acrylic media and a repair substrate cast on a silicone mold bearing the negative pattern of a leather or textile surface that matches the original. This method has been successfully employed in the conservation treatment of bound volumes, cased photographs, and objects with leather or other textured components.

Traditional treatment techniques for leather bindings, such as the leather reback, are often invasive. The degradation of modern leather can be influenced by a number of variables outside the conservator's control, such as delays in the supply chain, manufacturing secrets, and changing formulas. Repairs with toned paper are not as durable and can be more difficult to aesthetically integrate with the original leather covering. Textured infill techniques developed for objects and paintings can be very successful, but often require the mold to be made directly on the object; this is not possible on degraded leather bindings.

Commercially available, nontoxic, mold-making kits (such as Smooth-On Rebound 25 platinum-cure silicone rubber) can be used to create a negative grain pattern on leather surfaces. Sacrificial surrogate surfaces are recommended for creating the textured silicone rubber mold to avoid depositing oily residues on original objects. Molds of textures that match materials in your collection can be made and then reused repeatedly in your lab.

To create a textured fill, a mixture of acrylic paints and mediums, matched to the color and gloss of the original object, are cast onto the mold. A support layer of thin mulberry paper or similar repair substrate may be added to the back of the acrylic media. When dry, the newly combined acrylic and paper layer can be removed from the mold. This material can be made at low cost and with little training. It does not require hazardous solvents and is more flexible than texturing techniques using BEVA resin.

Before applying a textured fill to a leather-bound volume, the book must be prepared by surface cleaning, consolidating degraded leather, and completing any internal structural repairs to stabilize the board attachment. The textured fill is an aesthetic compensation that can complement other primary stabilizing repairs. With this method, like many methods relying on paper or textile, the internal repair materials should be doing the work.

When the book is ready to receive the textured fill, repairs can be prepared in a number of ways. The repair can be shaped by needle puncturing, tearing, cutting, or using a scalpel. Bulky edges can be sanded or pared from the verso to remove excess material and bevel the paper. Repairs can be adhered with either direct wet adhesives or indirect heat- or solvent-reactivated adhesives (Anderson and Reidell 2009). Indirect adhesive methods allow repair materials to be attached in stages, such as adhering over the boards and joints and then going back to complete the turn-ins.

Matching color, sheen, and texture is important for creating a seamless repair; however, matching just two of those criteria can result in a successful aesthetic integration. Careful selection of transparency ratings on the acrylics allow layering of different colors on the silicone mold to create more vibrant and natural colors. Examples of textured fills on a sample binding and boards were distributed to the audience to demonstrate the effectiveness of different combinations that met only two of the criteria (color and sheen, color and texture, etc.) using the "3-ft. rule" of aesthetic compensation, according to which, a repair material matches the original when held at arm's length but is acceptably visible at close distance.

Textured fills are a fast and relatively simple substitute for leather as a surface integration layer for effective structural repairs in bound volumes. They can and should be a part of the wide variety of techniques conservators use to repair bound volumes and other objects with textured surfaces. They don't replace more traditional leather techniques but give conservators a better ability to simply and quickly replicate complicated textures.

Q: Is it possible to cast the mold directly on the book?

Reidell: Yes, but it's very risky! In our experiments, we were unhappy with an oily residue sometimes leftover from the silicone rubber. Caution suggests that surrogates are the best option for now.

Audience comment: I have used a textured fill for a full reback, and experimented with textured fills on different supports, such as Aero Linen and Tyvek. I was able to apply it successfully, but it was stiffer than expected. In future attempts, I would make it thinner and more flexible, and change the number and layers of spine lining.

Sarah Reidell, University of Pennsylvania Libraries

SÉGOLÈNE GIRARD
SINTEVA CUIRS: AN ALTERNATIVE TO CURRENT MATERIALS FOR LEATHER LOSS INFILLS

The disciplines of conservator and craftsperson are intertwined and difficult to separate, as the first restorers of leather bindings were bookbinders. There are many difficulties in working with leather, including unknown materials used in the tanning process, dye bleeding during wetting and covering, hydrolysis and oxidation of the leather, as well as the irreversibility and invasiveness of the traditional method of the leather reback. European conservators are often more likely to choose alum-tawed skin or Japanese paper as a repair material than tanned leather.

BEVA 371 is often used for the conservation of ethnographic materials, developed as an alternative for wax consolidants. Analysis of BEVA has been conducted by the Canadian Conservation Institute (Down et al. 1996) and reassessment of repairs to leather with BEVA have shown positive results (Kronthal et al. 2003). However, BEVA can not be safely applied to a leather binding with heat, as it activates at a higher temperature than the skin denatures.

SINTEVA is a new alternative to leather in development, composed of BEVA 371, glass microspheres, and pigment. A multistep process is used to create thin, textured material. The solution is heated and brushed onto both a sacrificial leather surface and a stretched canvas. The stretched canvas is pressed onto the leather, sandwiching the BEVA mixture between leather and textile, and heat is applied to the verso of the canvas to fully join the two layers. When the mixture has dried and cured, it can be peeled away from each support. This method captures a negative impression of the leather surface, but the texture is easily visually integrated with leather. The material can be cut to shape and pared like leather. Experiments are currently ongoing to evaluate the addition of glass microspheres as a bulking agent and to broaden the range of compatible adhesives.

Tensile-strength testing of SINTEVA has been conducted, comparing unbacked SINTEVA to Tengujo (30 gsm) Japanese paper. Strips of SINTEVA and Japanese paper were adhered to the face of a leather-covered board. The SINTEVA strips failed under less force than the Japanese paper (16 newtons average) but did not break at the site of adhesion. By comparison, the Japanese paper failed at 56 newtons (on average) but tended to tear away the grain layer of the leather. Under tensile double-fold endurance testing, SINTEVA outperformed Japanese paper by approximately 10 to 1, on average.

Creating a leather alternative from BEVA is difficult and can be hazardous for conservators outside of a lab setting. Commercial production of SINTEVA is currently being pursued to offer the finished material for sale. Samples of SINTEVA are available upon request.

Q: Can you clarify the reason for using microsphere fillers with the BEVA? Are the microspheres also functioning as a bulking agent? Are they able to flex across the joint?

Girard: Yes, the microspheres are for bulk and adhesion. The BEVA will not stick with paste, so you need to add fillers in order for it to adhere with the usual rice or wheat starch adhesives. I've just been using them for areas of infill on the board. They are quite stiff, so maybe they are not useful in repairs across the joint.

Q: Have you considered using cellulose powder as a bulking agent?

Girard: Not yet, but it definitely sounds like an idea worth investigating.

Ségolène Girard, Versailles, France

KATHERINE KELLY, DAN PATERSON, SHELLY SMITH
THE FULL TOOLKIT APPROACH TO LEATHER REPAIR AT THE LIBRARY OF CONGRESS

The questions posed in the call for papers for this symposium were provocative. Why should conservators need to choose between leather and alternatives like Japanese paper? Why not use both? There is no perfect treatment; options can be chosen to prioritize cost, time, or other factors. This panel discussed a full toolkit through case studies of past treatments. They described the thought process behind the treatment decisions and evaluated the success of the repair after several decades of aging and use.

Dan Paterson surveyed items from the Thomas Jefferson Library, a collection that was started with a purchase by the Library of Congress in 1815. Thirty volumes that had been treated since the early 1980s were selected for review. After this initial survey, a second round of 22 volumes from non-Jefferson rare collections were reviewed, also consisting of treatments from the same period. Each book was evaluated and assigned a grade of one through five, with one representing a failed repair and five indicating that no other intervention was needed. Included in the sample were treatments completed using leather, Japanese paper, Tyvek, and linen.

Treatments in which the book was fully rebound or rebacked in leather appear to be functioning well, with an average rating of 4.2. Common problems observed include discoloration on the pastedowns at the turn-ins, discoloration of the leather along the spine from light damage, and minor cracking along the joints. Some of the treatments included in this set have smaller, supplementary repairs with textured fills or toned Japanese paper. The textured fills were cast using the same leather and toned to match, and are still functioning well. Some of the Japanese paper repairs have lifted.

Repairs completed with Japanese paper average a 3.4 on the scale. Treatments in which the Japanese paper is adhered over the leather have a higher rate of failure. The repair material may be lifting the grain layer of the leather and is often tenuously attached. Many of the case studies in this group included additional mechanical board attachment methods, such as board tackets, and were also boxed. The rate of failure could be an acceptable trade-off for the time and cost efficiency of the repair. At the current level of use for many of the books in this group, the Japanese paper repair could remain functional for another 100 years.

The last group of historic repairs examined used Tyvek and linen across the joint and scored quite high. The method for application of this repair is similar to board slotting, necessitating the lifting of the original spine. The laminated Tyvek and linen are adhered over the joint, as well as to the thickness of the board edge, and under the pastedown. These repairs are less visually integrated than others, due to smooth surface texture and flaking of acrylic from the Tyvek, but are still functioning well.

Successful case studies using Japanese paper as the primary repair material include cased photographs where the hinge was repaired with toned kozo, and an ongoing project in which hundreds of thin bindings have been repaired using board slotting and laser printing title information and color directly on kozo paper. Recent evaluation shows that the repair is holding up well and the project will continue.

The panel concluded by stating that conservators at the Library of Congress use a great deal of leather in their repairs. The conservation program at the library has a long history, and staff tend to work at the institution for many years. This means that new staff are trained in the standard workflows, and treatment approaches have remained very consistent over time. This does not mean, however, that they are not experimenting with new materials. It is necessary to be curious, take risks, and experience failure to push innovation.

Q: For books rebound in new leather, is the staining around the pastedowns caused by acidic degradation or by migration and oxidation of oil?

Paterson: We haven't done analysis on those volumes to know for sure. But that would be a good question for further research.

Audience comment: Everyone should be labeling the skins as they receive them from the supplier, including the date of purchase. It can be difficult to keep track as you cut the skin apart, but it's important for us to document.

Paterson: The staff at Library of Congress label the skins and keep a sample book of all the leathers to help keep track.

Smith: This is also a good opportunity to make a plug for good documentation practices. We saw a lot of older documentation that did not adhere to good record-keeping practices. For example, a lot of reports just had initials of the conservator on them and did not list suppliers. The more detailed your reports, the more they can inform you later on.

Audience comment: It's nice to see that the training model at Library of Congress is working out. Another technique that was not mentioned is adhering Japanese paper to Ultrasuede to recreate the bulk of leather.

Audience comment: It's interesting that Japanese paper adhered over leather appears to be lifting more than when adhered underneath. We often adhere it over the top to keep the leather from lifting or to make it look nicer.

Smith: We are also sending leather out to be split so that we don't have to pare it as much.

David Lanning: To what thickness are you splitting it? Doesn't that totally take away any strength from the leather?

Paterson: I can't tell you a number off the top of my head, but since there is additional board attachment underneath, we aren't relying on the leather as much for strength.

Katherine Kelly, Library of Congress
Dan Paterson, Library of Congress
Shelly Smith, Library of Congress

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