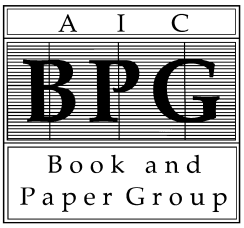
The Book and Paper Group

ANNUAL

VOLUME THIRTY-EIGHT 2019

The American Institute for Conservation



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2019

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THE BOOK AND PAPER GROUP

ANNUAL

VOLUME 38 2019

The Book and Paper Group Annual

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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 (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 Cushing-Malloy, 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.

MELINA AVERY AND ANN LINDSEY

Repairing a 52-Pound Antiphonary at the University of Chicago

INTRODUCTION

In October 2017, the University of Chicago Library conservation laboratory started planning the treatment of the largest item in the library's Special Collections Research Center, call number MS 967. The book is an antiphonary for matins: a book of music for a choir, specifically for the early morning prayers at a monastery. The book is Spanish in origin, and the textblock is estimated to date to the late 16th century. It weighs 52 pounds and is known as a "whale folio." It is a popular teaching tool and is used several times a year at minimum. The antiphonary's call number, MS 967, indicates that it was the 967th manuscript acquired by the library. Beyond that, its provenance is unknown to current library staff.

Antiphonaries are large because the whole choir has to be able to read them from a distance. The dimensions of MS 967 are $33 \times 21 - 1/2 \times 5$ in. This includes 3/4 in. thick wooden boards covered in a thick leather hide. The hide is one single piece, so it must have come from a large animal, such as an ox. There is large brass furniture on the covers, including four corners and five bosses on each board. One corner and one boss are missing from the back, and one boss is missing from the front. The textblock is made of 77 parchment leaves. Because the pages are too large to form a conjoined folio from a single skin, each leaf is a single piece of parchment, attached to its folio mate by a stub at the fold, adhered with hide glue. In addition to the ox hide cover, 77 goats or calves gave their skins for this book. These were probably large calves given the size of the pages.

The antiphonary is a manuscript, with content made up of neumatic notation, an early form of written music, and text in Latin. The media is primarily black ink, with red, blue, and yellow media as well. The book is not highly illuminated, but there are some large decorative letters and designs throughout.

The antiphonary has some unexplained characteristics. Four pages were cleanly sliced out near the fold and are loose in the book, possibly for previous display in an exhibit or for sale, as single pages can be more valuable than an intact book. The pages were somehow reunited with the rest of the book before it came into the library's collection.

The case is probably not original to the textblock. The exact age of the case is unknown, although it is estimated to be from the 18th century, making the textblock at least 100 years older than its case. It is unknown if the case was made for the textblock or whether it was repurposed. Pagination is also inconsistent, indicating that the book has been reordered and that many pages are missing. The numbers are out of order and go up to almost 300, although there are only 77 parchment leaves. In the 1970s, a scholar speculated that this change had to do with a revision of the matins liturgy. Some of the missing pages were repurposed; segments of discarded pages have been used to mend and fill losses in the retained pages.

The textblock fits perfectly in its case, without overall evidence of the pages having been trimmed to fit. Natural parchment edges along the bottom and fore-edge indicate that the textblock has not been trimmed. However, the top edge may have been trimmed. The top edges are all cleanly cut, and one illumination was either cut off at the top or unusually designed to appear cut off. This is evidence that the case was repurposed and the textblock was trimmed to fit into it.

Additionally, conservators noticed a slightly sticky substance on the areas of the leather case that have been tooled. On the front cover, there has been some dust and soil accumulation that makes these areas visually apparent. On the spine and back cover, these areas are slightly sticky to the touch but not noticeable under natural light. In all areas, the substance is visible under UV illumination, with bright pale-yellow fluorescence, and an appearance consistent with having been painted over tooled areas. The tooling is blind, but this sticky substance may be an egg white glair layer, meant for gold tooling. The bright pale-yellow fluorescence is consistent with egg white. If this is the case, the bookbinder may have planned to tool with gold but did not follow through, as no evidence of gold is present (fig. 1).

CONSERVATION ISSUES

MS 967 was brought to the attention of the University of Chicago Library conservators because its heavy use was

Papers presented at the Book and Paper Group Session, AIC's 47th Annual Meeting, May 13–17, 2019, Uncasville, Connecticut

Fig. 1. Before treatment

exacerbating the poor condition of the book. The book was prioritized for conservation because the Special Collections Research Center curators did not want to limit its use or risk further damage from handling.

The volume had been rebound in the late 19th or early 20th century, and this repair had failed. The textblock had been sewn without supports, with heavy buckram fabric and hide glue lining the spine; this lining was still holding the outer folds of the textblock spine together. The inner hinges had broken, meaning that the case was entirely detached from the textblock. The sewing was broken, leaving many sections detached or coming apart. As described previously, four loose pages had been cut out and placed unattached in the textblock. This situation left the textblock extremely vulnerable when handled.

The damage to the individual parchment leaves varied. Presumably, when in use for the choir or when on display, some pages would have gotten more use or more wear than others. Some of the leaves were quite soiled and had small tears and losses. Larger tears had been mended previously with sewn linen thread, a historic parchment repair technique. Some of these historic repairs were broken, leaving longer tears vulnerable to further damage during handling.

CONSERVATION TREATMENT GOALS AND PREPARATION

Treatment planning was a collaboration between conservation, digitization, and special collections staff. It was determined that the book should be brought back to the format in which it came to the collection. The primary goal was to get MS 967 back in one piece and safe for patrons to use. All original components of the textblock and case would be retained and reattached to each other. Rebinding would be based on the evidence of its prior binding. Parchment leaves and the leather on the case would be mended as necessary. The textblock would be sewn with thick thread onto double cords that would be laced into the boards. Additionally, the book would be digitized while disbound.

Digitizing loose pages of this size would be much easier for the preservation department photographer than handling the entire book. Because of the irregular pagination, the loose sections and the detached pages, MS 967 was carefully examined by conservation staff, special collections curators, and a University of Chicago music librarian to determine that the page order was correct before treatment began. Conservators also prepared for treatment by seeking advice from the conservation staff of the Newberry Library in Chicago. The

Newberry has a large collection of antiphonaries, and the conservation staff has treated many of them.

CONSERVATION TREATMENT

Surface Cleaning

Treatment began with surface cleaning. A rubber sponge eraser was used, and only blank spaces were cleaned so as not to disturb the media. The media was stable and did not require consolidation, but disturbing it during surface cleaning was not perceived to be worth the risk.

Cleaning The Spine for Disbinding

The next step was to disbind the textblock. Although many individual pages were fully or partially detached, the outer layer of the spine was still adhered together with thick hide glue and heavy buckram fabric spine liners. Typically, a conservator would expect hide glue to soften only under extended contact with hot water. Parchment is very sensitive to water, so directly applying hot water seemed risky. The necessary components of a safe and effective system were minimal moisture, sufficient heat, and extended contact.

The conservators decided to try a 2% gellan gum poultice. Gellan gum can be shaped to carefully control the size of the dampened area, and it is a relatively dry gel, so minimal moisture would seep through the spine linings into the parchment itself. Conservators were confident that using gellan gum for extended contact would be safe, as it releases moisture in a slow, controlled manner, and the progress and safety of the project could be monitored easily. Experimentation with cold gellan gum, held to the textblock spine with plastic wrap, was unsuccessful; the hide glue, unsurprisingly, did not soften. Conservators tried placing a heating pad over the plastic wrap to warm the cold gel. This was also unsuccessful, as the gentle heat of the heating pad did not warm the gel enough to warm and soften the hide glue.

Hide glue is known to soften at 140°F. Conservators experimented with methods to heat the gellan gum poultice to 140°F without causing it to dissolve. A probe thermometer was employed to take the internal temperature of the gellan gum, which was heated in a microwave. The most successful method was to warm a shallow water bath, then place the gellan gum poultice into the water bath and microwave for 20 seconds more. This method brought the poultice up to the required temperature just before it started to melt. The warm gellan gum was immediately placed against the textblock spine and was covered with plastic wrap, and the heating pad, to keep warm. Soft weights were placed against the heating pad to improve contact. Progress was checked regularly, and within 1 to 3 hours, the buckram could be removed from the area treated with the warm gellan gum poultice. The process had to be repeated to soften the hide glue beneath the buckram, as the moisture from the poultice did not penetrate through the buckram.

This method of spine cleaning required a fair amount of trial and error. Conservators tried to better control the heat of the system with a beaker warmer, which advertised precise temperature control. However, set to 140°F, it would spike to a surface temperature so hot that it would risk burning conservators and damaging the antiphonary. The heating pad, meant for home use, provided a lower but sufficient and safe source of heat. Efficiency was also attempted with longer pieces of gellan gum to soften more of the spine linings at the same time, but the dampened sections of the spine would cool too quickly to work with more than a few inches at a time. Once the glue cooled, it rehardened immediately.

After the second poultice process, the textblock sections could be fully separated. A thick layer of hide glue remained on the spine of each section, impeding flexibility. The folios are made of two pieces of parchment glued together at the spine, so flexibility was already limited. Very hot water was brushed on to reduce this glue layer, using a small brush, and once softened, the glue was mechanically reduced using a microspatula.

The full spine cleaning process took 3 weeks. The result was the separation of the sections to facilitate resewing, the reduction of the glue to a thin layer, and the return of flexibility to the folds.

Parchment Repair

The next step was to repair damaged pages. First, methods were tested on modern parchment. Repair materials need to be compatible with the original parchment, and need to have sufficient strength to mend the large pages. The material that performed the best in testing was goldbeater's skin, a transparent and robust material made from the intestinal lining of an animal. It is a commonly used, stable, and traditional repair material for parchment. Its strength, transparent appearance and flexibility would be assets in mending the antiphonary's parchment pages.

The adhesives tested were room temperature 5% photography-grade gelatin mousse, warm 5% photography-grade gelatin, and purified hide glue. All were effective for small mends, but warm gelatin and hide glue were the most effective for large mends.

For small mends and fills, gelatin mousse was chosen. This room temperature gelatin, worked through a sieve, is a weaker adhesive than hot gelatin and does not penetrate the materials as much as the warm adhesives do. These mends and fills are sufficiently strong, and they affect the original materials the least. The transparent goldbeater's skin did not obscure the color and texture of the parchment. Historic mends were also re-repaired with gelatin mousse and goldbeater's skin as needed.

Reattaching the loose cut-out pages required stronger mending materials. There is more pressure on those mends because the slice is only an inch from the fold, and the fold is quite stiff. The fold includes two layers of parchment, a stiff material to begin with, and they are adhered with hide glue, which further impedes flexibility. The mends along the cut edges needed to be very strong so that pressure from turning the pages would not cause the mends to fail. Because parchment reacts so strongly to humidity, and because decades have passed since the pages were sliced out, the two lines of the slice were both warped and wavy, no longer perfectly lining up. Stronger versions of the mending materials were chosen: thicker goldbeater's skin and warm 5% gelatin.

Tests had indicated that these materials would work, although no parchment scraps of such a large size were available to test the repair over the full 33 in. This repair had to be done very carefully, several inches at a time, to ensure that the edges lined up correctly and were adhered securely. The pages were successfully reattached, with goldbeater's skin mends on both sides of the page.

The full mending and page reattachment process took 6 weeks. Reattaching the sliced-out pages was the most time-consuming part of the process.

Digitization

After repair of the parchment leaves and before resewing, the preservation department photographer digitized the book. He was able to use the large sewing frame with a magnetic crossbar, built especially for this project, to position the pages. Digitizing a book of this size while disbound was much easier for him than digitizing it bound or in its delicate state before treatment.

Resewing

The next step in treatment was to sew the textblock onto cords in the same style used in its previous incarnation. The size of the cords was known, as they were still partially intact and laced into the wooden boards. High-quality linen cords in the required size were not available for purchase. The conservation team made new cords of the appropriate size by twisting thick linen thread into a new cord, using a hand drill. Eight double sets were made that were similar in size to the originals. Team members started out by standing 20 ft. apart, and eventually twisted and folded the thread down to 3-ft. lengths of cord. Making all of the cords for this project took 2 days.

The sections were prepunched and the cords arranged on the sewing frame according to measurements from the case. Glue and damage from the prior rebind obscured the original sewing holes, so measurements taken from the case were more reliable. The correct placement of the cords was especially important, as the leather spine of the case had raised areas to accommodate cords, and the boards have channels and holes that would be reused. Heavy shoemaker's thread was used to sew the book. It is the same size as the original linen thread, segments of which were found in the textblock folds. It is much thicker than typical bookbinding thread, although is the same high-quality linen that is used to sew smaller books. New parchment endsheets were also incorporated and added to protect the first and last pages, as well to help with board reattachment. Because new paste-downs were not desired or needed, the flyleaf endsheets had stubs that would be adhered under the original paste-downs during board reattachment. Sewing the book took a week. A large sewing frame on wheels, which had been built for this project, was also integral to facility security measures. The partially sewn book had to be returned to the conservation laboratory's secure vault every night and wheeled back out every morning.

Pressing

Once the textblock was resewn, it was then pressed. Increased textblock size is often a consequence of rebinding. This is not much of a concern if a new case is being made. For this project, however, pressing was necessary because the original case was fully intact, and there was added bulk from the new sewn-in endsheets. The textblock needed to be the exact size it used to be.

Spine Lining

While the textblock was pressing, the spine was lined. The first layer acted as a reversibility layer and was made up of heavy Japanese paper adhered with gelatin mousse. The second layer was an extended spine liner that would aid in reattaching the case and was made from thick cotton strips. These were placed between the cords and adhered using purified hide glue. Finally, a heavy paper was adhered between the cords, also using hide glue, to provide support.

Case Repair

Only minor repairs to small tears along the joints were needed for the case. Otherwise, the case was in excellent condition. After consolidating the original leather with Cellugel in isopropyl alcohol, Jade 403 adhesive was used to affix small pieces of Moriki paper of similar color to the original leather. The Moriki was chosen for its similarities in color to the original leather.

Board Reattachment

To reattach the case, sufficient access was needed to the lacing-in areas of each board. The original parchment paste-downs were lifted using a microspatula, as was the leather near the

Fig. 2. Before treatment

spine. The old cords were removed from the channels and holes, and lifted off the board where adhered.

Relacing the boards to the textblock made for a strong board attachment. This book is large, heavy, and difficult to handle; the hinges are the most vulnerable breaking point, and they had to be secured in multiple ways. In addition to lacing the boards, heavy cotton spine liners were also adhered between the boards and the original leather. Purified hide glue was used to adhere the cord, cotton, board, and leather layers.

The stubs of the sewn-on parchment endsheets were dampened with a sponge and left overnight to form to the board. Once they fit in place, they were adhered down against the board, and the original paste-downs were adhered over the top using purified hide glue. The hinge came together neatly, and the board attachment is very strong.

The leather spine was not adhered to the case. As such, the textblock is securely in the case but reversibility is better maintained, and scholars can more easily access the inner spine of the case (figs. 2, 3).

Treatment Conclusions

The result of treatment is that the antiphony is now back in one piece and safe for library patrons to handle. Every page is securely in place, with the added protection of the new parchment endsheets. The sliced-out pages, newly repaired, function well with mends that are flexible and strong. The textblock fits perfectly back into its case and the book opens easily, with good flexibility in the spine.

The treatment was highly successful and allowed conservation staff to develop solutions not only for MS 967 but also to set solutions in place for similar challenges in the future. MS 967 was returned to the Special Collections Research Center, where it returned to its previous life as a treasure of the collection and a popular teaching tool for University of Chicago faculty.

HOUSING

MS 967 is stored flat, and University of Chicago conservators were inspired by the Newberry Library's minimalist "sled"

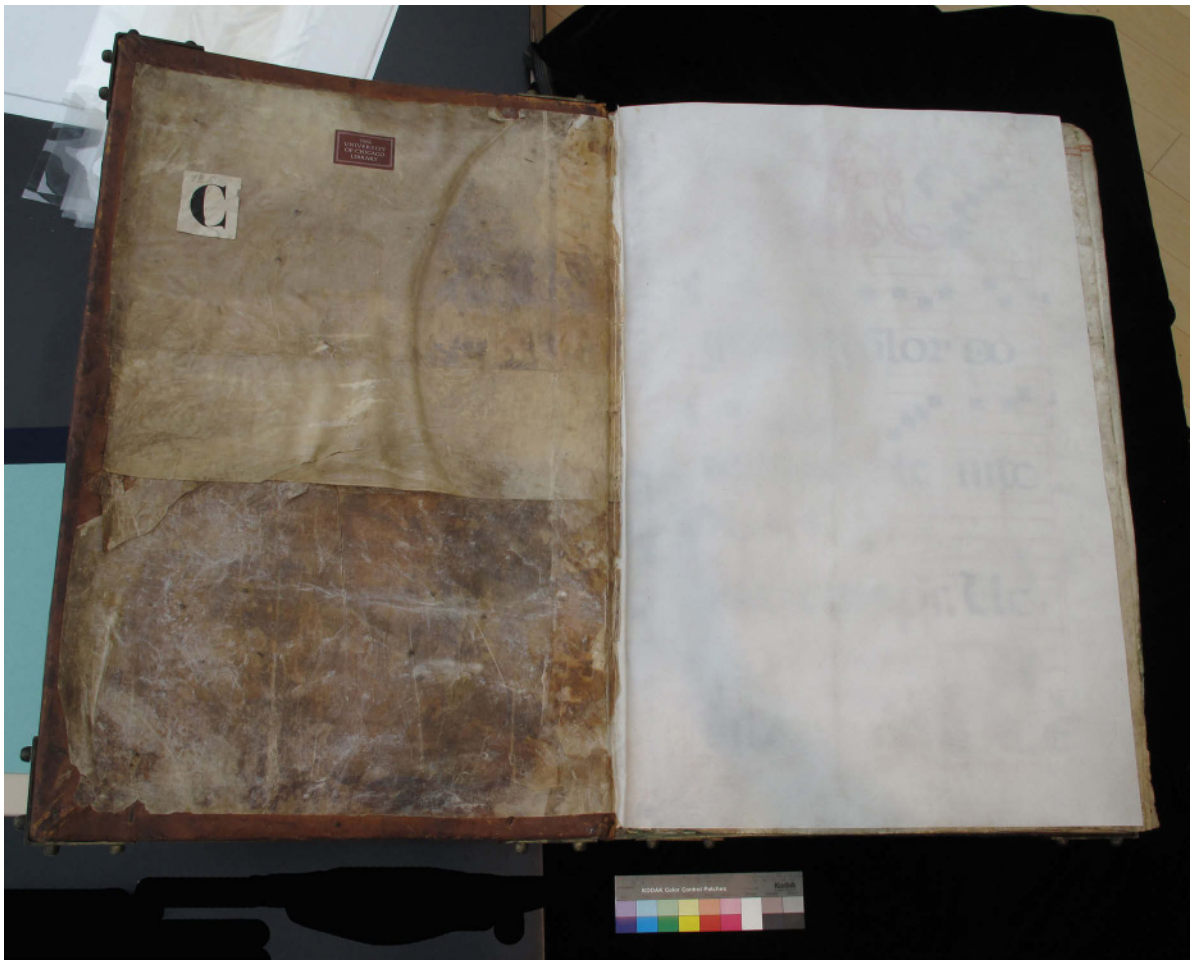

Fig. 3. After treatment

housings for their antiphonaries, also stored flat. Ann Lindsey built a large, double-walled corrugated polypropylene sled for MS 967, with handles, so that staff can more safely retrieve and return the heavy book. The sled has three high sides to protect the sides of the book, with a tail that is left open so that the book can be retrieved and returned easily. The inner bottom of the sled is lined with acid-free binder's board, which prevents the book from sliding as the sled is moved. There is a removable Velcro strap across the tail to further prevent the book from sliding out. The smooth polypropylene of the outer bottom of the sled slides easily against the metal shelf, and the handles make retrieving and returning the book safer and more comfortable for staff.

FABRICATING AN OVERSIZED SEWING FRAME AND PRESS

To complete the treatment of MS 967, it was clear that oversized equipment would be required. The conservators had been successful in the past, setting up temporary solutions for large items, but there was a concern that previous solutions would not work for something as large and heavy as MS 967. Of chief concern was that the textblock had to fit back into the case; there was little to no room for swell. The treatment would need a sewing frame and a press, neither of which are commercially available in the size required. The equipment had to be mobile to reduce handling of the object, convertible between the sewing frame and press, and collapsible and repurposed for reasons of space. In short, the equipment would have to be fabricated, and the decision was made to do that in-house.

A butcher block table on wheels was purchased. Two holes were needed for the sewing press, but to double as a press, four holes were drilled and threaded, one in each corner. Two additional holes were drilled, and a channel was sawn between them to allow the cords to pass through. For the uprights, 1-in. dowels that were 36 in. long were threaded from each end, leaving an area approximately 6 in. long to be used as a hand hold. Four wooden nuts were constructed and threaded to move up and down along the

Fig. 4. Using the oversized sewing frame

uprights. Crossbars were constructed to be placed over the uprights. One crossbar was intended to secure the cords, whereas the second crossbar was planed to create a flat side. Metal strips were attached to this flat side using small brass nails, and wooden handles were created to hold powerful earth magnets. During use, the two uprights were screwed into the table, and the first crossbar was secured with two of the wooden nuts. The second crossbar was similarly secured, and along with the metal strip and magnets, it was used to hold the manuscript leaves open during sewing.

The press component used four shorter 1-in. dowels that were threaded similarly, although these dowels were only 12 in. long and threaded along the entire length. Four heavier wooden nuts were also constructed. During use, the four shorter dowels are placed in each corner, and a Plexiglas sheet with corresponding holes is lowered over the dowels and secured with heavy wooden nuts.

In the end, the equipment met all of the requirements, was mobile, and quickly converted from a sewing frame to a press, and the parts are collapsible and can be stored for future use. (fig. 4)

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Developing a Comprehensive Approach to Light Exposure at the US Army Heritage and Education Center

INTRODUCTION

It is the responsibility of conservators to provide other museum professionals with the tools they need to ensure the stability of their collections and protect against the 10 agents of deterioration. Light is one of the 10 agents of deterioration and has been addressed by many (Ritzenthaler 1993; Thomson 2005). As many museums begin to consider whether to spare objects from fade or to sacrifice objects to tell a story (Brokerhof, Kuiper, and Scholten 2018), it is even more important to provide decision makers with the information and tools that allow them to understand the impact of these decisions. The US Army Heritage and Education Center (USAHEC) has developed a low-cost system that allows everyone in the museum and archive to understand and manage light exposure.

BACKGROUND

Six years ago, USAHEC and the US Army Museum Enterprise were relying on traditional light management techniques. Army regulations followed a similar format to industry recommendations, outlining three categories: high sensitivity, sensitive, and low sensitivity. Each category was given a maximum exhibit light level of 50, 150, and 300 lux, respectively. The regulations further stated that high-sensitivity and sensitive objects should be rotated on and off exhibit more frequently than other objects. The regulation did not include guidance for categorizing objects, nor did it include a time frame for "more frequently." This ambiguity led to arbitrary blanket exhibit decisions such as "no paper-based materials will be exhibited" and "all textiles have exhibit limits of 9 months." These blanket decisions did not take into account exhibit light levels or how many times items were exhibited.

Papers presented at the Book and Paper Group Session, AIC's 47th Annual Meeting, May 13–17, 2019, Uncasville, Connecticut

There was no light monitoring in exhibit spaces. Instead, exposure was tracked through the use of blue wool cards. Each exhibit case had a half-covered blue wool card to monitor exposure during exhibit. Considering that there was only one card per case and the cards were placed in the bottom of cases, sometimes in the shadow of the objects on display, the cards did not capture the true exposure of the objects in the case, nor did they tell how close an object was to noticeable fade. One card per case also meant that exposure could only be tracked for a single exhibit. For blue wool cards to track lifetime exposure, each object would have to have its own blue wool card, which would have become overly cumbersome.

Of great concern to all museum staff was the repeated exhibit of certain "favorite" objects. Many of the USAHEC exhibits are driven by nonmuseum professionals who do not understand the desire to spread light damage over multiple objects. Additionally, the USAHEC mission of telling the Army story one soldier at a time made the use of type pieces a contentious issue, as decision makers preferred to use the artifact directly related to a soldier rather than a type piece. Without a clear understanding of the effects of light on artifacts, it was difficult to steer decision makers in other directions. Clearly, a new approach was needed—one that treated all objects as the unique items they are and that treated each exhibit as a unique space.

REEDUCATION

Before a new approach could be devised, certain misinformation about light needed to be dispelled. The first piece of information that needed to be understood was the fact that light damage is cumulative. A standard of 50 lux for 3 months over 5 years has many problems and can cause confusion. It does not give finite exhibit recommendations, it does not address what happens after 5 years, and it does not give a cumulative exposure limit. Unless a museum tracks exposure beyond a single exhibit, how do conservators know how many times an object has been exhibited at 50 lux in the previous 5 years or even the last time an object was exhibited?

Removing this confusing language was essential to gaining a better handle on light exposure.

Related to the concept of cumulative damage is the misconception that "resting" a collection in dark storage can extend "light life." Just like the misunderstanding about the cumulative nature of light damage, this misconception has its seeds in traditional light standards. Standards that require rest in dark storage may lead some to believe that this resting will reverse damage. Perhaps the original purpose of these types of requirements was to allow items to be exhibited to larger audiences by spreading exhibits over larger periods of time; however, with few exceptions, resting the object will not reverse damage. Damage from exposure at 50 lux for 3 months with a 12-month rest period and then reexposure for an additional 3 months will result in the same damage as exposure at 50 lux for 6 consecutive months.

The last hurdle faced at USAHEC was the nature of light itself. An incident with case construction informed conservation that not all museum professionals understand the differences in light. At USAHEC, curators asked conservators to check the UV filtering properties of some cases. It was found that the cases were not filtering UV, and the case construction company was immediately contacted to remedy the oversight. When the "fixed" cases were installed, conservation became aware that the cause of the concern was due to an object fading on exhibit. The curators had thought that blocking the UV would eliminate any potential for fade. This misunderstanding provided conservation a good opportunity to educate museum staff on UV and visible light, how each type of light damages the collections, and the light situation in each of the USAHEC galleries. Considering that none of the galleries contain sources of UV, cases that filter UV are not necessary. Although the exclusion or filtering of UV light has always been a part of the USAHEC exhibit plan, the staff now understands the effects of UV light on collections and that visible light needs to be managed as well.

A NEW APPROACH

Developing the System

The new system developed at USAHEC utilizes the existing knowledge of the ISO Blue Wool Standard and two new tools for collecting and tracking light data. The ISO Blue Wool Standard lists eight categories of fade based on the fade rate of eight pieces of blue wool (fig. 1). The figures in the chart are the amount of exposure, in megalux, the materials in each category can withstand until a "just noticeable fade." This standard has become the basis for museum industry exhibit recommendations; however, these industry recommendations often regroup the eight categories into three or four broader categories. These broad categories are not precise enough to be useful in long-term light tracking. Grouping a category 1 object and a category 3 object into the same "high sensitivity" group can either cause the category 1 object to be overexposed or cause unnecessary rotation of the category 3 object.

With the new system, USAHEC went back to the original eight Blue Wool Standard categories as a way of determining the light life of each object. Categorization of objects is based on industry research, the conservator's knowledge of materials, and the objects' light-based deterioration. Figure 2 includes some of the materials that have been categorized by USAHEC conservators. Putting objects into a light category tells conservators approximately how many lux hours an object can withstand until a just noticeable fade. When the object reaches the just noticeable fade mark, it has reached the end of its light life.

When an object is slated for exhibit, a two-part process is undertaken to ensure safety of the objects. The first step is for a conservator to review the object and determine its suitability for exhibit. At this time, the conservator identifies the object's light life by placing it in one of the eight ISO categories. The conservator reviews previous exposure data, the proposed length of the exhibit, and the need to exhibit

	ISO #8	ISO #7	ISO #6	ISO #5	ISO #4	ISO #3	ISO #2	ISO #1
With No UV	1000	300	100	30	10	3	1	0.3
With UV	120	50	20	8	3.5	1.5	0.6	0.22
	Low Sensitivity		Medium Sensitivity			High Sensitivity		

Fig. 1. ISO blue wool categorization chart. Adapted from Michalski (2018, table 4).

Category 1 **Light life = 300,000**	**Category 2** **Light life = 1,000,000**	**Category 3** **Light life = 3,000,000**	**Category 4** **Light life = 10,000,000**
• Watercolor • Iron gall inks • Construction paper • India Ink	• Ballpoint ink • Silk • Color photos with "color" in the name • Felt-tip ink	• Textile • Wood	• Tintype • Leather • Color photographs with "chrome" in the name
Category 5 **Light life = 30,000,000**	**Category 6** **Light life = 100,000,000**	**Category 7** **Light life = 300,000,000**	**Category 8** **Light life = 1,000,000,000**
• Printer inks	• Painted wood • Acrylic paints	• Silver gelatin black and white photos • Lithographs	• Oil paintings • Metal

Fig. 2. USAHEC-developed materials categorization chart

the object in the future. The conservator then makes an exhibit recommendation based on projected exposure during exhibit. A typical exhibit recommendation at USAHEC is to not exceed half of an object's light life in any exhibit. Limiting the exposure of the object to its half-life balances the desire to exhibit with the desire to avoid noticeable fade of the object.

The second part of the exhibit process is to look at the exhibit spaces. Thanks to the efforts of previous conservators, USAHEC exhibit galleries have well-developed lighting designs. All exhibit spaces are free of all sources of UV light and direct case lighting is reduced so that most objects can be exhibited within traditional light recommendations.

When an object is placed on exhibit, the conservation team takes light readings on each object. Several readings are taken for each object to determine the brightest spot. Conservators work with exhibit staff to adjust light levels to minimize hot spots and reduce light levels to extend exhibit length while still providing viewability.

Calculating Exposure

Once the readings are taken, potential exposure is calculated by multiplying the light level by the intended exhibit length. For an object with a light reading of 70 lux in a 4-year exhibit that runs 8 hours a day, 7 days a week, the formula would be as follows. First, the number of hours on exhibit is determined by multiplying the hours per day (8) by the number of days on exhibit ($7 \times 52 \times 4$): $8 \times 7 \times 52 \times 4 = 11{,}648$ hours on exhibit. This number is then multiplied by the light reading to get exposure in lux hours ($11{,}648 \times 70 = 815{,}360$). To determine if the object can be exhibited safely for this exhibit, the projected exposure is then subtracted from the light life. If the object were a watercolor painting, it would be in category 1 with a light life of 300,000 lux. Considering that the projected exposure of 815,360 lux is greater than 300,000, the recommendation would be to remove this object prior to the end of the exhibit. In this case, conservators would need to recalculate to determine when half the light life would be reached. If the object were a Kodachrome photograph, it would be in category 4 with a light life of 10,000,000 lux. Considering that 10,000,000 is greater than 815,360, this object would not noticeably fade while on exhibit and could remain on display for the full 4 years. The results of these calculations are used to populate an exhibit light spreadsheet (fig. 3) that is shared with collections management and curatorial staff. These estimates are worst-case scenarios; reduced exposure achieved through timers or motion sensors are not included in these estimates.

Understanding the Spreadsheet

All objects on exhibit are listed on the spreadsheet by exhibit gallery and case. Columns 1 and 2 are used to identify each object. The next four columns are used to indicate the data needed to make projected exposure calculations, the install date (column 3), the projected end date of the exhibit (column 4), the light reading taken at installation (column 5), and the allowance or light life assigned to each object by the conservator (column 6). The remainder of the spreadsheet is used to convey the projected exposure data. Color coding is used to indicate the extent of fade, with light gray meaning that there is no visible fade, medium gray meaning that the object is halfway through its light life, and black meaning that the object has exceeded its light life. Column 7, "full," is highlighted when an object is able to stay on exhibit for the full length of the exhibit. The first

1	2	3	4	5	6	7	8	9	10
		Color code key		OK					
				Half life					
				Fading					
Object by Exhibit		Install Date	Exhibit end Date	Light reading	allowance	full	Now	Jul-19	Aug-19
Main Gallery									
Preserving Legacy	**Yarulis**								
	Book	Jul-18	Jul-21	70	30,000,000				
MHI2016.08.21	Opium Pipe	Jul-18	Jul-21	60	3,000,000				
MHI2016.08.20	Prayer Book	Jul-18	Jul-21	204	1,000,000,000				
Spanish American War	**Taylor**								
MHI 1898.0123.09	Cartridge Belt	Aug-15	Aug-20	116	3,000,000				
E 726 N5 71st Inf. E4 1899	Souvenir Book	Aug-15	Aug-20	127	3,000,000				
Spanish American War	**Look Down**								
FLW1996.0098	Haversack	Feb-18	Feb-21	434	3,000,000				
MHI 2012.23.15	Canteen	Feb-18	Feb-21	556	3,000,000		Feb-19		
Phillipine Insurection	**Van Dusen**								
MHI 07.36.36A-B	Wicker Helmet	Aug-15	Aug-20	48	1,000,000				
MHI 07.36.48A-B	Spear, Barbed	Aug-15	Aug-20	23	3,000,000				
MHI 07.36.52	Spear	Aug-15	Aug-20	9	3,000,000				
Mexican Border	**Fye**								
MHRC 77.05.34A	Pistol, Semi Auto	Aug-15	Aug-20	54	10,000,000				
TRAN 1978.020.020A-B	Stirrups	Dec-18	Aug-20	52	10,000,000				
TRAN 1978.020.021	Bit	Dec-18	Aug-20	46	1,000,000,000				
TRAN 1978.020.044A-D	Drafting Set	Dec-18	Aug-20	47	10,000,000				
203.6PA 1933 C.4	6th Field Artillery	Dec-18	Aug-20	79	10,000,000				
World War I	**Reynolds**								
MHI 1917.6999.01A-C	ID Disc	Aug-15	Aug-20	95	3,000,000				
MHI 1917.6999.02A-C	St. Mihiel Medal	Aug-15	Aug-20	107	1,000,000				
MHI 1917.6999.04A-YY	Housewife	Aug-15	Aug-20	66	3,000,000				
	Letter	Aug-15	Aug-20	93	10,000,000				
	Certificate	Aug-15	Aug-20	100	1,000,000		Jan-18		
	Table	Aug-15	Aug-20	117	10,000,000				

Fig. 3. Exhibit light spreadsheet

item on the spreadsheet in figure 3 is a book that was placed in category 5, which means that it will not reach a noticeable fade until 30,000,000 lux hours of exposure. After performing the calculations, it is determined that the book can be safely exhibited for the full exhibit term; therefore, the "full" column is highlighted in light gray for this item. Column 9 begins change-out recommendations. Each column to the right is a different month during which an

object will reach its half-life. The cell is highlighted in the appropriate month when an object is projected to reach its half-life. Column 8, "Now," which is updated monthly, is used for the current state of objects. Highlighted boxes in this column also have a date that indicates when the object moved into that column (in fig. 3, the canteen reached its half-life in February 2019).

Tracking After Exhibit

When an object is removed from exhibit, exposure is finalized down to the day and a light exposure worksheet (fig. 4) is filled out for each object. The total light life is indicated based on the pre-exhibit categorization. The exhibit title and date lines are filled out, and the calculated light exposure is entered. Exposure is subtracted from the total light life to get the "remaining hours till fade." This worksheet becomes part of the permanent object record and can be referenced during future exhibit planning. As the item is included in future exhibits, the exhibit information will be added to the worksheet and the exposure subtracted from the remaining hours till fade from the previous exhibit.

Post Exhibit Light Exposure Worksheet

Item Number: MHI 79.01.01

Total lux hours till Fade: 3,000,000

Exhibit #1: Treasures Exhibit
Dates: 29 April - 6 May 2015

Exposure on Exhibit: 86,400
Remaining lux hours till fade: 2,913,600

Exhibit #2: Treasures Exhibit
Dates: 7 May 2015-5 July 2017

Exposure on Exhibit: 1,036,672
Remaining lux hours till fade 1,876,928

Exhibit #3:
Dates:

Exposure on Exhibit:
Remaining lux hours till fade

Exhibit #4:
Dates:

Exposure on Exhibit:
Remaining lux hours till fade

Fig. 4. Exhibit light worksheet

BENEFITS OF THIS NEW APPROACH

This new system has brought a new understanding of light exposure to curators, archivists, and exhibit designers. Before the program, nonconservation professionals did not always understand the reasons conservators suggested limiting exhibit length for some objects but not others. Giving curators and archivists a concrete visual guide for each artifact reinforces the scientific approach to collection care and shows that the recommendations made by conservation are not arbitrary. Where in the past light was only a tool to aid the viewer rather than a part of the total environment that required control and monitoring, light is now a guiding force in exhibit design and scheduling.

This understanding of light allows curators and archivists to make better-informed exhibit decisions. No longer do blanket rules restrict exhibit designs. Curators now have more flexibility in what they can include in an exhibit, which expands their ability to tell the Army story and allows the public to see a larger portion of the Army's collections. Decisions whether to sacrifice a single piece or spread the damage over several objects can be made with a clear understanding of what that decision means.

The processes established by this system have helped streamline the entire exhibit process. Initial light estimates help inform exhibit length and assist curators in preparing additional objects for change-out during the planning phase of the exhibit. The light spreadsheet helps inform change-out decisions and keep curators and exhibit designers on a change-out schedule. The light exposure worksheet gives a clear record of exhibit history that provides a better understanding of how the collection is used and allows curators to make decisions that reduce damage to overexhibited objects.

An unexpected benefit of this new approach is an easing of the exhibit change-out schedule. Many curators believed that this procedure would lead to increased change-outs and more work for the exhibit staff. Instead, it was discovered that many of the objects could remain on exhibit for longer than originally thought. This new approach means targeting change-outs to the artifacts that will actually be damaged by prolonged exposure, giving curators the ability to create static or permanent exhibits using lightfast material.

The creation of a comprehensive light program that includes cumulative light exposure tracking is an essential task for any museum wishing to avoid noticeable fade to displayed material. It greatly reduces the impact of one of the 10 agents

of deterioration, and it can foster a greater understanding of what conservation professionals aim to achieve—the long-term stability of collections.

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Whistler's Little Game: Watercolor Materials and Techniques

INTRODUCTION

Although James McNeill Whistler (1834–1903) dabbled in watercolors as a child and in his early years as an artist, he did not turn to watercolor painting in earnest until after his lawsuit against the art critic John Ruskin in 1878 and subsequent bankruptcy in 1879. At that point, in an effort to revive his career, Whistler traveled to Venice with a commission for etchings from the Fine Art Society. After his return from Venice more than a year later, Whistler's painting in watercolor intensified, becoming an integral part of his working oeuvre and complementing the artistic techniques of his oils and etchings.

This technical study included the 52 watercolors in the Freer Gallery of Art, all bought by founder Charles Lang Freer.[1] They were exhibited for a decade after the museum's opening in 1923 and only sporadically on view since then. In all, there are just more than 200 firmly documented watercolors by Whistler. This number is based on existing watercolors identified in the Whistler catalogue raisonné (MacDonald 1995) but does not include drawings with single color washes, design watercolors, butterfly sketches, or colored etchings. In addition to the Freer works, another 81 watercolors from 19 museums around the United States and Europe were examined, resulting in a significant body of information informing this study.[2]

EXISTING WATERCOLOR MATERIALS

Pennell Collection at the Library of Congress

The project began with the examination of known Whistler watercolor materials. A paint box and palette purported to have belonged to Whistler was donated to the Library of Congress in Washington, DC, by Whistler's biographers, Joseph and Elizabeth Pennell, in 1917. Analysis of this paint box published in *Studies in Conservation* (Fitzhugh, Leona, and Shibayama 2011) contained the results for several tubes of watercolor, including ones manufactured by James Newman, George Rowney & Co., Dr. Schoenfeld, and Charles Roberson & Co. At that time, researcher Jacob Simon brought attention to the fact that, based on label information, seven tubes of watercolor from Charles Roberson could not have been sold until after Whistler's death (Simon 2012, 58). Therefore, it is important to note that the paint box is a composite of materials used by Whistler and from the Pennells, both of whom were artists.

The online resource of Simon (2019), "British Artists' Suppliers," helped us conclude that eight tubes of watercolor are from the correct time period and could have belonged to Whistler, including Newman's moist golden ochre and Dr. Schoenfeld's raw sienna (appendix 1). The collection also includes three tubes of Beckmann's Synotonos-colour in zinc white with Roberson resale labels. Beckmann's Syntonos-colour, a German-manufactured paint, became available in England in 1893. Although considered a substitute for oil paint, its use for watercolor was mentioned in *The Art Journal* in 1895: "They dilute readily with water for water-colour painting, and we have been much pleased with the delicacy and transparency of the washes which they make even on rough paper" ("Art Notes" 1895). Sales records in the archives of colorman C. Roberson & Co. (HKI MS.121-1993 489) list Joseph Pennell's purchases of "Syntonos" white starting in 1895 and continuing through 1896, but they do not list any purchases of this material by Whistler.

Studio Materials at the Hunterian Art Gallery

Materials that remained in the artist's studio after his death were donated by Whistler's sister-in-law, Rosalind Birnie Philip, to Hunterian Art Gallery in Glasgow, Scotland (appendix 2). They include 10 tubes of watercolor, 13 jars of gouache, and two watercolor palettes, as well as a mixing tray and the lid of a wooden box, which all have remnants of mixed watercolors. The jars of gouache, four of the tubes of paint, and the paint on the palettes were analyzed by Joyce Townsend and Erma Hermans during a study of Whistler's oil paintings at the Tate and are summarized in appendix 2 of *Whistler in Watercolor: Lovely Little Games* (Glazer et al. 2019).

Whistler likely had to relinquish his art supplies during his bankruptcy in 1879. He wrote to Walter Greaves that he

Papers presented at the Book and Paper Group Session, AIC's 47th Annual Meeting, May 13–17, 2019, Uncasville, Connecticut

should take the "best kind" of Japanese papers from his studio and leave only the "commonest kind" of paper for the bank to claim (GUW 09125, Whistler to Walter Greaves, 10 September 1879). Therefore, the materials in the Hunterian are generally associated with his works after 1880. It is possible that some of the materials in the studio may have belonged to Beatrice Whistler, the artist's wife, who also painted in watercolor.

Sales Records in the C. Roberson & Co. Archives

New information about Whistler's purchases of watercolor supplies was uncovered in sales records at the archives of C. Roberson & Co., held at the Hamilton Kerr Institute in Whittlesford, England (HKI MS.110-1993 601). A transcription of the page referencing Whistler from the ledger book (fig. 1) shows that he began making purchases from Roberson in January 1881. Whistler likely turned to Roberson because he had left numerous other colormen with unpaid bills after his bankruptcy, including Winsor & Newton, Lechertier, Barbe & Co., and Hardy-Alan.

The sales records are in ledger books, written in shorthand, that contain a wealth of information summarized in table 1 of *Whistler in Watercolor—Lovely Little Games* (Glazer et al. 2019, 251). Between 1881 and 1883, during Whistler's most prolific period of painting in watercolors, he purchased numerous watercolor supplies from Roberson. For example, on October 11, 1881, Whistler purchased camel hair brushes, sable brushes, a block of paper, a waterproof sketching bag, a japanned water bottle, and watercolor paints—equipment essential for working outdoors. This purchase was immediately before he went on a painting trip to the Channel Islands.

Most importantly, further details from the Roberson warehouse records confirmed that Whistler was buying his watercolor paints in tubes. The description of an 18-tube japanned watercolor box with a divided palette from the ledger matches almost exactly one of the palettes at the Hunterian (GLAHA 54148).

PAPER

Watermarks

Computed x-ray radiography was undertaken on the 52 works in the Freer collection, with five watermarks identified. For his early watercolors, those painted before the bankruptcy, Whistler used papers not necessarily intended for watercolor, including laid papers, like those he used for his etchings. Three of the five watermarks found appear

1881		J. McN. Whistler ~~28 Wimpol~~
Jany	22	Box Etching materials to order 40/ Box 1/- Apl 9. Coarse Can h patt med size
Apl	9	Light grey ? Box 1 of 3 28/6 F White 4/ Ch White 4/ Lin & terps 5/4 Foun white & colors 16/
Ju.	17	Mad Lake 6/· Oil sables 5/9 Box & Pos 6· 25. F White 2/6 Ind Red 1/ Dk Dry s oil 6 Ex fine
	25	Hog longhand 3/9 1 lb F White in oil 5/· Box 1/· 29. Oil colors 1/ box & Pos. 4 Aug 22 1 lb Coarse
Aug	22	Ground F White & Pot 5/· Sept 17 set Poles & rings for Easel 30/· Old mahog oval Palette 12/
		1 lb Rough F White in Pot 5/· Turps 1/9 Linseed 1/· Oil colors 12/8 Oct 10. Set hooks Poles & Rings 30/·
		Turps. 2/6 Lin 1/6 Lt dry oil 5 Rgh grd white 5/· Oil colors 14/6 11th 2 ea Cop Plates 7 x 5. 6/· 8 x 6 10/·
		9 x 7. 12/· Hd Vice 3/6 22 in stool enc seat 8/· Hogtool 2/6· CH Brushes 4/6 Sable 1/6 8° Block x N 3/6 Brown
		WProof skg Bag 24/· Jap W Bottle 3/3· 18 tube Jap WC Box div Pal 8/6 WColors 16/4 22in 3x9 Ex fine
		SPCan 5/10 Nov 3. 1 lb Pot Rgh F White 5/· 11th Oil colors 9/6 Linoil 1/6
1882		
Jan	27	2 lb Rough F White 6/8 29 Pot Rgh Grd White 3/4 Oil tubes 26/· Aug 8. 8° Imp Blk
		& base 5/· Sables 13/6 Ex fine WC Hog 2/6 2 Prep Millbds 12 x 8 1/10· 13 x 9 2/· 9th WColors 4/8
Sep	16	WColors 11/8 Ex Fine Hog 9/9 6 Prep Millbds 10 x 8, 4/6· 1 Block 11-1/2 x 9, 7/ 10 x 7 3/6 x N
	23	(Rep WC palette) 2 Copper Plates ea 5-3/8 x 3-3/8 4/· 3-3/8 x 1-3/4 2/· 5-3/8 x 1-3/4 1/6 Etg ground 1/-
Oct	9	Bn Paper Block 11-1/2 x 9. 3/·
1883		
Jan	27	Etchers HandBk 5/· Feb 2. Etch Ground 2/ Silk Dabber 1/6 Pos. 4 8th Etg ground 1/-
Feb.	8	Silk Dab 1/6 Pos 2 Mar 8. WC Sables 11/4 Dble Elept 8° Blk x N 7/· Imp 8° do 4/6
Apl	14	Oil colors 2/ Exf Hog 2/ Flat oil sables 15/5 Box & pos 6 ~~Ju 18 Mar 1/6 Pe 1/8 Imp~~
July	12	3 Dbl Elep 8° Blks x HP 21/· 2 Imp 4to Blk x HP 14/· Chi White 8 Red WC Sables 8/4 Au 8. Flat
		oil sables long han 11/11 Pochade Box 7/· 2 ea 8° Blk x N, x HP 14/· WColors 11/4 oil do 1/6 Bsh Case 2/·

Fig. 1. Transcription of the C. Roberson & Co. ledger page of purchases by James McNeil Whistler.

in works painted during a trip with fellow artist Ernest Delannoy in Northern France and the Rhineland in 1858. One watermark, with the initials "LL" in a wreath (fig. 2), has been identified by paper historian Peter Bower (pers. comm., May 16, 2018) as that of a French stationer and was found in both versions of *The Kitchen* (F1898.152 and F1898.153). A partial "BLAUW" watermark (fig. 3) was found on the watercolor *Boutique de Boucher—Saverne* (F1898.156). This is part of the countermark of Dutch papermakers Dirk and Cornelis Blauw. It is unclear whether this is a Dutch paper considering that this watermark is known to have been copied by French papermakers throughout the 18th and 19th centuries. Finally, the blind stamp "FRÈRES" (fig. 4), found on *Street at Saverne* (F1898.147), could be the mark of a number of French papermakers with "Frères" in their names but has not yet been firmly linked to one specific papermaker.

Most of Whistler's watercolors (about 80%) created during the 1880s were painted on traditional wove watercolor papers. Although he continued to use Japanese and old papers for etchings produced in Venice, one of only three watercolors painted during the trip, *Venice Harbor* (F1905.118),

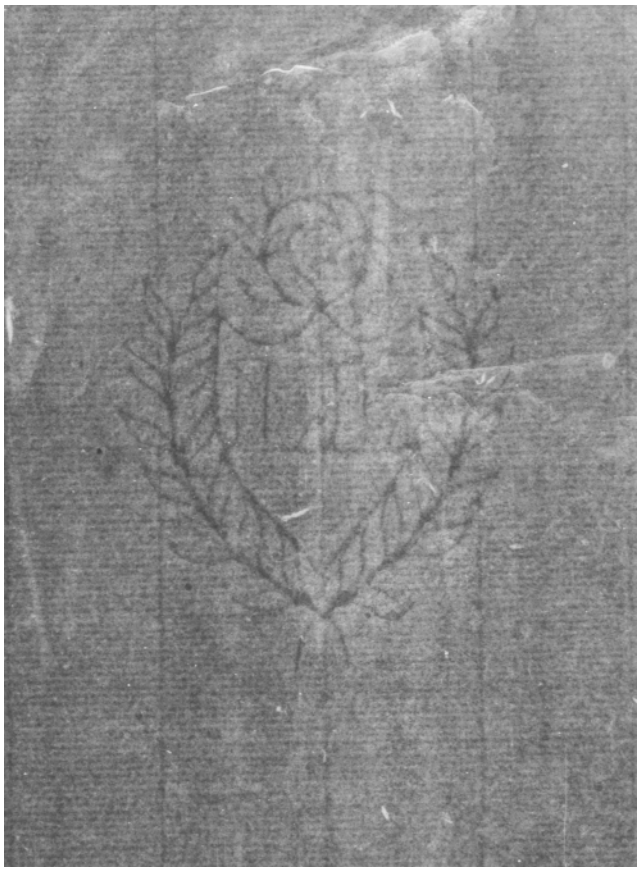

Fig. 2. Computed radiograph of watermark with the initials "LL" in a wreath found in *The Kitchen* (F1898.153).

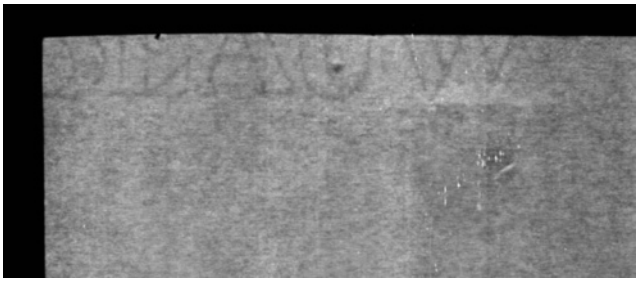

Fig. 3. Computed radiograph of partial watermark reading "BLAUW" found in Boutique de Boucher—Saverne (F1898.156).

presages a change in the type of paper Whistler used for watercolors in his mature period. Painted in 1879, the paper of *Venice Harbor* has a "J. Whatman/Turkey Mill/187[?]" watermark (fig. 5). Turkey Mill was the Whatman mill run by the Hollingsworths in Boxley, England. Another Whatman watermark appears on *Nocturne: Grand Canal, Amsterdam* (F1902.161), painted in 1882. It has a partial name and date, "[?]MAN 1881," followed by the letter "B" (fig. 6) and has been identified by Peter Bower (pers. comm., April 9, 2018) as a partial Whatman watermark. The letter B was added to indicate that it was made by papermaker William Balston at Springfield Mill in Maidstone, England.

Paper Blocks

The Roberson archives includes the information that between 1881 and 1883, Whistler purchased 16 blocks. A block was made with sheets of paper compressed and sealed around the edges, except in one section along the top edge. Once the top sheet was painted, it could be separated by inserting a sharp tool into the unsealed section and running it around the edges to cut the adhesive and release the top sheet. Blocks made it much easier for watercolor artists to travel and paint outdoors. Roberson offered blocks made with papers from multiple papermakers, including Whatman, and those named after watercolor artists such as Varley, Cox, and Harding. Unfortunately, no information about the paper or papermaker for the blocks Whistler purchased is included in the Roberson ledgers. Block sizes were extrapolated from information listed in the ledger and ranged from 7 × 10 in. to

Fig. 4. Blind stamp reading "Frères" found along the edge of *A Street at Saverne* (F1898.147).

Fig. 5. Computed radiograph of watermark reading "J. WHATMAN/ TURKEY MILL/187[?]" found in *Venice Harbor* (F1905.118).

10 × 14 in. These sizes are approximate, as variations in sheet size were common in hand production. The use of blocks was confirmed by the presence of blue fiber and adhesive residues along the edges of 23 watercolors (fig. 7).

There are also three small blocks, each 3-1/2 × 5 in., in the Hunterian collection (GLAHA 55489-55491), although no watercolors this small were seen during this study. The label on one block identifies it as being purchased in Algiers, which Whistler only traveled to in 1901, a few years before his death (GLAHA 55491). A majority of Whistler's watercolors, ranging from the smallest at 3-3/4 × 6-1/8 in. to the largest at 8-11/16 × 12-3/16 in., are sizes that could have come from the blocks Whistler purchased through Roberson.

Paper Texture

Watercolor papers during the 19th century were manufactured with surfaces sold under the following names: rough, cold press, and hot press. Watercolor paint takes on a difference appearance when brushed across these three surfaces, lying more smoothly on a hot-pressed paper and less evenly on rough surface (figs. 8–10). The Roberson ledger includes details on the particular surface textures that Whistler requested for his blocks—he purchased seven hot-pressed blocks and seven cold-pressed blocks, with another two blocks unidentified.

Each papermaking mill developed its own processes for the finishing of the paper, so the distinctions between the three textures are very subjective; what looks like a cold-pressed paper from one mill may resemble a rough surface from another. For this study, three modern Sennelier watercolor papers were chosen to use as standards for assessing Whistler's papers (N139911 cold pressed, N139912 hot pressed, and N139913 rough). Although Whistler used the hot and cold pressed papers relatively equally, two discernible trends were identified: Whistler used mainly cold pressed papers for his seascapes and preferred the smooth, hot-pressed surface for a majority of his street scenes.

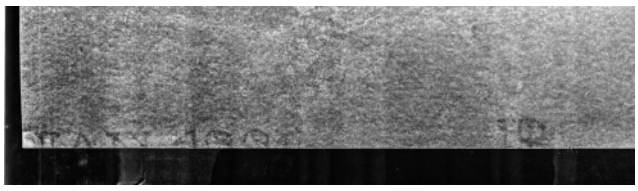

Fig. 6. Computed radiograph of partial watermark reading "MAN 1881 B" found in *Nocturne: Grand Canal, Amsterdam* (F1902.161).

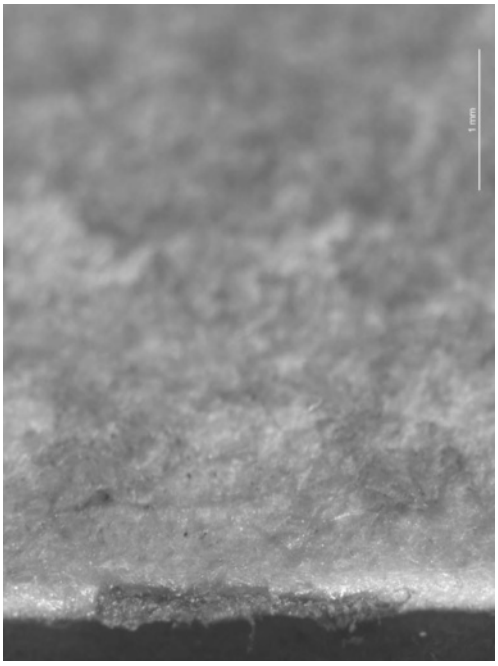

Fig. 7. Blue fabric remnants, like those seen at the edge of *Southend Pier* (F1904.82), confirm that many of the papers that Whistler used were removed from blocks.

Experimentation

Whistler purchased at least five fabric-covered boards that bear the stamp of E. Mary & Fils (fig. 11). Opened in 1882, E. Mary became the Paris agent for Charles Roberson & Co. in 1883. The boards for the five works (including *Green and Silver—Beaulieu, Touraine* (F1899.25) are a similar size and all have the maker's stamp on the verso. Although the boards were probably manufactured for oil painting with a pre-prepared ground layer of white lead (confirmed by XRF and FTIR of F1899.25), Whistler experimented with them nonetheless.

Eleven watercolors examined were painted on Japanese paper. Whistler used Japanese paper for his etchings and was well aware that the surface of these papers could be soft, unsized, and not conducive to painting in watercolor. Seven of these 11 works are painted on Japanese paper-wrapped boards. These Japanese paper-wrapped boards do not appear in the sales catalogs of artists' suppliers from this time period. *Two Pettigrew Sisters Asleep with a Baby* (GLAHA 46159) at the Hunterian Art Gallery is on a Japanese paper-wrapped board

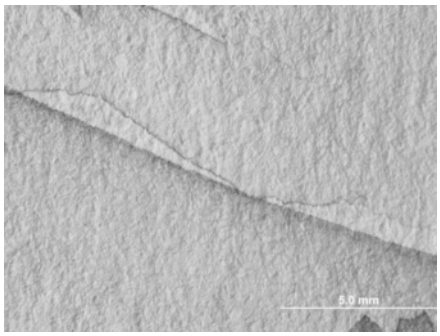

Fig. 8. Detail of *St. Ives: Cornwall* (F1905.117) showing the smooth texture of a hot-pressed paper.

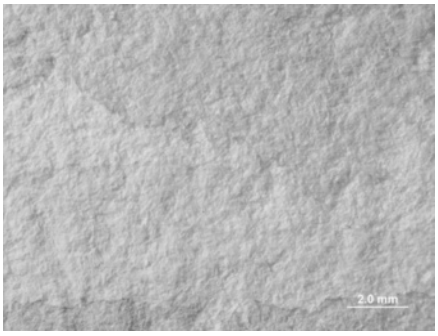

Fig. 9. Detail of *Grey and Silver—Pier, Southend* (F1902.169) showing the slight texture of a cold-pressed paper.

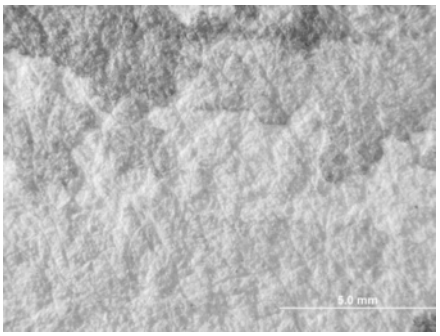

Fig. 10. Detail of *Venice Harbor* (F1905.117) showing the pronounced texture of a rough paper.

that has a maker's stamp on the verso—that of E. Mary & Fils—raising the possibility that Whistler requested that these special boards be made for him.

After 1888, Whistler experimented using brown paper for his watercolors, producing at least nine works on that support, including *Blue and Gold—The Rose Azalea* (F1894.25). This was a paper that Whistler had always favored for his pastels, writing to the artist Auguste Delâtre, "Enclosed I am sending you a sample of the brown paper with which you wrapped the etchings when you sent them to me . . . Now it is just the paper I need for my drawings. I am always looking for some" (GUW 09057, Whistler to Auguste Delâtre, October 1871/1874).

PIGMENT ANALYSIS

Pigment analysis on the Freer watercolors began with non-invasive methods of x-ray fluorescence spectroscopy (XRF) and fiber optic reflectance spectroscopy (FORS), attempting to analyze each color by picking about 10 or more spots that appeared to be the most pure and to have only one layer of watercolor (fig. 12). This was followed by reflectance Fourier transform infrared spectroscopy (FTIR), in situ on the painting, for confirmation of Prussian blue and identification where possible of yellow. These methods provided targets for further analysis: potential organic colorants using high-performance liquid chromatography—mass spectrometry with a UV-VIS diode array detector (LCMS-DAD).

Fig. 11. Manufacturer's stamp on the verso of *Green and Silver—Beaulieu, Touraine* (F1899.25). This stamp appears on the verso of four other works on the same fabric-wrapped boards.

The results were complicated by Whistler's use of pigments, which, similar to his oil painting practice, often utilized a mixture of the same pigments in varying amounts to form almost every color. His apprentice, Inez Bate, wrote that the artist taught his students not to "use too independent colours—Let everywhere the same material run throughout" (GUW 00226, Inez Bate Addams to Whistler, May 1899/1901). Thus, this study was defining the colors of the Whistler watercolors by their major components, recognizing that each color also contained minor amounts of the other pigments that he used in the specific work. Limited XRF or FORS analyses were carried out on watercolors in other collections, although the results shared here are primarily those on the Freer works.

Student Palette

The earliest watercolor in the Freer, *A Fire at Pomfret* (F1905.333), contains the pigments lamp black, vermilion, cochineal/carmine, cobalt blue, indigo, iron oxides, and Prussian blue and an organic yellow to make green. Although it is unlikely that Whistler was still using the same paints for *Sam Weller's Landlord in the Fleet* (F1905.332), painted about 5 years later, he likely was still using materials that were readily available, although painting with a limited number of colors and applied sparingly (lamp black, vermilion, cobalt blue, indigo, iron oxides with touches of zinc white). Whistler is known to have torn pages from books to use for his drawings, and this watercolor is the exact same size as a page from one of Whistler's textbooks (Whistler 166) held at the University of Glasgow Library. Whether the page comes from this textbook has not been confirmed.

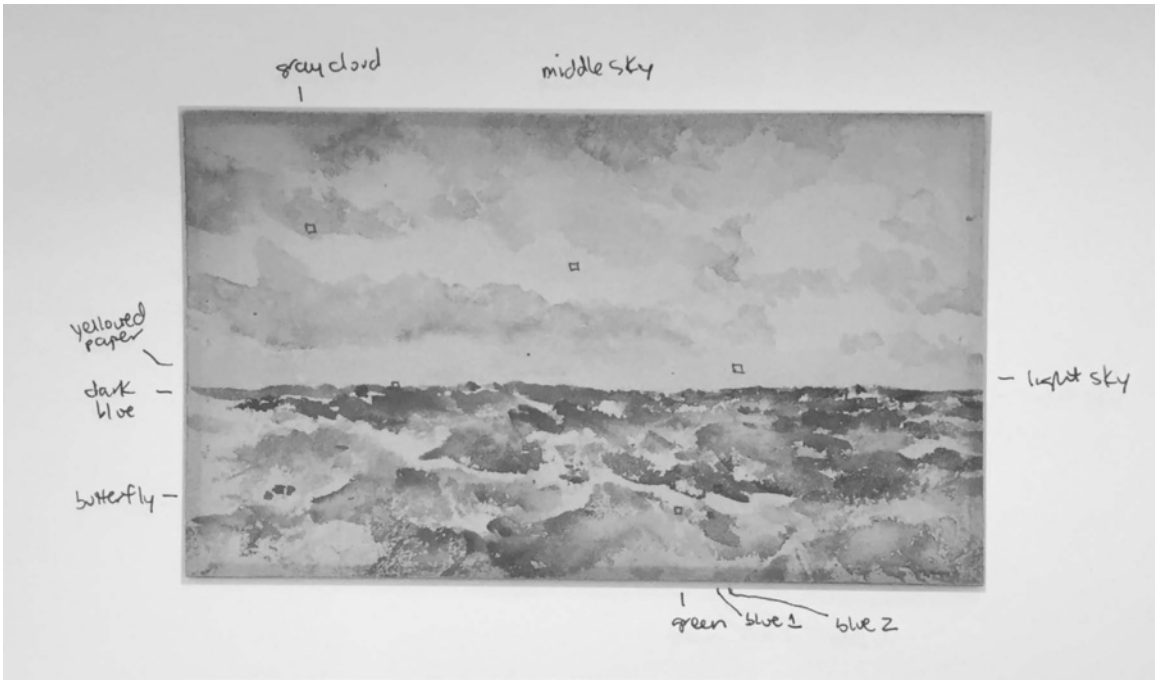

Fig. 12. Photocopy image of *Blue and Silver—Choppy Channel* (F1899.24) marked to identify the spots analyzed by FTIR and FORS. Similar templates were made for all 52 watercolors.

Early Palette

Throughout the 19th century, discoveries of new colorants extended the palette available to artists, but with the exception of cobalt blue, Whistler's early watercolors rely primarily on well-established pigments. A variety of iron-based pigments, bone black, vermilion, indigo, cobalt blue, lead white, and an unidentified organic green, are found in the watercolors from his 1858 trip with Delannoy. The early watercolors contain multiple iron oxide pigments within each work. Yellows generally were iron oxides, although chrome yellow was found in *Boutique de Boucher—Saverne* and both examples of *The Kitchen*.

Assuming that his supplies were lost due to his bankruptcy, the pigments used in *Venice Harbor* likely were new purchases or supplies borrowed from the young American artists, such as Otto Bacher, who Whistler met in Venice. The palette seems to continue what he was using earlier. Although the use of zinc white here is a departure from the watercolors he painted during his 1858 trip, it was not new for Whistler. He was using zinc white touches in his juvenilia, and zinc was found in the ca. 1867 watercolor study *In the Studio* (DIA 51.223) in the Detroit Institute of Art.

On his return to England, Whistler had great success with the sale of his small pastels from Venice. He began painting a series of small, portable watercolors that he hoped would be equally as marketable. "I have done delightful things," he confided to a fellow artist, "and have a wonderful game to play" (GUW 09420, Whistler to Waldo Story, January 1884). Whistler used the word *game* in a double sense: to refer to both his latest work and his plans for selling it.

At Whistler's probable instigation, his friend, architect Edward W. Godwin, described *London Bridge* (F1905.115) in the journal *British Architect* in September 1881 as Whistler's first watercolor. Although put forward as something new, this work is well aligned with Whistler's previous work in watercolor in terms of materials and technique. *London Bridge* was also one of the last of Whistler's watercolors to feature underdrawing—a striking element of Whistler's technique after September 1881 is that he stopped utilizing any underdrawing.

Mature Palette

It was after an October 1881 purchase from Roberson that Whistler appears to have made a definitive switch from painting with cobalt blue to the cheaper cerulean blue. The latest identification of cobalt blue by FORS in the Freer watercolors is in *London Bridge*, painted before September 1881, whereas the earliest watercolor with cerulean blue in the Freer, *Note in Blue and Opal—Jersey* (F1904.83), dates to a November 1881 trip to the Channel Islands. This trip was taken after the purchases from Roberson in October 1881. FORS was used to differentiate these two cobalt pigments based on their different absorptions. After 1881, only cerulean blue was found with FORS. In some cases, cobalt without tin was found on the watercolor by XRF, often with cerulean blue

seen in FORS in other areas of the watercolor. This non–cerulean blue cobalt was seen in some watercolors together with Prussian blue and was perhaps the mixture referred to as Leitch's blue, Antwerp blue, or cyanine blue ("Leitch's Blue" 2013). In a few works with cobalt, neither cobalt blue nor cerulean blue pigments were found by FORS, and no Prussian blue was present. In these cases, there was always a hydrated iron oxide present. Metals were added to alter the tint of iron oxide pigments (Helwig 2007), and the cobalt may be present in the iron pigment.

Both zinc white and bone black were found in all of the watercolors in the Freer collection dated after 1880. Various scholars have attributed either blue or brown tints to bone black. In Whistler's watercolors, small blue particles were present, and the blacks have a blue cast. Tubes of ivory black are found among the Whistler materials at both the Library of Congress and the Hunterian. Prussian blue or cobalt are often found in the black areas, and it is likely that Whistler used them to form a mixed black (Field 1835, 179).

In the 1880s, the palette expanded to include more of the modern, manufactured pigments. Cadmium and lemon yellow, emerald green, and madder are found in addition to the pigments that Whistler used previously. Some of the iron-based pigments in use after 1881 were quite pure and lacked the chemical elements, such as silicon, aluminum, magnesium, and rubidium, normally associated with the quartz and clay components found in natural ochres. This suggests that some of these pigments may be artificial Mars colors.

A critic's review of Whistler's 1884 exhibition "Notes"–"Harmonies"–"Nocturnes" in the *Standard* described *A Note in Green* (F1902.165) as a girl standing "in front of a blazing greenish-yellow background" ("Mr. Whistler's Exhibition" 1884). Only traces of this bright yellow can be seen along the left edge, where the frame protected the watercolor from light, whereas the yellows in the rest of the painting have dulled. Energy-dispersive x-ray spectroscopy (EDS) confirmed the presence of a strontium chromate yellow, which is known to display a color shift toward green due to degradation from light exposure, as well as cadmium sulfide (Otero et al. 2017). Both strontium chromate (lemon yellow) and lead chromate (chrome yellow) were identified in works from this period, although they are not found among Whistler's studio materials. Cadmium sulfide yellow is among the materials at the Hunterian.

Madder, a red anthraquinone plant dye with two major colorants (alizarin and purpurin), fluoresces in UV light due to purpurin. Only purpurin was found in the pink gown in *Southend Pier* (F1904.82) using LCMS-DAD. Although madder is present in *Southend Pier*, iron oxide reds, mixed or layered with vermilion, are more common in Whistler's watercolors.

Multiple pigments were mixed together to form the varied green shades used in Whistler's seascapes and landscapes. Copper arsenic-containing pigments with similar appearance were found in the *Reach in the Upper Thames* (F1905.121) and *Blue and Silver—Choppy Channel* (F1899.24). A sample from *Blue and Silver—Choppy Channel* was identified as emerald green using Raman spectroscopy. However, the majority of Whistler's greens are optical greens made from the mixing or layering of pigments. The dominant pigment is often tinted with a secondary blue, yellow, or green. The optical greens generally contain yellow iron oxides, cadmium sulfide or chromates, or more than one of these, mixed with Prussian blue. Indigo or cerulean blue, either in addition to the Prussian blue, or occasionally without it, were also identified. Some or all of the Prussian blues may be Antwerp blue, a mixture of Prussian blue and aluminum sulfate; however, the analytical methods used in this study do not permit differentiation.

During FTIR analysis of pigments in the three watercolors associated with St. Ives on the Cornwall coast, kaolin clay was discovered in the paper. Kaolin clay is a natural resource in the Cornish hills and may have been used as a filler or coating in the paper. The St. Ives papers are the only ones among Whistler's watercolors found to contain kaolin. Another factor that differentiates the St. Ives watercolors from other seascapes is a lack of cerulean blue (or cobalt for that matter), which is unusual for Whistler's seascapes.

Late Palette

The palettes and the paint box lid at the Hunterian Art Gallery contain both lead and zinc whites mixed together, although they were not found together in any Freer works. Using XRF, the elements lead and zinc were found together in white areas in two watercolors at the Art Institute of Chicago, dating to the 1890s: *The Little Blue Cap* (AIC 2012.96) and *Green and Blue: The Dancer* (AIC 1988.219). The presence of both zinc and lead in the Hunterian palettes supports an association of these materials with the later years of Whistler's career.

WORKING TECHNIQUES

Little has been written about Whistler's working techniques in watercolor painting. Indeed, Whistler himself rarely wrote about his watercolors; a trove of his correspondence survives but answers few questions about his watercolor practice (GUW—The Correspondence of James McNeill Whistler). The only information comes from Whistler's follower Mortimer Menpes, who wrote "In water colours Whistler always used Chinese white [zinc white] with every tone, to give body to the pigment—just as in his oil colours he used ivory black" (Menpes 1904, 73).

Whistler added zinc white to his paints in almost all of his watercolors after 1880; however, he sometimes used it in discrete areas, and other times over the entire painting, as indicated by the fluorescence of zinc white in the watercolors (and confirmed by XRF and FORS analysis). For example, *Southend—Sunset* (F1905.119) only fluoresces in some of the

Fig. 13. Black and white image of *Milly Finch* (F1907.170) in normal light.

Fig. 14. Reflected infrared image of *Milly Finch* (F1907.170), which reveals changes made to the skirt of the reclining figure.

clouds, whereas *Pink Note: The Novelette* (F1902.158) fluoresces almost all over. It is important to keep in mind that the fluorescence of zinc white can be quenched over time due to exposure to light and moisture (Artesani et al. 2016). This is clearly visible in the UV image of *Grey and Silver—Purfleet* (F1902.117), where the frame rabbet covered the edges of the painting, preserving the fluorescence. Therefore, a lack of fluorescence does not necessarily indicate an absence of zinc white.

Terminology of watercolor and gouache paints became an interesting issue based on Whistler's watercolors. Although zinc white is mixed into most of his mature watercolors, many of them remain quite transparent, so the terms *gouache* or *opaque watercolor* have implications that do not seem to fit with these works. However, calling them watercolors does not convey the fact that they incorporate zinc white. It would be interesting to hear how other conservators deal with this question and what terminology would be suggested.

Although the watercolors appear quite simple and dashed off, many have been reworked. One example is a change made in the skirt of the reclining figure in *Milly Finch* (F1907.170) that was revealed during examination with reflected infrared light (figs. 13, 14). The infrared image shows that the skirt of the figure was originally spread wider and was subsequently painted over.

Examination with the microscope revealed many areas that had been reworked using various watercolor techniques, including sanding, rewetting, and blotting. Areas of disturbed fibers in the paper indicating rewetting and reworking can been seen in the detail of the face in *Harmony in Violet and Amber* (F1902.164) (fig. 15).

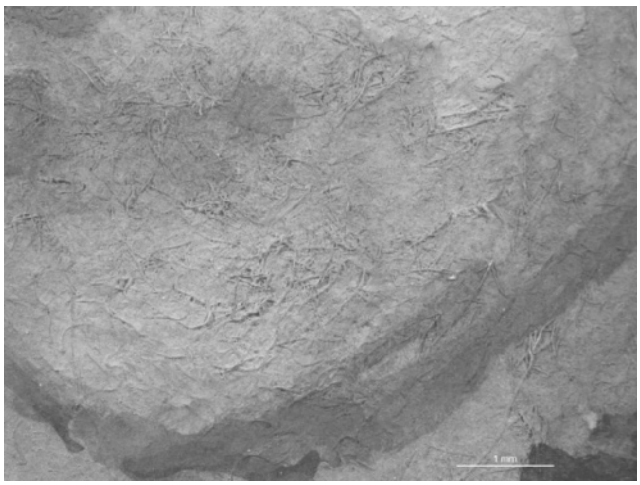

Fig. 15. Detail of *Harmony in Violet and Amber* (F1902.164). The disturbed fibers in the face indicate that Whistler reworked this area of the watercolor.

MOUNTING AND PRESENTATION

Throughout his career, Whistler dictated all elements of his artworks—from choosing frame colors and decorating the frames himself to selecting wall colors and writing exhibition text. Whistler placed his watercolors into the frames with no mats or spacers, giving his watercolors the same status as his oil paintings (fig. 16).

Small graphite "sight" marks were found in at least 29 watercolors, either in the corners (fig. 17) or as marks along the edges. It is quite possible that these are marks made by Whistler to show his framer how he wanted his watercolors to appear in the frame. Whistler once wrote, "[T]ell Grau to measure them for the usual frames he always makes for all my little pictures—Oil or watercolour or Pastel—and tell him to be most particular . . . to get the exact measurement of the 'sight'" (GUW 08001, Whistler to Charles James Whistler Hanson, September 14/21, 1888?).

Whistler also preferred that his works be adhered overall to a backboard for display, writing "I should really like them to be 'laid down'" because "they would look all the more solid, and fit their frames better and appear smarter if they were 'laid down'" (GUW 08610, Whistler to Charles Dowdeswell, February 25/28, 1886). *Green and White: Dieppe* (B2011.26), at the Yale Center for British Art, has an L. Cornellisen stamp on the verso. Based on a visible adhesive layer between the watercolor paper and board, the watercolor was probably mounted by Cornellisen after Whistler had painted it. A label on the verso of *A Little Red Note—Dordrecht* (F1908.15) (fig. 18), of Lechertier Barbe & Co., suppliers in London, could indicate the work was a premade watercolor board or mounted by them. Four of the watercolors examined during this study had been removed from their mounts at some point in their past. Because Whistler dictated that his watercolors be mounted, many boards are likely historic and should be considered an integral part of the work.

Paper discoloration is visible in about half of the watercolors observed in all collections. Small areas of unpainted paper have now yellowed, in many cases with a halo of unchanged paper around the discolored area. It is possible that this deterioration occurred while the watercolors were stored in their original wood frames; however, this has not yet been confirmed. Although it is imperative to maintain the connection between original Whistler frames and their watercolors, it would be best to house them separately to avoid potential damage.

Fig. 16. *Note in Pink and Purple—The Studio* (F1902.163) in its original Whistler-designed frame

Fig. 17. Detail of *Pink Note—Shelling Peas* (F1902.166) with one of the sight marks that may have been left by Whistler.

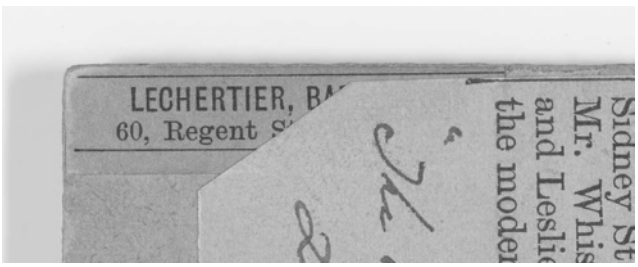

Fig. 18. Partially visible Lechertier, Barbe & Co. label on the verso of *A Little Red Note—Dordrecht* (F1908.15).

CONCLUSION

In keeping with his paper choices for his etchings, Whistler used older and unusual papers in his watercolors painted before the 1880s. These watercolors were sketched first in graphite and subsequently painted, adhering to the British tradition for watercolor painting. In some early works, he used mixtures of cobalt blue, Prussian blue, bone black, iron earth pigments, and lead white, which has oxidized in many instances (e.g., in *The Kitchen*, F1898.153).

Once Whistler began painting in watercolor in the 1880s, he moved to using traditional wove watercolor papers, including Whatman paper. He used zinc white predominantly, alternating between mixing it with almost every color he used and adding it in specific areas only. His preferred palette shifted to painting with cerulean blue rather than cobalt and saw the addition of touches of cadmium, lemon, chrome, and strontium yellows, as well as cadmium orange and emerald green. Similar to his works in oil, Whistler used varying amounts of the same set of pigments that were used throughout the watercolor to obtain subtle variations in shade.

Most importantly, in his watercolors, as well as his pastels and oils, Whistler chose to create small, intimate works. Although the portable aspect of these works was certainly part of Whistler's "game" to create sellable artworks, the watercolors also continued the same painting principles that he applied to his works in all media.

ACKNOWLEDGMENTS

A project of this scope could not have occurred without the assistance of many colleagues. The authors would like to thank everyone who hosted them at their institutions, undertook analyses, patiently answered queries, and assisted in this project: Christina Bisulca, Katherine Blood, Stacy Bowe, Peter Bower, Bruker AXS Inc., Victoria Button, Francesca Casadio, Soyeon Choi, Matthew Clarke, Kristie Couser, Kristi Dahm, Patricia de Montfort, Alan Derbyshire, Ann Driesse, Anne Evenhaugen, Theresa Fairbanks-Harris, Beth Finch, Elisabeth West Fitzhugh, Chris Foster, Lee Glazer, Alexandra Greathead, Erma Hermens, Roy Hewson, Erica Hirshler, Rena Hoisington, Amy Hughes, Bruce Kaiser, Penley Knipe, Natalie Lawler, Marco Leona, Alison Luxner, Margaret MacDonald, Annette Manick, Amy Marquis, Justin McCann, Niamh McGuinne, Chika Mori, Lauren Murtagh, Barbara Natanson, Mark Norman, Lizzie O'Neill, Antoinette Owen, Régine Page, Tom Primeau, Pamela Robertson, Kerry Roeder, Kim Schenck, Bhavesh Shah, Nobuko Shibayama, Jacob Simon, Martha Smith, Harriet Stratis, Joyce Townsend, Sidney Williams, Jo Kirby, Kate Helwig, and Sally Woodcock.

APPENDIX

Appendix 1. Watercolors in the Library of Congress Whistler paint box
This list of paints includes analytical results from Fitzhugh et al. (2011); paint availability information taken from the National Portrait Gallery, "British Artists' Suppliers" (Simon 2019); and additional label information discovered through enhancement of digital images.

Label Information	When Available	Fitzhugh et al. Number	Pigments Identified
The following watercolors could have been used by Whistler:			
[Elfen]beinschwartz Dr. Fr. Schoenfeld (label not fully legible)	1862; sold in England from 1882 on	26	Ivory or bone black
Newman's Moist Cadmium Orange 24 Soho Square, London	1801–1937	19	Cadmium orange
Geo. Rowney & Co. CR. LAKE. (Crimson Lake) 52 Rathbone Place & 29 Oxford St., London	1862–1881	10	Carmine and calcium carbonate
Fine Watercolor Paints Cobalt Blue Dr. Fr. Schoenfeld & Co., Düsseldorf	After 1862; sold in England from 1882 on	14	Cobalt aluminate

(Continues)

Appendix 1. Watercolors in the Library of Congress Whistler paint box (*Continued*)

Label Information	When Available	Fitzhugh et al. Number	Pigments Identified
French Ultramarine C. Roberson & Co. (label fragmentary)	1840–1908	23	Synthetic ultramarine (sulfur-containing aluminosilicate)
Newman's Moist Golden Ochre 24 Soho Square, London	1801–1938	21	Yellow iron oxide (goethite) and quartz
Rowney & Co. Moist Color Neutral Tint (label not fully visible)	1848–1923	17	Graphite with red and blue particles
Fine Watercolor Paints Raw Siena Dr. Fr. Schoenfeld	1862; sold in England from 1882 on	15	Yellow iron oxide (goethite)
The following watercolors could not have been used by Whistler:			
Tempera Colours for Decorative Design Antwerp Blue Roberson & Co. 99 Long Acre, London	Not seen in catalogs before 1903	9	Prussian blue
Burnt Sienna C. Roberson & Co. 99 Long Acre, London (label not fully visible but likely to be Ltd.)	No earlier than July 1908	7	Red iron oxide (hematite)
Emerald Green C. Roberson & Co. Ltd. 99 Long Acre, London	No earlier than July 1908	4	Emerald green (copper aceto-arsenate)
Indian Red C. Roberson & Co. Ltd. 99 Long Acre, London	No earlier than July 1908	5	Red iron oxide (hematite)
Light Red C. Roberson & Co. Ltd. 99 Long Acre, London	No earlier than July 1908	6	Red iron oxide (hematite) and quartz
Vermilion C. Roberson & Co. Ltd. 99 Long Acre, London	No earlier than July 1908	12	Artificial vermilion and unidentified organic red
Vermilion Roberson & Co. Ltd. Long Acre, London	No earlier than July 1908	20	Artificial vermilion
Beckmann's Syntonos [Colours] Zinc White L. Auerbach & Co. Partially covered by resale label: Roberson & Co. 99, Long Acre, and 154, Piccadilly, London	1893 or later	3	Zinc white

Appendix 2. Watercolor Supplies from Whistler's Studio at the Hunterian Art Gallery, University of Glasgow

Hunterian Number	Watercolor Supply	Size	Notes
GLAHA 54139	Dr. Fr. Schoenfeld & Co. finest wet watercolor tube, raw sienna		
GLAHA 54140	Glass bottle of Newman's luminous body colour, Antwerp blue	10 mL	
GLAHA 54147	Wooden paint box with watercolors mixed on lid		
GLAHA 54148	18-tube japanned watercolor box with divided palette		
GLAHA 55460	Japanned palette; lid with 3 wells		Newman label
GLAHA 55461	Tube of Winsor & Newton moist colour, raw umber		
GLAHA 55462	Tube of Winsor & Newton moist colour, light red		
GLAHA 55463	Tube of Winsor & Newton moist colour, ivory black		
GLAHA 55464	Tube of Newman's moist colour, French blue		
GLAHA 55465	Glass bottle of Newman's luminous body colour, Newman's white	10 mL	
GLAHA 55466	Glass bottle of Newman's luminous body colour, unknown black	10 mL	
GLAHA 55489	Block of cold pressed paper with incorporated wood base	5-1/6 x 3-9/16 in.	
GLAHA 55490	Imperial 32 mo (32°) block of Whatman cold pressed paper with incorporated wood base	5 x 3-5/8 in.	Made by Rowney; sold by Sennelier and/or Prevost
GLAHA 55491	Block of cold pressed paper with incorporated wood base (purchased in Algiers while there in 1901)	5-1/8 x 3-5/8 in.	Sold by Grande Droguerie/Produits chimiques/L. Ferriol/Rue de Constantine, 19/Alger
GLAHA 55492	Ceramic mixing tray (purchased in Algiers while there in 1901)		Sold by Grand Droguerie/Produits chimiques/L. Ferriol/Rue de Constantine, 19/Alger
GLAHA 57765	Glass bottle of Newman's luminous body colour, cobalt blue	10 mL	
GLAHA 57766	Glass bottle of Newman's luminous body colour, vermilion	10 mL	
GLAHA 57768	Glass bottle of Newman's luminous body colour, venetian red	10 mL	
GLAHA 57769	Glass bottle of Newman's luminous body colour, cadmium yellow	10 mL	
GLAHA 57770	Glass bottle of Newman's luminous body colour, yellow ochre	10 mL	
GLAHA 57771	Glass bottle of Newman's luminous body colour, lemon yellow	10 mL	
GLAHA 57772	Glass bottle of Newman's luminous body colour, raw umber	10 mL	
GLAHA 57773	Glass bottle of Newman's luminous body colour, raw sienna	10 mL	
GLAHA 57774	Glass bottle of Newman's luminous body colour, burnt sienna	10 mL	
GLAHA 57792	Tube of Newman's moist colour, cadmium orange		
GLAHA 57793	Tube of watercolor? Cobalt blue		
No number	Dr. Fr. Schoenfeld & Co. finest wet watercolor tube, Antwerp blue		
No number	Dr. Fr. Schoenfeld & Co. finest wet watercolor tube, raw umber		
No number	Dr. Fr. Schoenfeld & Co. finest wet watercolor tube, viridian		
No number	Dr. Fr. Schoenfeld & co. finest wet watercolor tube, Indian red		

NOTES

1. Technical examination of the watercolors employed multiple techniques. A binocular microscope was used to study paints, application techniques, and paper structure. Reflected infrared images were taken under tungsten light using a Nikon D100 camera with a Kodak Wratten 87C filter. UV-induced visible fluorescence images were taken under a Blak-ray, Model XX15 UV-A lamp using a Nikon D100 camera with Kodak Wratten 2E and X-Nite CC1 filters. The imaging of the watermarks was carried out with a GE Rhythm system using a Picker hotshot x-ray tube with a .3-mm focal spot. Low-energy (Grenz) radiation was used at 13 to 18 kV, 3 mA at 5 minutes, and 20- to 23-in. tube distance. Five to 15 locations on each watercolor were analyzed noninvasively with a Bruker Artax 800 x-ray fluorescence spectrometer (XRF) with a polycapillary lens and an excitation spot size of approximately 100 μm. Conditions were 45 kV, 10 μA, in air, with 30- to

32-second acquisition. The same locations were analyzed using a Cary 50 UV-VIS spectrometer with fiber optic probe over the range of 300 to 800 nm (FORS) with a scan rate of 30 nm/min at a resolution of 1 nm. Measurements were made in situ in reflection mode or on small samples removed from the watercolors using a Nicolet Nexus 670 Fourier Transform Infrared spectrometer with a Continuum microscope (FTIR). We collected 32 to 256 scans with a resolution of 4 nm, dependent on the signal to noise. A background was collected on gold. After FTIR measurement, samples were examined with polarized light microscopy.

2. Watercolors were examined at the following museums: Ashmolean Museum, Oxford, England; Baltimore Museum of Art, Baltimore, Maryland; Chicago Art Institute, Chicago, Illinois; Colby College Art Museum, Waterville, Vermont; Detroit Institute of Art, Detroit, Michigan; Fitzwilliam Museum, Cambridge, England; Harvard Art Museums, Cambridge, Massachusetts; Hunterian Art Gallery, Glasgow, Scotland; Metropolitan Museum of Art, New York, New York; Museum of Fine Arts, Boston, Massachusetts; National Gallery of Art, Washington, DC; National Gallery of Ireland, Dublin, Ireland; Terra Foundation for American Art, Chicago, Illinois; University of Michigan Art Museum, Ann Arbor, Michigan; Victoria & Albert Museum, London, England; Yale Center for British Art, New Haven, Connecticut.

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Comparison of Chinese Painting and Western Paper Conservation Techniques

BACKGROUND

Traditional Chinese painting conservation has been a part of the broad field of art conservation in US institutions for more than 30 years. However, Western conservation training often does not address the background, education, and practices of this specialized area. Through the support of the Andrew W. Mellon Foundation and within the past decade, there has been a push to integrate the apprenticeship model of training into Western studios, resulting in two conservation perspectives (East and West) across the next generation of institutional positions (fig. 1).

Training in restoration/conservation of Chinese paintings has traditionally followed a 5- to 10-year master/student apprenticeship model. The author studied paper conservation at New York University, specializing in Chinese mounting. In what she calls a "hybridized apprenticeship," the author also trained in China and worked under Ms. Xiangmei Gu, senior conservator at the Freer|Sackler, adapting Japanese and Western conservation techniques into traditional Chinese approaches. Through her experiences, she noted significant divergence between the cultural approaches to conservation and wondered how these would translate to treatments. How would a Western conservator treat a Chinese painting?

Five paper conservators were asked to submit treatment proposals for the same painting. All conservators work in major institutions across the US and have 7 to 15 years of experience working with archives, prints and drawings, contemporary art, or Asian prints and manuscripts. All five initially stressed that they would send this type of painting to a specialist and only attempt treatment if absolutely necessary and with consultation. Each proposal was unique and different but shared key techniques.

This article will discuss the remounting of this 19th-century Chinese painting, focusing on Chinese conservation techniques that are standard in the field (fig. 2). These techniques will be compared with alternative treatment approaches offered by Western paper colleagues. The examination of these practices and the principles that guide both traditions can provide a better understanding of how Chinese and Western approaches can be leveraged to advance the field of conservation. The Chinese approaches presented here follow traditional techniques and are not intended to ignore more recent developments in conservation in China, or suggest that the practice of these techniques and approaches have not evolved in other US museums. Because the practice of remounting is quite complex, this article will focus only on major steps.

Papers presented at the Book and Paper Group Session, AIC's 47th Annual Meeting, May 13–17, 2019, Uncasville, Connecticut

TOOLS, MATERIALS, AND STUDIO

Chinese painting mounting and conservation requires special tools and materials (fig. 3). *Xuan* paper is the most common paper used for painting and mounting. It is white, thin, short fibered, and absorbent, and composed of various mixtures of bark from the blue sandalwood tree and rice straw. The name *xuan* comes from its location of manufacture in the Anhui province. A traditional studio has red lacquer tables and a drying wall.

INTRODUCTION TO CHINESE PAINTINGS

Chinese paintings are often mounted in the format of a flat mounted painting, hanging scroll, handscroll, album, and fan. Scrolls are the most common format—they are complex objects composed of different materials such as paper, silk, wood, metal, ceramic, or bone. They have a multilaminate structure, including the painting, which is lined with a first lining paper, its surrounding mounting materials (typically silk lined with paper), and a final backing composed of two or more layers of paper for support (fig. 4). A successful mounting is aesthetically appropriate, and supports and preserves the painting by achieving a flat, balanced, flexible structure that withstands repeated handling.

A flat mounted painting, known as a *jing pian*, was selected for this project. It is similar to a hanging scroll, without the elaborate mounting, wooden rollers, and accessories. This format is similar to large-format works of art on paper, familiar to most Western paper conservators, making it more amenable to compare techniques.

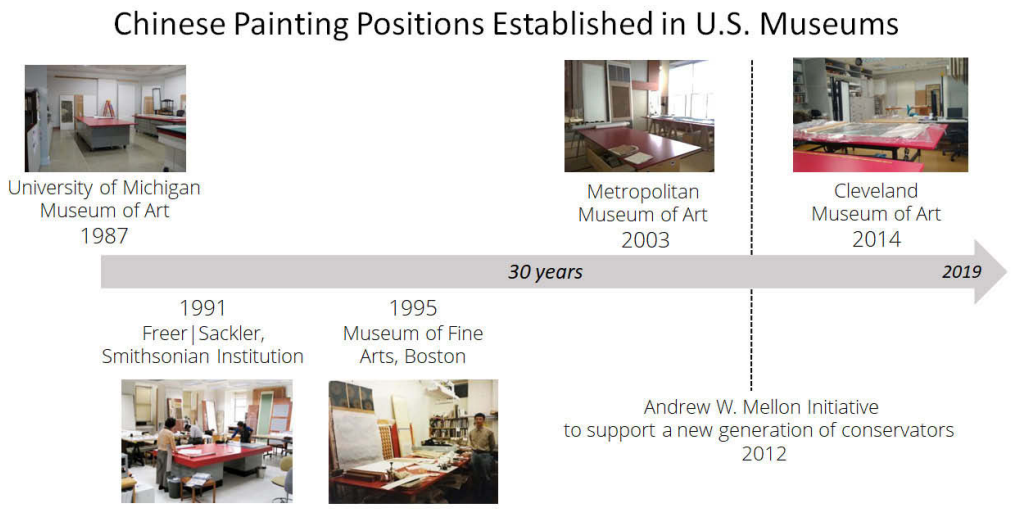

Fig. 1. Timeline of Chinese painting conservation positions established in US institutions

DESCRIPTION AND CONDITION OF THE PAINTING

The Qing Dynasty painting depicts a male figure, presumably a high-ranking Manchu official, seated on rocks under the shade of a flowering tree near a winding stream. The overall dimensions are roughly 6 ft. wide by 3 ft. tall. The image is painted using Chinese watercolors on a coated Chinese paper with thick, long fibers. Pink-colored paper borders surround the painting. On the verso, there are inscriptions along the corners and margins written in pencil and ink. The painting was rolled for storage.

The initial condition of the painting was poor (fig. 5). The laminate structure is considerably thick, stiff, and difficult to handle. There are extensive vertical creases throughout. The surface appears slightly soiled with a few small stains and fingerprints. There are light brown stains left of the figure and around the shoulders. The painting had been remounted previously, as seen from several old vertical and horizontal breaks

Fig. 2. Man Seated Outdoors ["Su Chun"], China, Qing Dynasty, 1644–1911, ink and color on paper, H × W (painting): 85.6 × 157.7 cm, H × W (with mounting): 100.3 × 189.5 cm, Freer|Sackler, S1991.131

Fig. 3. Chinese painting conservation studio (Shanghai Museum in 2007), materials, and tools

that were poorly realigned, exposing visible gaps between the cracks. On the verso, the backing paper shows minor foxing and a large water stain along the bottom edge. The paint layer appears stable, but the heavier pigments are cracked, abraded, and lost in some areas. The blue robe is abraded, and areas of old repairs are crudely retouched. The blue pigment has transferred to the outer edges of the robe and is visible on the verso from rolling. Some of the dark pink petals show bleeding from a previous mounting campaign.

CONSERVATION TREATMENT COMPARISON

Does this painting need to be remounted or can it be stabilized using remedial treatment? Before answering this question, unique characteristics of remounting Chinese paper paintings are highlighted (fig. 6). These treatment steps are water based and traditionally carried out in a specific sequence before work can stop: (1) washing, (2) stain reduction, (3) disassembly by removal of backing papers, (4) infill of losses, (5) application of new lining paper, and (6) infill of remaining losses.

For a Chinese painting conservator, this painting would be completely remounted. The structural integrity of the painting is lost and can be restored only after remounting with new materials. Only one paper conservator suggested complete remounting. All others offered remedial intervention, using controlled moisture, and selective removal and addition of backing layers. This article will discuss the differences between the author's approach and those of her Western paper colleagues for applicable steps.

Documentation and Scientific Analysis

First, treatment began with examination and documentation. Accurate documentation and justifiable application of scientific analysis are fundamental to Western practice. However, for conservation of Chinese paintings, written documentation is often secondary to treatment.[1] Prior to treatment, scientific analysis or use of a stereomicroscope for examination were not applied. In Chinese painting conservation, close examination typically is done with a magnifying glass. Scientific examination is a recent development in Chinese art conservation, with limited overlap in the work of the conservator and

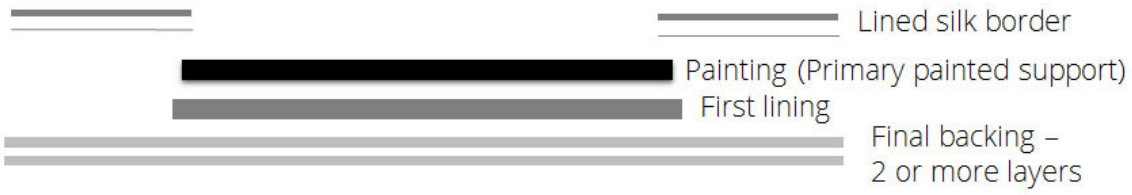

Fig. 4. Cross sectional view of laminate structure of a standard mounted Chinese painting

Fig. 5. S1991.131 painting in raking light showing severe creasing

scientist. In contrast, all paper colleagues cited routine use of the stereomicroscope.

Surface Cleaning

The painting was not surface cleaned. The initial step of surface cleaning, common in Western practice, is not applied routinely to Chinese paintings, primarily because it is not seen as a necessary step if the painting will be washed. Chinese papers have soft, short fibers that easily can be abraded when rubbed, and therefore surface cleaning should be considered carefully. In contrast, most Western papers can stand up to tools suggested the author's paper colleagues, such as a soft cloth, cosmetic sponges, grated eraser crumbs, soot sponge, and vinyl erasers.

Consolidation

In remounting, routine consolidation of sensitive pigments is necessary to fix colors to withstand aqueous treatment. The blue, green, and dark pink colors transferred when rolled with a damp cotton swab. These areas were consolidated with a 1% solution of animal glue, traditionally cow bone, using a brush. Animal glue is the binder in Chinese watercolors,

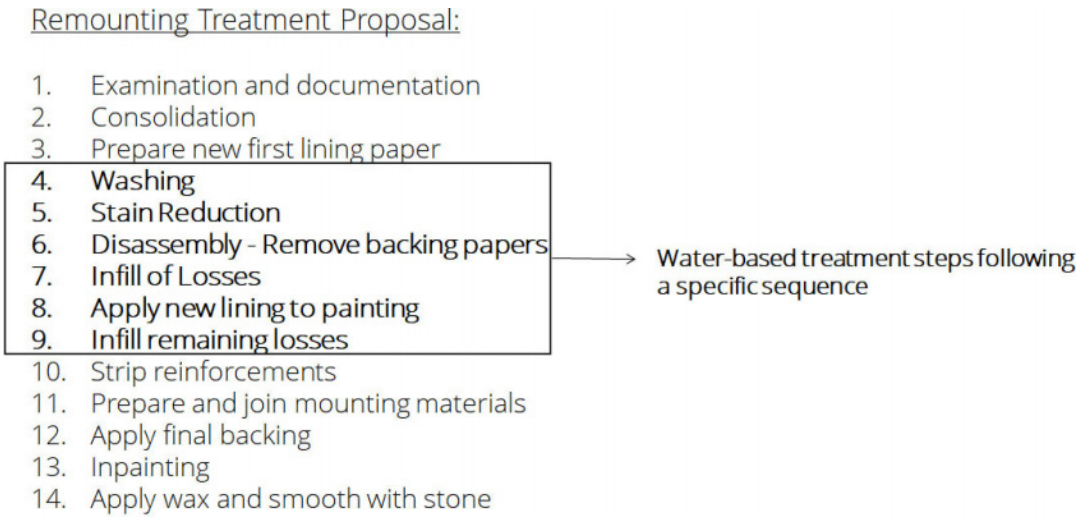

Fig. 6. Comparison of conservation treatment approaches for S.1991.131

and the tradition has been to consolidate using the original binding medium.

None of the paper colleagues proposed animal glue as a consolidant, because it shrinks, yellows on aging, and can discolor and create a shiny surface on the paint layer. Their preferred consolidants include isinglass and funori, and one suggested Klucel G in ethanol or acetone—all applied with a nebulizer or ultrasonic mister to avoid disrupting the surface of the paint layer. Their selection of consolidants was more nuanced than the traditional Chinese approach. Consolidants are chosen based on characteristics like strength, surface appearance, viscosity, flexibility, aging properties, and sensitivity to moisture, not necessarily on their ability to withstand water treatment. If pigments were too sensitive for aqueous treatment like washing, the paper conservators would adjust their treatment approach, applying alternate techniques such as the use of a suction table, blotter washing, or treatment options without water.

At the Freer|Sackler, funori is used on Chinese paintings, typically in combination with wheat starch paste for minor repair, and less as a consolidant considering that it lacks the durability of animal glue. Animal glue is a tried and true material that appears to withstand the repeated rolling of Chinese paintings. However, further study on consolidants is needed with respect to traditional treatment practices and the inherent function of Chinese paintings. For now, traditional techniques are reliable, but these could be challenged in light of other areas of conservation.

Preparation of the First Lining

Before further treatment of the painting, a new first lining must be prepared that is colored a shade lighter than the background of the painting. The color of the lining paper is important because it can affect the overall color tone of the painting. The author used Chinese *xuan* paper and colored it with Chinese watercolors using a large bush known as a *paibi*. Multiple sheets were colored to form a layered stack and each sheet hung to dry.

Aqueous Treatment

For the next step, the painting is washed with liberal application of water. During remounting of a painting, this aqueous treatment is necessary to remove surface dirt and degradation products and soften the paste between the layers of the painting so that the backing papers can be removed. This step is routine and considered essential with any risk to the artwork as an acceptable consequence. Traditionally, warm to hot water is used. The *paibi* brush is used to carry water onto the painting, covering the entire surface. A soft cotton cloth is placed flat over the surface and rolled from the center outward to flatten the painting and absorb excess water (fig. 7). The process is complete when water rung from towel appears clear. The author followed the preceding steps but used a dahlia sprayer for greater control and to protect the surface coating, despite having consolidated the sensitive pigments.

All paper colleagues suggested gentler and selective humidification, using humidity chambers or Gortex, locally and/or overall, at one point or during several stages of a treatment, combined with pressure drying to address creases and deformation. Use of different humidification techniques allows one to monitor the sensitivity of the pigments and the differential expansion of the backing layers and borders as moisture is introduced. For many, the goal was to help return the painting to its original flat state, using conservative intervention with gradual introduction and minimum moisture, not to completely disassemble the painting. This level of control provides for safer and alternative treatment options when necessary. However, although these alternative approaches should be considered and investigated, they may not be appropriate considering that it is challenging to account for the multilayered, complex structure of a mounted painting.

Stain Reduction

Stain reduction typically occurs during aqueous treatment. The author chose not to treat the stain beyond washing. For Chinese paintings, more experimentation is needed with respect to stain reducing agents and methods of application beyond using water at different temperatures and chemicals like hydrogen peroxide, which she did not find necessary to use on this painting. The paper colleagues either proposed leaving it alone or using deionized water at varied pH, temperature, and conductivity; poultices and gels; and chelating agents like dibasic ammonium citrate. This is an area where further research and testing could be explored.

Removal of Backing Layers

After washing, the backing layers were removed using tweezers and fingertips, and exposed areas were covered with damp towels to retain moisture. Backing layers were removed to the primary painted support. Work was performed on a red lacquered table to increase contrast between the layers being removed. This step took three conservators several hours to complete (fig. 8). If the paper colleagues were to attempt removal of backing layers without washing, they suggested local humidification or use of agarose gels or gellan gum squares to facilitate separation or thinning down of the paper.

Preparation of Paste

Both wheat flour and wheat starch are used to make paste in China, but flour tends to be preferred. The gluten and small amounts of alum have raised questions among Western

Fig. 7. A soft cotton terry cloth used to absorb water during aqueous treatment

conservators about its stability. For this reason, US-based Chinese conservators switched to wheat starch paste, but some have returned to flour because of its favorable working properties despite remaining questions on re-treatability, remounting, flexibility, and insect and microbial attack. This raises the following questions. Can the linings be separated easily in subsequent remountings? Is the paste flexible and durable enough to withstand repeated flexing of the support from rolling and unrolling? Does addition of alum have beneficial effects like protect the painting from insect and microbial attack and mitigate reactivity to environmental conditions?

Infill of Losses

This is the verso of the painted support after removal of the backing layers and before application of paste (fig. 9). Lost areas in a painting are patched using two methods. The first is to apply the infill directly to the loss. The second is to apply infills immediately after adhering the first lining paper. Application of these methods depends on the extent of damage, the size of the losses, and ability to match the paper characteristics of the painted support. Chinese paper is workable when wet, allowing infills to be shaped with a small knife in a short amount of time.

As mentioned previously, the blue robe exhibited extensive repair and retouching. During lining removal, a very thin paper applied during a previous remounting was discovered, covering the area of the figure. That repair was left in place because removal would have been difficult and risked loss of original material. Discerning when to remove old repairs is paramount in treating Chinese paintings and comes with experience. Old infills found in other areas were removed and replaced.

Application of the First Lining

Because the painting is large, the lining was applied in two sections so that the paste would not dry out and for easier handling of the damp lining paper. The wooden stick in figure 10 indicates where the lining paper was folded back. Diluted paste was brushed across half of the verso of the painted support and the lining paper brushed in place. A dry sheet of Chinese paper was used to absorb excess moisture and serve as a barrier for more forceful brushing to ensure contact between the layers. After lining, the remaining infills were applied.

The author's paper colleagues proposed applying the paste to the lining paper, not the painted support. Traditional Chinese thinking follows that paste applied to the painted

Fig. 8. Xiangmei Gu, Zhichao Lyu, and Grace Jan removing lining papers from the back of the painting

support will reinforce or add strength to the paper and paint layers and promote adhesion along broken edges and cracks. The essentially irreversible practice of reimpregnating the painted support every time it is remounted warrants further research to understand the different adhesives used for the paste layer and consolidation.

Strip Reinforcements

Next, strip reinforcements were applied to the verso of the painting to stabilize the creases. Different thicknesses of Chinese *xuan* paper and Japanese *mino* paper that were precut into narrow strips were pasted and applied to the creases (figs. 11a, 11b). For shallow creases, one layer of paper

Fig. 9. Verso of painted paper support

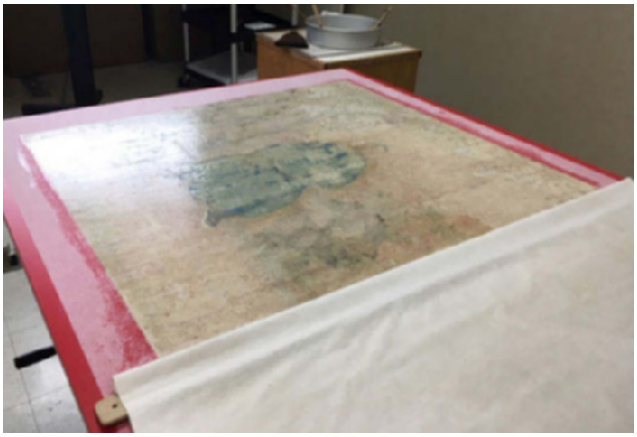

Fig. 10. Application of the first lining paper

Fig. 11. (a) Chinese *xuan* paper and Japanese *mino* paper used for strip reinforcements. (b) Application of strip reinforcements.

provided enough support, but for deep creases, two or three layers of paper were used for extra support. Japanese papers have longer fibers and are made in a broader range of thicknesses, providing more options for a very thin but strong paper that does not add bulk to the surface. The treated painting had more than 100 strip reinforcements.

One paper colleague proposed the minor treatment technique of applying strip reinforcements of Japanese *kozo* paper to the back of the mounting after humidification and flattening of the painting. However, this technique may cause additional damage and must be applied with caution because successful strip reinforcements depend on the conservator's ability to use appropriate papers and paste consistency. Other colleagues suggested a new lining using Japanese paper to strengthen the overall painting instead of local reinforcement. Generally, Western paper conservators are more familiar with Japanese papers, and few, if any, have used Chinese papers. Japanese papers are not always appropriate for Chinese paintings and should only be applied based on a knowledge and understanding of Chinese mounting.

Mounting Materials

The color and style of mounting materials are traditionally chosen by the conservator. In this case, the curator was consulted, and the pink paper borders were replaced with silk borders having a bird pattern. A piece of the old mounting was kept as historical documentation. Preparation of mounting materials requires basic mounting techniques and careful selection of appropriate silks and papers.

Mountings traditionally were viewed as having little historic value, except for borders with artists' or collectors' seals. They were often discarded after being remounted, and most of them today are not original. This treatment of Chinese mounting materials is comparable to how mounts, mats, and frames for Western works of art on paper were once disregarded.

Final Backing

After the silk borders were joined to the painting, the final backing was attached. For the backing paper, two sheets of *xuan* paper were adhered together in advance to form a double layer. Traditionally, the final backing is two or three layers depending on the size, format, and level of support needed for the painting. It is applied in a similar manner as the previous first lining paper, but diluted paste is applied to the final backing paper. After the lining was attached, the painting was partially air-dried and then adhered to the drying wall with paste applied along its outer edges. Use of the drying wall remains the most common method for drying paintings (fig. 12).

Inpainting

Once the painting was attached to the drying wall, it was inpainted using traditional Chinese pigments. Most Chinese pigments are purchased as small square chips that are already bound with animal glue, and they require hot water to solubilize. Mineral pigments such as azurite and malachite are sold as loose pigment particles and are mixed with animal glue before using. A principle of Chinese painting conservation is that the repair should not be detectable when looking from four different directions. This inability to distinguish the original work from restored areas can be problematic in Western conservation. New infills, old repairs that were not removed, and abraded areas, particularly on the robe of the figure, were inpainted.

For the robe, the author exercised discretion, reintegrating the paint layer using Chinese azurite in animal glue, and where azurite could not mask previously darkened repairs, she used Western watercolors with a broader selection of color options. It would be difficult to distinguish these areas because the author used traditional pigments similar to the original and retouched abraded areas that can be difficult to document accurately (figs. 13a, 13b).

Fig. 12. Remounted painting attached to the drying wall

Fig. 13. (a) Before inpainting. (b) After inpainting.

The paper colleagues approached damaged media in a variety of ways, including infilling or disguising areas with cellulose powders, and inpainting with watercolors or pastels using an isolating layer such as methyl cellulose. They advised against inpainting abraded areas and emphasized the need for accurate documentation. The principle of reversibility with respect to loss compensation guides Western conservators in the decision to use detectable materials that are different from the original, to not inpaint on original surfaces, and to document as much as possible to preserve the integrity and history of the artwork. In contrast, the principle of reversibility or re-treatability is not established in Chinese painting conservation.

After Treatment

Finally, the painting was removed from the drying wall, the verso coated with a light application of wax, traditionally from the lac bug found in Sichuan Province, and the back smoothed with a stone to compress and soften the layers. This step, which restores flexibility to the scroll, was still carried out despite the decision to house the painting flat.

CONCLUSION

Overall, this process helped the author crystalize the fundamental differences in the approaches of Chinese and Western paper conservation practices, which she has been examining throughout her career. Most notable was a divergence in protocol. The conservation and remounting of Chinese paintings take tremendous skill, experience, and specialized tools and techniques that have been developed over time. Traditional methods are time sensitive, and the wet conditions increase the risk of damage to the paper, media, and adhesives. It may require several hours and additional hands to complete these steps before work can stop. In contrast, the workflow in Western paper conservation implements a treatment plan that carefully incorporates stopping points or off-ramps between steps to check that the treatment is progressing appropriately.

More nuanced were differences in treatment goals, materials, and the role of the conservator. Chinese practice focuses more on restoring a painting's beauty and how that contributes to its historic value. For example, a painting could be given a new mounting because it complements or frames the painting and plays a functional role in handling the artwork. Western practitioners, in hesitating to remove old materials and mask losses and damage, focused more on the role of the conservator to balance artistic and historic values and create a record of where the conservator and time have been.

This exercise emphasized that Chinese practice could be more transparent and flexible with their treatment decisions to meet the individuality of the object and requires a clear understanding of techniques and materials, not a simple dependence on tradition. This understanding could be refined through the integration of traditional training and practice with more scientific approaches.

Currently, the field of Chinese art conservation is undergoing evolution and progress in China and Taiwan, and their inclusion in our dialogue will allow us to continue to protect and preserve our collections. This, in turn, will support a new generation of conservators, both international and domestic, to embrace Western conservation techniques while maintaining the values of traditional Chinese painting conservation. The means to this end are not simple, especially given the relative scarcity of institutional positions that can support this kind of care. But individuals trained in both cultures can provide a bridge that helps consult, train, and inform other conservators and caretakers to address these needs. This is an ideal forum for this dialogue and discussion to occur. In response to this article, the author welcomes and appreciates any further discussion, questions, and input.

ACKNOWLEDGMENTS

The author thanks her fellow colleagues in conservation and scientific research at the Freer|Sackler, the Smithsonian's museums of Asian art, for their input and support, particularly Xiangmei Gu and Zhichao Lyu for their assistance on the treatment of the painting. Special thanks to Rebecca Capua, Soko Furuhata, Amy Hughes, Erin Jue, Kerith Koss, Mary Oey, and Annie Wilker for their collaborative effort by sharing their expertise and time in helping to make this a rewarding exercise.

NOTE

1. With respect to works of art on paper, China's National Cultural Heritage Administration (2010) established the following protocols for standardizing documentation:

- 馆藏纸质文物保护修复方案编写规范 [Specifications for compilation of conservation and restoration plan of paper collection]
- 馆藏纸质文物病害分类与图示 [Classification and legends of the diseases of paper collection]
- 馆藏纸质文物保护修复档案记录规范 [Specification for recording of conservation and restoration archives of paper collection]

However, there is not uniform adoption of these protocols across museums.

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Heat- and Solvent-Set Repair Tissues

Precoated heat- and solvent-set tissue has a long history of use at the Library of Congress (LC) and the National Archives and Records Administration (NARA). It is the preferred method for mending certain types of library and archival materials due to its translucency and ability to be applied with ease, speed, and consistency. Because it does not require moisture for activation, it is useful for mending tracing paper, brittle wood pulp paper, mold-damaged paper, and other water-sensitive items.

In 2013, LC was informed that adhesives used for many years to make the "Library of Congress Heat Set Tissue" were no longer available. LC and NARA began collaboration on a joint research project to identify replacements. Initial research results were presented in the 2015 AIC presentation, "Heat-Set Tissue: Finding a Practical Solution of Adhesives." Mixtures of Avanse MV-100 and Plextol B500 were identified as possible replacements that would continue to be tested at both institutions. Concerns were raised when it was later discovered that some of the adhesives had turned brown after being stored at ambient conditions. The history of conservation adhesives is unfortunately plagued with discontinued products and changing formulas. Finding the correct combination and dilution of adhesives is a tricky balancing act: the adhesives must remain flexible and strong enough to ensure good adhesion, yet they must be readily reversible, not cause blocking, and pass analytical testing.

NARA and LC performed joint testing of a variety of precoated tissues made with Lascaux 498 HV, Lascaux 303 HV, Avanse MV-100, Plextol B500, Aquazol 200, and Aquazol 500. Prepared tissues were applied to substrates using both solvent- and heat-set methods. Testing assessed color change and reversibility after artificial aging, blocking of mends and fills after natural aging under pressure, and the adhesives' interaction with silver-based photographic materials. The method of application—heat or solvent—did not affect results. The Avanse-Plextol tissues failed the color change tests and exhibited some other concerning characteristics. The six successfully tested mixtures were 1:4 Lascaux 498 HV: water (L1:4); 1:1:2 Lascaux 498 HV : 0.25% methylcellulose: water (Lm1:1:2); 1:1:1:1 Lascaux 498 HV : 0.25% Klucel G: 0.25% methylcellulose : water (Lkm1:1:1:1); 3:2:8 Lascaux 498 HV : Lascaux 303 HV : water (LL3:2:8); 10% solution of Aquazol 200 in water; and 5% solution of Aquazol 500 in water.

Based on these results, both institutions have begun to use the new and modified adhesive mixtures while discontinuing their use of Avanse-Plextol. Several case studies were presented involving L1:4, LL3:2:8, and the two Aquazol solutions, and recommendations were given for ongoing quality assurance testing.

This report was presented as two presentations, "Analytical Testing of Heat and Solvent Set Repair Tissues" in the Photographic Materials Group Session and "Use of Heat and Solvent Set Repair Tissues" in the Book and Paper Group Session, at AIC's 47th Annual Meeting, May 13–17, 2019, in Uncasville, Connecticut. The authors intend to submit the two presentations as a single paper to the *Journal of the American Institute for Conservation* in the near future.

Handout from "Use of Heat and Solvent Set Repair Tissues"
National Archives and Records Administration and Library of Congress Adhesives Research Team
Book and Paper Group Session, AIC's 47th Annual Meeting, May 17, 2019, Uncasville, Connecticut

Lascaux 498 HV Tissue (1:4 in water)

Materials and Tools

- Lascaux 498 HV
- Deionized water
- Silicone-release Mylar
- Kozo tissue, 5–9 gsm
- 3-in. Hake brush

Prepare adhesive mixture: A 1:4 volume-to-volume mixture of Lascaux 498 HV to water was found to produce a good precoated tissue for mending paper. Use the displacement method for measuring the thick, viscous Lascaux 498 HV: Fill a 250 mL beaker with 200 mL of deionized water, then add Lascaux 498 HV to bring the contents up to the 250 mL mark. Mixing the solution for 10 to 15 minutes using a magnetic stirrer gives the best results, but stirring slowly with a glass rod is fine. Avoid shaking, as this will introduce bubbles.

Papers presented at the Book and Paper Group Session, AIC's 47th Annual Meeting, May 13–17, 2019, Uncasville, Connecticut

Precoating: Precut tissue to be 2 in. smaller than silicone-release Mylar. Label with formula, tissue, and date made. Work on a dark surface. Lay tissue on silicone-release Mylar and gently brush adhesive mixture through the tissue with the "Union Jack pattern" followed by parallel stripes. Let dry thoroughly.

The silicone-release Mylar is reusable if excess adhesive is cleaned up with blotter while it is still wet. Tissue can be stored on the silicone-release Mylar until ready to use, or removed and stored between sheets of silicone-release paper.

Applying with heat: Cut out pieces with scissors or a scalpel. Apply the tissue to the tear adhesive side down. Lightly touch the tissue with the bare iron to position and secure it. Place silicone-release paper over the mend. Apply heat for about 5 seconds, through silicone-release paper, using a tacking iron set to about 110°C to 120°C. Set under weight, such as a small Plexiglas square, until cool.

Applying with ethanol: Saturate a 3 × 5 in. piece of thick blotter with ethanol and place in a polyester sleeve. Cut piece of coated tissue for mend. Pick up tissue with tweezers, lift cover of polyester sleeve, and gently touch the adhesive side of tissue to blotter. Quickly close the polyester cover over the tissue and gently apply pressure over length of mend. Remove tissue from ethanol/blotter packet. Using too much solvent washes the adhesive away. Apply the tissue to the tear adhesive side down. Place polyester webbing on top of the mend and press with Teflon folder. Let dry under blotter and weight.

Handout from "Use of Heat and Solvent Set Repair Tissues"
National Archives and Records Administration and Library of Congress Adhesives Research Team
Book and Paper Group Session, AIC's 47th Annual Meeting, May 17, 2019, Uncasville, Connecticut

Lascaux 498 HV : Lascaux 303 HV Tissue (3:2:8 in water)

Materials and Tools

- Lascaux 498 HV (60 mL)
- Lascaux 303 HV (40 mL)
- Deionized water (160 mL)
- Silicone-release Mylar
- Kozo tissue, 5–9 gsm
- 3 in. Hake brush

Prepare adhesive mixture: A 3:2:8 volume-to-volume mixture of Lascaux 498 HV, Lascaux 303 HV, and water was found to produce a good precoated tissue for mending paper. Use the displacement method for measuring the thick, viscous Lascaux 303 and 498: Fill one beaker with 80 mL of deionized water, then add Lascaux 498 to bring the contents up to the 140 mL mark. Fill another beaker with 80 mL of deionized water and add Lascaux 303 to bring the contents up to 120 mL. Combine both beakers into one jar and mix the solution for 10 to 15 minutes using a magnetic stirrer for best results, but stirring slowly with a glass rod is fine. Avoid shaking, as this will introduce bubbles.

Precoating: Precut tissue to be 2 in. smaller than silicone-release Mylar. Label with formula, tissue, and date made. Work on a dark surface. Lay tissue on silicone-release Mylar and gently brush adhesive mixture through the tissue with the "Union Jack pattern" followed by parallel stripes. Let dry thoroughly.

The silicone-release Mylar is reusable if excess adhesive is cleaned up with blotter while it is still wet. Tissue can be stored on the silicone-release Mylar until ready to use, or removed and stored between sheets of silicone-release paper.

Applying with heat: Cut out pieces with scissors or a scalpel. Apply the tissue to the tear adhesive side down. Lightly touch the tissue with the bare iron to position and secure it. Place silicone-release paper over the mend. Apply heat for about 5 seconds, through silicone-release paper, using a tacking iron set to about 110°C to 120°C. Set under weight, such as a small Plexiglas square, until cool.

Applying with ethanol: Saturate a 3 × 5 in. piece of thick blotter with ethanol and place in a polyester sleeve. Cut piece of coated tissue for mend. Pick up tissue with tweezers, lift cover of polyester sleeve, and gently touch the adhesive side of tissue to blotter. Quickly close the polyester cover over the tissue and gently apply pressure over length of mend. Remove tissue from ethanol/blotter packet. Using too much solvent washes the adhesive away. Apply the tissue to the tear adhesive side down. Place polyester webbing on top of the mend and press with Teflon folder. Let dry under blotter and weight.

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Aquazol 200 / Aquazol 500 Tissue

Materials and Tools

- Aquazol 200 or Aquazol 500
- Deionized water
- Silicone-release Mylar
- Kozo tissue, 5–9 gsm
- 3 in. Hake brush

Prepare adhesive mixture: Aquazol comes as white to yellow chunks of crystal. It dissolves in water, but slowly. Aquazol 500 is a larger molecule and produces a more viscous solution in

water than Aquazol 200 at the same proportion. A 10% solution of Aquazol 200 and a 5% solution of Aquazol 500 were both found to produce a good precoated tissue for mending paper:

— Aquazol 200, 10% (w/v) solution in water: Place 10 g of the crystals into ~60 mL of deionized water.
— Aquazol 500, 5% (w/v) solution in water: Place 5 g of the crystals into ~60 mL of deionized water.

Allow to dissolve and then increase the volume of water until the total volume of the solution is 100 mL. Agitation helps, but it is best to prepare the solution a day or two before preparing the tissue.

Precoating: Precut tissue to be 2 in. smaller than silicone-release Mylar. Label with formula, tissue, and date made. Work on a dark surface. Lay tissue on silicone-release Mylar and gently brush adhesive mixture through the tissue with the "Union Jack pattern" followed by parallel stripes. Let dry thoroughly.

The silicone-release Mylar is reusable if excess adhesive is cleaned up with blotter while it is still wet. Tissue can be stored on the silicone-release Mylar until ready to use, or removed and stored between sheets of silicone-release paper.

Applying with heat: Cut out pieces with scissors or a scalpel. Apply the tissue to the tear adhesive side down. Lightly touch the tissue with the bare iron to position and secure it. Place silicone-release paper over the mend. Apply heat for about 5 seconds, through silicone-release paper, using a tacking iron set to about 95°C. Set under weight, such as a small Plexiglas square, until cool.

Applying with ethanol: Saturate a 3 × 5 in. piece of thick blotter with ethanol and place in a polyester sleeve. Cut piece of coated tissue for mend. Pick up tissue with tweezers, lift cover of polyester sleeve, and gently touch the adhesive side of tissue to blotter. Quickly close the polyester cover over the tissue and gently apply pressure over length of mend. Remove tissue from ethanol/blotter packet. Using too much solvent washes the adhesive away. Apply the tissue to the tear adhesive side down. Place polyester webbing on top of the mend and press with Teflon folder. Let dry under blotter and weight.

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Legacy Versus Losses in Hedda Sterne's Complex Monotypes

INTRODUCTION

Since 2010, the Artist-Endowed Foundation Initiative of the Aspen Institute has been conducting research on the emerging field of artist-endowed foundations. According to the Initiative's 2018 supplemental study, there are 433 artist-endowed foundations in the US today. This number increased rapidly from just 261 recognized foundations in 2010. Furthermore, the field's assets have soared by 120%, from $3.48 billion in 2011 to $7.66 billion in 2015 (Vincent 2018). With the exceptional growth of artist-endowed foundations, there is an increasing demand for conservators to meet the needs of foundation collections, which often extend beyond treatment to include media identification, materials research, rehousing, and collections care. Collaboration with the Hedda Sterne Foundation presented a unique treatment case study and catalyzed this research surrounding the ethics of loss compensation on works belonging to an artist-endowed foundation.

Best recognized as the lone woman among the Irascibles in a 1950 image from *Life* magazine, Romanian-born Hedda Sterne (1910–2011) became a leading American artist of the 20th century, both on canvas and on paper. Although often exhibited with Surrealists and Abstract Expressionists, Sterne did not want to be identified as belonging to any particular artistic group (Eckhardt 2006). Six works on paper dating from 1947 to 1950 were brought to the Conservation Center, Institute of Fine Arts, New York University, for treatment in the spring of 2018. The works presented numerous conservation issues, including losses, tears, tape, adhesive stains, and inappropriate backings. Because little is known about Sterne's creation of these complex monotypes, key articles in the conservation literature on ethical treatment decisions were consulted and served as a model for developing a treatment approach.

Publications that began to codify treatment ethics and methodology were introduced in the mid-20th century. Noteworthy publications include Max Schweidler's *The Restoration of Engravings, Drawings, Books and Other Works on Paper* (2006) and "Ethics in Paper Conservation" by Arthur David Baynes-Cope (2014), first published in 1938 and 1982, respectively. The Committee on Professional Standards and Procedures within the IIC-American Group, the forerunner of AIC, drafted the first documents that would become *The Code of Ethics and Guidelines for Practice* (AIC 1994) at their second meeting in May 1961. Paper conservators have since continued to debate the ethics behind treatment practices. In "The Practice of Looking in Paper Conservation," Irene Brückle (2001) articulates that often the effort to establish an ideal appearance is at odds with the ideal state of preservation. More recent publications expanding on the discussion of ethics include *Conservation Treatment Methodology* by Barbara Appelbaum (2007) and *Retouching of Art on Paper* by Tina Grette Poulsson (2008). Although these are only a select few of the numerous publications on the subject, all of the authors recognize a degree of subjectivity in the conservator's decision-making process and that notions of appropriate intervention continue to evolve within the field.

The conservation literature provided a framework within which to make treatment decisions; however, in practice, conservators do not make decisions in a vacuum. Whether in museums, libraries, archives, or private practices, conservators collaborate with curators, collectors, collections care staff, and numerous others, not only with respect to treatment decisions but also with regard to the technology of the works, storage recommendations, and display parameters. All of these operations are conducted in settings with different sets of goals or official missions. A private collector may bring an artwork to a conservator to improve its aesthetic appearance with the personal goal of continuing its display. The mission of a museum with an expansive, comprehensive, and global collection is quite different, often including active collection practices and efforts to reach a broad, public audience.

Like a museum, artist foundations share a public responsibility and educational mission, but they differ in their specificity and service of the namesake artist. Another factor to consider is that artist foundations occasionally

Papers presented at the Book and Paper Group Session, AIC's 47th Annual Meeting, May 13–17, 2019, Uncasville, Connecticut

sell artwork. The Hedda Sterne Foundation (2019) works toward the mission of "exploring the legacy of the artist Hedda Sterne (1910–2011) and her philosophy of art as a process of engagement and discovery . . . With these collections, the foundation promotes the study of Sterne in the context of her era through the support of exhibitions and scholarship."

In light of the fact that the 20th-century literature on ethics was written at a time when artist-endowed foundations were insignificant, it is interesting to evaluate the more recent ethical recommendations and rubrics in conjunction with the Hedda Sterne Foundation's specific mission. In the 2002 article "The Practicalities and Aesthetics of Retouching: Rationality Versus Intuition," Jane McAusland (2002) poses five guiding questions that served as a starting point for the decision-making process with respect to loss compensation of the double-sided monotypes:

What was the artist's intention?
What is the amount of loss in the sheet, and how great the damage?
What is the position on the sheet of the losses and other damages?
What method of reintegration, if any, should be used in repairing the damages?
What is the artistic, historic, sentimental and/or commercial value of the work to be conserved?

ARTISTIC INTENT AND HISTORICAL CONTEXT

McAusland's initial question of artistic intent prompted several subsequent questions: How are the monotypes understood within Hedda Sterne's greater body of work and artistic practice? Are they studies for larger pieces? Are they experimental works? Were they intended to be shown? Despite a wealth of archival information, the Hedda Sterne Foundation had little information on the role of these works in Sterne's practice, leaving the objects alone and works in other collections as the only evidence to even begin to address artistic intent.

Scientific investigation, including Fourier-transform infrared spectroscopy (FTIR), x-ray fluorescence (XRF), Raman spectroscopy, and fiber-optic reflectance spectroscopy (FORS), was performed on *Untitled (Airplane)* (fig. 1) to answer material-related questions. The binding medium was identified as linseed oil. Although printing ink was considered as a possible medium in the monotypes, Sterne was not experimenting with printmaking at the time and likely would not have had easy access to a wide array of colored printing inks (Shaina Larrivee, pers. comm., spring 2018). These findings support the identification of the media as modern oil paints, easily accessible to the painter.

Reconstruction using modern oil paints on similarly textured papers yielded results resembling Sterne's double-sided works. Oil paint was applied to a matrix, the paper was placed on top, and graphite pencil was applied to the back. Some

Fig. 1. Hedda Sterne, *Untitled (Airplane)*, recto, 1947, monotype, 12-3/8 × 17-1/4 in. The Hedda Sterne Foundation, New York. During treatment. ©The Hedda Sterne Foundation, Inc.|Licensed by ARS, New York, NY.

Fig. 2. Hedda Sterne, *Untitled (Boiler)*, recto, ca. 1949–1950, monotype, 19-1/8 × 13-1/4 in. The Hedda Sterne Foundation, New York. Before treatment. ©The Hedda Sterne Foundation, Inc.|Licensed by ARS, New York, NY.

Fig. 3. Hedda Sterne, *Untitled (Boiler)*, verso, ca. 1949–1950, monotype, 19-1/8 × 13-1/4 in. The Hedda Sterne Foundation, New York. Before treatment. ©The Hedda Sterne Foundation, Inc.|Licensed by ARS, New York, NY.

of the brushwork on the matrix would be transferred to the impression, but the pencil would yield a finer line of oil paint. A detail image of one of Sterne's monotypes, *Untitled (Boiler)* (figs. 2–4), shows the multiple passes or tracings of the graphite pencil drawing in the different printing stages. This use of graphite pencil parallels the process of transfer drawing, which is likely why some collectors have referred to these works as trace monotypes.

Although not typically essential to most treatment approaches, these additional research steps better served the Hedda Sterne Foundation, as specific features of the double-sided sheets could be more thoroughly explained through the reconstruction. For example, after printing, the transparent matrix was exposed where graphite pencil was applied, leaving behind a negative of the drawing in the wet media (fig. 5). At this stage, the matrix could be reused on another sheet, producing negative lines, which is evident in several of Sterne's works.

Many of the monotypes are on thin papers and exhibit extreme topography, indentations and even tears or holes where the sharp pencil punctured the paper during transfer. The use of a variety of low-quality, poorly sized, limp papers suggests that the longevity of these works was not prioritized at the time of their creation. The crude process, use of readily available materials, and selection of poor-quality papers further indicate that these works were likely experimental studies.

Additionally, the boiler image (fig. 2) reappears in another monotype from the RISD Museum and in a 1951 oil painting, *Machine Motor Light Blue*, in a private collection. This suggests that the monotypes may have even played a preparatory role. Nevertheless, results of scientific analysis and reconstruction require interpretation to place these complex monotypes in context. Although supported by objective details, the understanding of these works as experimental remains interpretive and nonconcrete. How does this interpretation influence treatment decisions? If the works are considered exploratory sheets that were tossed around the studio, should losses be considered acceptable?

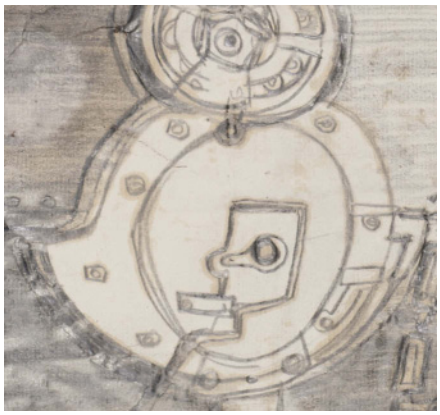

Fig. 4. Hedda Sterne, *Untitled (Boiler)*, verso detail, ca. 1949–1950, monotype, 19-1/8 x 13-1/4 in. The Hedda Sterne Foundation, New York. Before treatment. ©The Hedda Sterne Foundation, Inc.|Licensed by ARS, New York, NY.

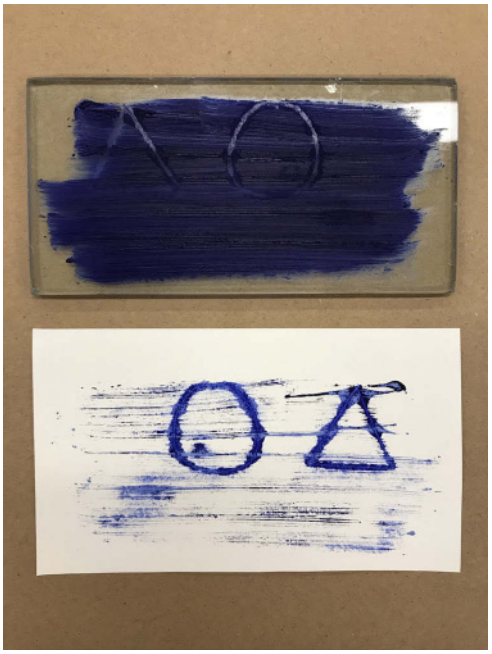

Fig. 5. The monotype reconstruction shows the exposed matrix where the pencil was traced on the sheet, leaving the negative of the drawing. ©The Hedda Sterne Foundation, Inc.|Licensed by ARS, New York, NY.

EVALUATION OF DAMAGE

The second and third questions posed in McAusland's article address the extent and location of the damages to the works on paper. Although most of the monotypes had corner and/or edge losses that did not disrupt the image area or pose significant risk to the object, *Untitled (Boiler)* (fig. 2) had a long rectangular loss in the upper right from the deterioration of tape with a rubber-based adhesive, leaving a delicate narrow strip of paper along the top edge susceptible to loss in the future. *Untitled (Airplane)* (fig. 1) had a very minor loss in the heavily printed black background that may or may not have been present during the printing process.

These examples draw attention to the critical question of the nature of the losses. Are the losses from damage or process? Some of the losses in the monotypes clearly were associated with tape and adhesive damage, but the causes of others remained unclear. Does the nature of the loss influence the treatment approach? Should only losses associated with "unoriginal" damage be filled?

ASSESSMENT OF TREATMENT OPTIONS

McAusland's fourth question asks how losses should be repaired, if at all. This question is the crux of serious ethical debate. At this stage, a conservator may consider the outcomes of the most conservative and the most extensive of interventions. The most conservative approach to the treatment of the monotypes would be to "stabilize" the works, making them safe for handling and display. This would include minimal tear repairs, primarily to the edges of the sheets.

When considering a more extensive alternative, Poulsson's four categories for types of fills may be considered. Poulsson's categories of intervention include "[1] infilling of missing areas in the support; [2] the addition of colour to those fills; [3] the infilling of missing areas of media by direct application of pigments; and [4] the infilling of missing areas of media by application of materials such as pulp or paper overlays, which are toned prior to or after application" (Poulsson 2008). Based on the nature and location of the losses in the Sterne monotypes, the most extensive treatment approach would include [1], [2], and [4]. In this case, all losses, including losses to areas of media, would be filled and toned. Of course, there are varying degrees of action that could be taken between the two extremes. For example, the same steps for filling could be performed only to areas of damage that appear to be unoriginal, such as the loss associated with tape degradation.

When answering McAusland's fourth question, the conservator must not only consider *how many* fills but also *how visible* those fills should be. What kind of paper should be used? Should fills be toned to match the surrounding paper? Should the fills be imperceptible on the verso, as well as on the recto? Historically, Schweidler (2006) created fills so seamless that they are nearly imperceptible to the naked eye. Such undetectable treatment began to be perceived as deceptive or approaching forgery toward the end of the 19th century, as emphasis on the historic over the aesthetic value of artwork increased (Poulsson 2008).

UNDERSTANDING VALUE

It becomes clear that McAusland's fourth question of reintegration methods is inevitably tied to the fifth question: "What is the artistic, historic, sentimental and/or commercial value of the work to be conserved?" Values are not inherent to art objects but assigned to objects by stakeholders. Most often, the primary stakeholder is the owner. However, additional stakeholders include the viewer, the researcher, and the conservator, all of whom may assign different values to the work.

In this case, the primary stakeholder, the Hedda Sterne Foundation (2019), works toward the mission of "[promoting] the study of Sterne in the context of her era through the support of exhibitions and scholarship." In consideration of a treatment plan, Shaina Larrivee, the director of the foundation, emphasized the potential for displaying these works in the future, as well as making them accessible to scholars. Furthermore, mention of artistic intent in the discussion of treatment options with the foundation brought the series of

McAusland's questions full circle. After considering the possible context of the objects and their physical properties, it was the aim of the foundation that was crucial in determining the goal of treatment. It was decided that the tape and adhesive stains would be reduced, the inappropriate and unoriginal backings removed, and all losses filled.

TREATMENT

After removing the backing and disfiguring adhesive from a 1949 untitled monotype on extremely thin paper (figs. 6, 7), the liveliness and opacity of the paper returned to the work. Loss compensation was performed with a thin, antique laid paper of similar thickness and texture, toned with watercolors and shaped to fill the losses. After their placement, further toning was performed on the fills with pastel powder to continue the subtle pattern of the laid lines, caused by the translucency of the original paper. The treatment not only reduced the distraction of the losses but provided greater strength and stability to the overall sheet (fig. 8).

This approach was implemented for the majority of the losses to the monotypes. All of the toned fills were prepared such that the recto and verso of the fill matched the recto and verso of the surrounding paper. Acknowledging the fact

Fig. 7. Hedda Sterne, *Untitled*, recto, 1949, monotype, 12-1/2 x 8-3/4 in. The Hedda Sterne Foundation, New York. During treatment. ©The Hedda Sterne Foundation, Inc.|Licensed by ARS, New York, NY.

Fig. 6. Hedda Sterne, *Untitled*, recto, 1949, monotype, 12-1/2 x 8-3/4 in. The Hedda Sterne Foundation, New York. Before treatment. ©The Hedda Sterne Foundation, Inc.|Licensed by ARS, New York, NY.

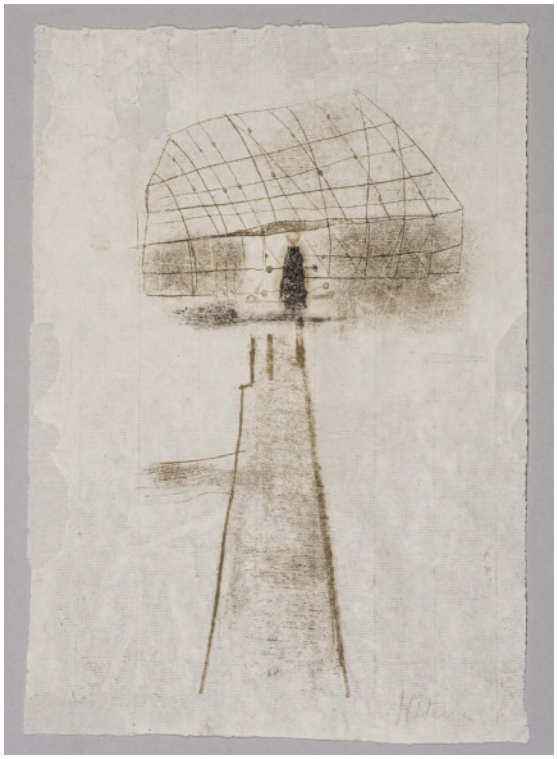

Fig. 8. Hedda Sterne, *Untitled*, recto, 1949, monotype, 12-1/2 x 8-3/4 in. The Hedda Sterne Foundation, New York. After treatment. ©The Hedda Sterne Foundation, Inc.|Licensed by ARS, New York, NY.

Fig. 9. Hedda Sterne, *Untitled (Airplane)*, recto detail, 1947, monotype, 12-3/8 x 17-1/4 in. The Hedda Sterne Foundation, New York. During treatment. The minor loss is marked with a circle. ©The Hedda Sterne Foundation, Inc.|Licensed by ARS, New York, NY.

that both sides are equally important when considering process and that either side may be displayed, it was decided not to preference one side from another, as much as possible. When necessary, reinforcing mends were adhered to the side with the drawing or what has been referred to as the verso.

Only one work, *Untitled (Airplane)* (fig. 1), had a very minor loss in an area of media. The loss was located in the heavily printed black background in the upper right (fig. 9). Although black media spatter immediately adjacent to the loss on the verso suggested that the loss may have been extant during printing, it remained uncertain whether the loss occurred before or after the creation of the work because there was extensive black media spatter throughout the verso. Despite this uncertainty, the loss was filled due to its proximity to the edge of the sheet and potential for further damage. India ink was applied to the recto side of the toned paper fill to match the surrounding media, and graphite pencil was applied to continue the lines on the verso.

In the case of *Untitled (Airplane)*, it is interesting to consider Keiko Keyes' different approaches to color compensation for printed lines versus drawn ones. In "The Unique Qualities of Paper as an Artifact in Conservation Treatment," Keyes (1978) wrote that she would not perform compensation of drawn lines because of their personal nature. In contrast, Keyes would often continue a lost line on a fill for a print because multiple copies of the print were often available.

In the case of the monotypes, the printed lines correspond directly to personal, drawn lines, and each print is unique. This is a reasonable argument against the treatment decision that was made. Instead, it was viewed as more important to integrate the fill in *Untitled (Airplane)* to achieve the uniformity of the background and not draw attention to the loss. This example demonstrates that even the smallest of fills can present large ethical dilemmas and debates.

CONCLUSION

In filling and toning the losses such that the images were not disrupted, the artistic value of the work was given upmost importance. The historic value, however, was not neglected. Although several treatment steps were irreversible, such as removal of old adhesive, thorough documentation was performed, and all of the fills can be easily removed, if desired.

As artist-endowed foundations continue to grow and their collections receive greater attention, collaboration with conservators will also continue to expand. As the mission of the Hedda Sterne Foundation differs from that of traditional museums and institutions, this collaboration presented an interesting case study in which to consider the ethics of loss compensation. Examination of this unusual, lesser-known body of double-sided works raised numerous questions surrounding the extent of treatment and appropriate display that led to a survey of the past and recent conservation literature on ethics, and posing McAusland's questions provided a framework within which to make appropriate treatment decisions. The decision to reduce the distraction of the losses allows each print to be appreciated as a unified whole and forwards the mission of the foundation to promote Sterne's legacy through exhibitions and scholarly research.

ACKNOWLEDGMENTS

This project would not have been possible without the generous contributions of the George Stout Grant, the Foundation

for Advancement in Conservation, and the Antoinette King Fellowship. The author would like to thank Shaina Larrivee of the Hedda Sterne Foundation, Margaret Holben Ellis and Kevin Martin of the Conservation Center, Institute of Fine Arts, New York University, for their continued support of this research.

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KYLA UBBINK

Unconventional Uses of Conventional Treatments: Three Case Studies in Paper Conservation

INTRODUCTION

As Brené Brown asserts, "Vulnerability is the birthplace of innovation, creativity and change" (Walters 2012). For conservators, it is when we delve into the unfamiliar with treatment projects that we face our vulnerabilities. When we are uncertain of how to proceed and are without our armor of knowledge, we become our most creative selves. These are the times that allow us to expand our thinking, probe information that is new to us, and collaborate with others, then assimilate and combine all of this with experience to develop innovative solutions to complex problems.

Fortunately, this field not only provides ample challenges but also supports and encourages experimentation and knowledge sharing. Conservators pioneer new techniques regularly, and innovation abounds in our field. We are almost overwhelmed with keeping up, making it easy to forget the tried and tested methods. What we must not forget, though, is that creativity and innovation reside in a holistic approach of bringing together the new, the old, and the potentially relevant.

The three case studies presented here will illustrate how conducting historical research, collaborating with a variety of colleagues, and adapting techniques in new creative ways can lead to highly successful treatments. The first project comes from India—a Punjabi manuscript from the early 20th century that had been saturated in disinfectant during a tuberculosis outbreak. The second is a previously repaired 17th-century Qur'an exposed to water and mold, resulting in pages blocking together. The last features a 19th-century print of Canada's capital city Ottawa, heavily encrusted with dirt (fig. 1).

CASE 1

All of Professor Puran Singh's possessions were burned upon his death from tuberculosis in 1931. This manuscript survived and had been disinfected against tuberculosis with an unknown chemical. It certainly had a very pungent and yet familiar odor; one that was reminiscent of camping. The paper felt oily, and initial testing showed that water would not penetrate the surface of the fibers. The disinfectant had rendered the linen bond paper brown and so brittle that one felt it would crack with the slightest agitation. The ink had bled, presumably when the disinfectant was applied, reducing the legibility of the text.

A notable academic, scientist, and the founder of modern Punjabi poetry, Singh is celebrated to this day. Although this manuscript had sentimental value for the family, it is also the only physical representation of the personal life of this influential figure. The client's primary goal for treatment was to make the paper strong enough for digitization, with overall preservation and a reduction of discoloration a welcome side effect. The owner understood that research and testing would have to be conducted and that there was no guarantee of finding a successful course of action.

Research began with historical medical texts on the disinfectant methods of the early 20th century. Surprisingly, nothing surfaced on what was used to disinfect items exposed to tuberculosis.

The familiar odor of the paper remained a prominent issue. While discussing the project with an elderly neighbor, she recalled that camphor oil was used as a means of warding off tuberculosis. With a little more research into the use of camphor oil as a disinfectant, the likelihood of its use on the manuscript could be comfortably asserted.

Testing possible ways of removing the oil from the paper proceeded based on a previous treatment the author carried out on a set of documents caught in a furnace oil leak. In that case, mineral spirits had proved successful. A test was conducted beginning with rolling a mineral spirit–soaked cotton swab against the surface of the paper. This produced no results, nor were the use of other solvents successful. Acetone was tested next, which instantly produced a lovely yellow swab, and yet it did not affect the ink. Based on the treatment protocol used previously to push furnace oil out of documents and into blotting paper, a full manuscript sheet was treated with exceptional results.

Papers presented at the Book and Paper Group Session, AIC's 47th Annual Meeting, May 13–17, 2019, Uncasville, Connecticut

Fig. 1. Left to right: A 20th-century Punjabi manuscript, a 17th-century Qur'an, and a 19th-century print of Ottawa

Each page of the manuscript was laid on a blotting paper and carefully doused with acetone applied with cotton balls. The process required two to three applications per sheet (fig. 2). The pages were then transferred to clean blotters and allowed to air-dry. Treating all 240 pages of the manuscript required 8.5 gallons of acetone and produced three-quarters of a large garbage can full of used cotton balls. This part of the treatment was carried out over 4 days.

The treatment brightened the paper considerably and allowed water to penetrate the fibers (fig. 3). Once the oil was removed, the pages could successfully be deacidified and lined with handmade paper. The lining provided renewed suppleness and provided overall strength. Although the pages appeared brighter, they remained too fragile for bathing. They were thus wet-out with a water and calcium hydroxide solution at a pH of 9.5. This brought the paper up from an average pH of 3 to an average pH of around 7. The fragments were fit in, the tears were aligned, and repair tissue was adhered to one side using wheat starch paste. The project was completed by placing each page in a numbered mylar sleeve and for digitization.

As the treatment was completed, a chance meeting with Gus Shurvell of Queen's University at the Canadian Association for Conservation of Cultural Property's annual conference in Edmonton confirmed the success of the treatment. Gus generously offered to perform tests through Queen's University's FTIR equipment. Disassociated fragments, both treated and untreated, were sent. The results of the tests were inconclusive, although the results combined with the historical research indicated that camphor oil was used as the disinfectant, and the treatment had succeeded in pushing out the oily product (fig. 4).

Fig. 2. Using acetone-soaked cotton balls and blotting paper to wick out camphor oil

CASE 2

The 17th-century Qur'an that arrived in the laboratory during the winter of 2015 is a treasured family heirloom. The owner did not know much about it, not even the date. As the owner put it, however, with great pride, the book was "really, really old." Mold growth was evident, and the book had been repaired previously with binders tape applied along the spine and edges of the boards (fig. 5).

Prior to treatment, the author consulted with the Canadian Conservation Institute's Christine McNair and Crystal Maitland. They were both excellent sounding boards for potential approaches, and they helpfully provided a list of reference materials and potential contacts.

The most helpful resources for dating and identifying the paper and binding techniques were *Arab Paper* by von Karabacek (2001), "The Arts of the Book in the Islamic World, 1600–1800" by Marika Sardar (2000) on the Metropolitan Museum of Art website, and "Middle Eastern Bookbinding—The Islamic Book" by David Jacobs, presented in Contributions to the Symposium on the Care and Conservation of Middle Eastern Manuscripts at the University of Melbourne in 2008. Even more helpful was Sherif Afifi, conservator at the Library of Alexandria, who was a most willing and enthusiastic source of information.

The paper used in the book was most certainly handmade. It had uneven densities, as is typically found in handmade paper, and flecks of plant fibers that are typically reduced in machine-made alternatives (Hunter 1947). This likely placed the paper as being pre-19th century. The paper was heavily sized, accounting for blocking observed throughout, which was another indicator of being handmade. According to sources, the sizing may be wheat starch paste (von Karabacek 2001).

The ink, being hand applied, suggested that it was made before industrialization, and the blackness of the ink, with no red or brown undertones, indicated that it was carbon based (James 1997). The research further suggested that the ink probably contained a gall extract that created a slight translucency (Sircar 1996). These properties placed the ink to after 1600 and before 1800 (Sardar 2000).

The applique decorations on the cover were commonly used from the mid- to late 17th century and through the

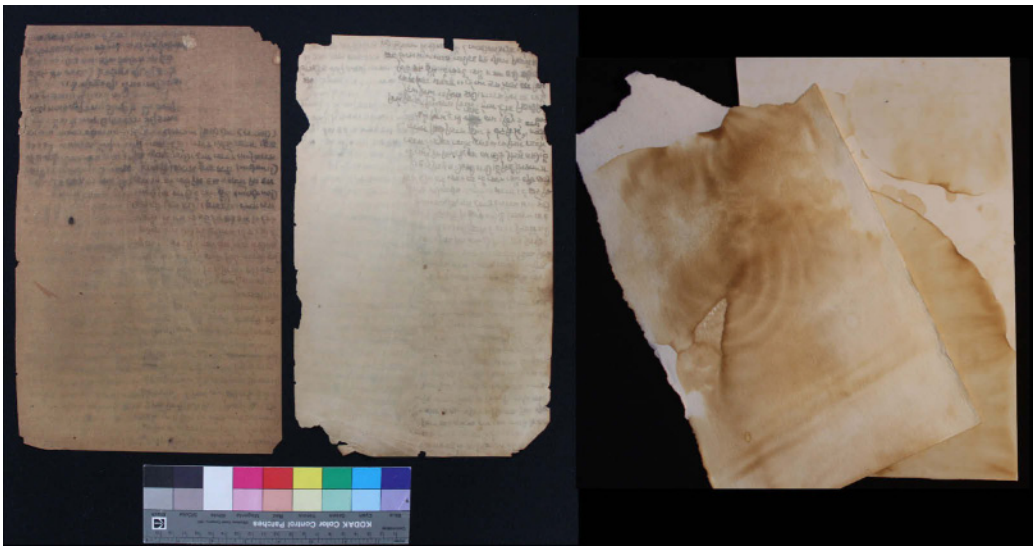

Fig. 3. Manuscript page before acetone treatment, next to the treated manuscript page and oil-soaked blotting paper

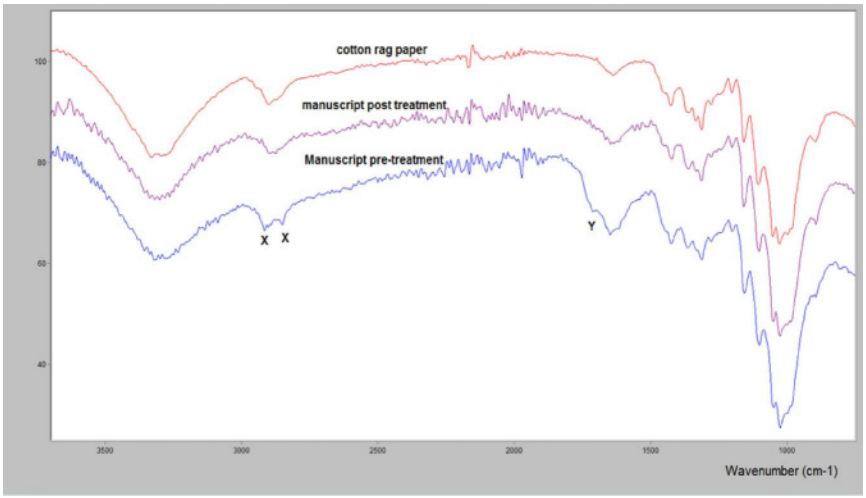

Fig. 4. FTIR results for the manuscript page prior to and after treatment, with to rag pulp paper reference line

Fig. 5. Blocked Qur'an prior to treatment

18th century, as was the hand-painted decoration found on the endpapers (Jacobs 2008). The hand-sewn whipstitch technique was more commonly applied to more substantial books but was a popular technique applied in the Middle East during the 1600s (Jacobs 2008).

Being more confident that a whipstitch style was original to the piece and could be recreated, that the ink was an insoluble carbon-based ink, and that the culprit of the blocking was the wheat starch paste sizing meant that treatment could proceed with a little more certainty. A technique commonly applied to lift prints adhered to backing boards with wheat starch paste using very hot water was used.

After disbinding, the first attempt to separate the pages involved steaming them with a wet blotter and tacking iron.

It was thought that this would be an easy-to-control method, but it resulted in dampening the edges of textblock, incubating the mold further. The process was also going very slowly, and the smell was abhorrent, even through the N100 mask.

In a subsequent attempt, one-half of the textblock was submerged in the hot tap water. There was no miraculous floating apart of the pages; however, it did allow for separation of the pages using Hollytex to provide support as each sheet was peeled off of the textblock and laid out to air-dry.

As the pages cooled, it became difficult to separate the pages, and fresh hot water had to be introduced every 15 minutes. The other challenge was that the pages were not numbered; therefore, each page was placed on a blotter, orientated carefully to keep the top and bottom and left and right aligned, and the blotter was numbered. The pages were then soaked with 70% isopropyl alcohol to kill the mold. After air-drying, the numbers were transferred to the leaves in graphite, indicating the location of the bottom recto.

Fortunately, the book was in two halves, because once the process was started, it could not be stopped for more than a few minutes or the paste sizing would reset. There was also a fear that if it were removed and set to dry, the mold would incubate and flourish. It took two very long working days, one for each half of the book, to separate the pages. The mold had eaten away the paper in many places, resulting in some small losses on every page.

Once apart and numbered, the pages were washed, resized with a thinned wheat starch paste, and the tears repaired with tinted handmade repair tissue, and the losses and tears filled and repaired. The pages could not be washed for longer than two 15-minutes baths, as the paper would have turned to mush and been lost entirely.

Many photographs of the original sewing style were taken prior to treatment, and diagrams had been drawn as the stitching was cut (fig. 6). The pages were gathered into gatherings of 25 leaves and resewn through the original holes using a whipstitch and pick up sewing technique matching the original style. The spine was then glued up with a wheat starch paste, lined with Japanese paper, and the original endbands attached, then a strip of wide cotton muslin was affixed to the textblock spine, followed by a tube.

A new cover was constructed from acid-free binders board and covered in black, Moroccan-textured calfskin, which closely matched the remnants of the original binding. New endpapers were affixed, and the new cover was attached in a case-bound fashion. The case binding was employed to keep the rebinding obvious, allow for future incorporation of an Islamic binding if desired, and keep the costs down while allowing for the renewed use by the owner. The remnants of the original binding and original endpapers were humidified and stretched before being incorporated into the new binding, ensuring their association with the textblock. For this book, the case binding serves the same purpose as an archival enclosure to hold all of the original components—the difference being that it is attached to the pages. In the end, a new life was given to this "really, really old" family treasure (fig. 7).

Fig. 6. Original whipstitch next to the recreated whipstitch

CASE 3

The latest challenge to come across the workbench was a print from Ottawa's Bytown Museum. The quiet, friendly, and cultured capital city was once a rough town, run by gangs and thugs. Colorful historic characters include the French lumberjack Joseph Montferrand, who is said to have fought 150 Irish Shriners waiting for him on the Chaudière Bridge, and Mother McGuinty, who ran a popular Irish pub and was known for being able to land a good blow. When the town wanted to vie for the position of Canada's capitol city, it shed the name *Bytown* and took on city status in 1855 with a campaign to shake its seedy reputation.

Although the note on the back of the print stated that it was from *Hunter's Ottawa Scenery*, a book 13-1/2 × 10-1/4 in., it was actually produced by Whitefield as part of his 1855 series "Original Views of North American Cities" (Hunter 2008, GIGI 2018). The print's pastoral and serene feel reflects the makeover being undertaken by the city at the time. The margins of the museum's print had been trimmed, and the note indicated that it had been on "wooden retainers." It is believed that this referred to a wooden stretcher and that the print was probably trimmed and coated in shellac at the time of mounting, as other copies are not coated.

Prints on high-quality, heavyweight rag pulp papers are usually a fairly common and straightforward artifact to treat. This one, however, had been coated with shellac, was encrusted

Fig. 7. Qur'an after treatment

with grime, and featured many cracks (fig. 8). Several crude repairs were present on the verso, including strips of cloth and newspaper adhered with a protein-based adhesive.

Mechanical removal of the dirt and grime caused the shellac to crack, lifting chips of the print layer, and therefore was not an option. The grime was so thick that it prevented isopropyl alcohol from penetrating the shellac, prohibiting the removal of the dirt along with the shellac layer. The shellac prevented wet submersion treatments for removal of the grime.

Finding a remedy for this problem came from techniques used in painting conservation featured in Wolbers' book on cleaning painted surfaces with aqueous methods (Wolbers 2000). If the shellac was thick enough to protect the paper from the water, a swab-washing technique had the potential for removing the grime to expose the shellac layer.

Similar to lifting dirt from a coated painting, cotton balls wetted with warm water were dabbed over the surface, followed by dry cotton balls. The wetting served to slowly dissolve the dirt, which was sucked up by the dry cotton balls—a simple and yet very effective solution (fig. 9). Various combinations of water and isopropyl alcohol were tried, but just plain warm water worked the best. Once the grime had been lifted, the shellac was removed with isopropyl alcohol, and applied and soaked up with cotton balls, followed by an aqueous treatment of the print.

Fig. 8. Close-up image of the grime-encrusted, shellac-coated print

Fig. 9. Print partially cleaned with wetted cotton balls to remove the grime prior to shellac removal

Bathing in room temperature water with a small amount of Photoflo (an emulsifier commonly used in photographic developing) removed the ingrained dirt, and deacidification with calcium hydroxide was carried out in two subsequent baths. The old backing and repairs were removed, retaining the incorrect notation, and the cracks were aligned. A new cotton muslin backing was applied with wheat starch paste, and the print was dried by pressing between blotting paper, followed by infilling of the losses. Any lost media was recreated with Prisma color felt-tipped marker. Treatment finished with hinging the print to an acid-free backing board, with a window mat and a 20-pt board cover that folds backward to accommodate both framing and storage. The transformation of this

Fig. 10. An 1855 print of Ottawa prior to and after treatment

print was as successful as the Ottawa's 1855 transformation from rough to charming (fig. 10).

CONCLUSION

Admitting to what we do not know, facing our vulnerabilities, and taking risks always leads to amassing more knowledge, skills, and experience. The use of camphor oil on the Punjabi manuscript would never have been discovered without the casual discussion with a neighbor who suggested the possibility of its presence. Having the confidence and inclination to remove it came from previous experience, and a chance meeting led to confirming the success of the treatment. Taking the time to seek out information into Arabic papers and bindings, as well as finding support and guidance from colleagues at the Canadian Conservation Institute and the Library of Alexandria, enabled the successful discovery and application of a technique for separating the blocked pages of a treasured family heirloom. Applying a technique used to treat paintings returned life and beauty to a grimy print, giving it a new place of honor at the Municipal Museum and the ability to tell Ottawa's story once again.

Challenges are simply opportunities for growth, both personal and for the entire community. Whether it is through research into unfamiliar subjects or collaborations with experts and neighbors, and those in related fields, we can bring together knowledge and skills from a variety of sources and continue to design and employ successful treatment solutions. When we acknowledge what we do not know, and embrace our vulnerabilities, we are freed to discover and learn.

ACKNOWLEDGMENTS

Many thanks to Victoria Palmer, the conservation technician who assisted in the first two case studies; Gabby Miron, next-door neighbor; Gus Shurvell, retired professor at Queen's University; Christine McNair and Crystal Maitland, conservators at the Canadian Conservation Institute; Sherif Afifi, conservator at the Library of Alexandria; Grant Vogl, curator at the Bytown Museum; and Peter Turton, photographic conservator and consultant at Ubbink Book and Paper Conservation.

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It All Comes Out in the Wash . . . or Does It? A Comparative Study of Washing Treatments on a Group of 18th-Century Engravings

INTRODUCTION

A 33-piece collection of 18th- and 19th-century plates depicting the Slave Coast of Africa was acquired by the African and Middle Eastern Division of the Library of Congress in 2017. The collection comprises Italian, Dutch, French, and English engravings and etchings from contemporary travel books by Moore, Middleton, Marchais, Barbot, Banks, and Smith. The black-and-white prints on antique laid paper were generally in fair to good condition; however, they had localized staining and tide lines, and overall discoloration and localized staining that detracted from the image, as well as tears and losses that needed to be addressed prior to exhibition.

EXPERIMENTAL DESIGN

In consultation with curatorial staff, conservators chose to adopt a multiyear approach to the treatment of the collection and selected a representative set of nine prints for the first phase. Taking into consideration that all of the prints required wet treatment to reduce staining and discoloration prior to exhibition, curatorial and conservation staff decided to treat the collection in phases over several years.

Recently, the paper conservation community has investigated polysaccharide gel treatments, introduced by Italian conservators Sotgiu and Iannuccelli (2010), and pH- and conductivity-adjusted solutions, such as those pioneered by Wolbers (n.d.). Chelators can be incorporated into the adjusted solutions to increase the efficiency of cleaning. Conservators at the Library of Congress have begun investigating the advantages of gels and adjusted chelating solutions in the treatment of items in the library's collections. The planned treatment offered a good opportunity to perform a comparative study of different washing methodologies. For this project, the research team chose to compare three washing techniques: (1) on a rigid polysaccharide gel, (2) in adjusted chelating solutions, and (3) by traditional immersion in pH-adjusted water. The set of 9 prints was divided into groupings of three that were similar in condition and appearance (fig. 1). Each print within each group was assigned one of the three different washing methods. The goal was to evaluate and compare the methods, based on change in the appearance of the prints after treatment, ease of use, and time involved for each treatment protocol. In addition, if one method consistently outperformed the others, in terms of the preceding criteria, the team would consider applying this "best" protocol for treatment of the other 24 prints in the collection.

Digital photodocumentation of the prints in normal and raking illumination and UVA-induced visible (UV-vis) fluorescence was completed before, during, and after treatment. Consistency in capture and processing of digital documentation photographs was identified as crucial from the beginning. Images of the three print groups were captured in the same shot to limit variables of lighting and relative placement. Standardized practices for processing those images were followed carefully. However, assessing treatment changes using photographs of nearly white paper is often difficult, especially if changes are subtle, making visual assessment somewhat subjective.

Quantification of color difference is important for any color-based research. To obtain objective, measurable data on the colorimetry of our prints, CIELAB brightness measurements were taken with a Brightimeter and compared with reflectance spectroscopy color measurements using a fiber optic spectrometer. TAPPI standards for measuring brightness specify the use of a Brightimeter. Brightimeter measurements typically require weighting objects to improve conditions of measurement through full, even contact of the instrument with the object. Fiber optic reflectance spectrometry (FORS) presented an alternative to Brightimeter readings because it offers a noncontact, noninvasive method of gathering color values. FORS gathers spectra from 350 to 2500 nm, offering the opportunity to observe the effects of washing treatments in the full range of the spectrum, from UV to infrared.

Several randomly selected prints were measured with both the Brightimeter and FORS. Consistency in color

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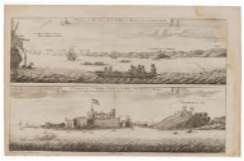
	Rigid Gel	Adjusted Chelating Solutions	Conditioned Water
Group 1	1.1  "Africa"	1.2  "Plan of James Island in the Gambia, 1732"	1.3  "Negro Women in different dresses"
Group 2	2.1  "Animals and Birds of Africa"	2.2  "Cape de Verde Camels and Lions of Africa"	2.3  "A Pholey Town"
Group 3	3.1  "Prospect of the European Factories at Xavier"	3.2  "Prospect of the Coast from El Mina to Mowri"	3.3  "Procession to the temple of the Great Snake"

Fig. 1. Assignment of prints to groups and methods.

measurements was ensured with overlay templates, created by punching 9-mm-diameter holes in translucent paper with an arch punch. During the Brightimeter measurements, the sheet was positioned on the instrument recto side up, with a light weight to ensure good contact (fig. 2). During the FORS measurements, all spectra were normalized to a white standard. The measurement probe was fixed and the print was positioned beneath it, so there was no contact between the probe and the print (fig. 3). The readings taken with the Brightimeter and with the FORS were found to be within comparable range, so the FORS data were used for the remainder of the study. Nine readings were taken from each print: three from blank areas in the image, three from the more discolored margins of the print, and three from the verso. The readings were averaged together to obtain a more representative value for each print.

Fig. 2. Brightimeter measurement of Print 2.2.

TREATMENT

Prior to treatment, the prints were surface cleaned, the paper was tested for permeability with water, and the printing ink was tested for friability and solubility in ethanol and water. All nine prints were humidified in Gore-Tex envelopes for 1 hour to 1 hour 30 minutes and misted recto and verso with a 50:50 mixture of ethanol and deionized water prior to washing.

RIGID POLYSACCHARIDE GEL PROCEDURE

Preparation of Cast Sheets of 2% Gellan Gum

To make an evenly dispersed, fairly thick gel, 20g of gellan gum powder was slowly stirred into 1 L of a 0.4-g/L calcium acetate solution. The solution was cooked in an 1100-watt microwave on the highest power for successive short intervals. A silicone floppy lid was used to contain the hot solution in the glass beaker during cooking. After each interval, the oven door was opened to observe the solution. By the end of the final interval, the solution was bubbling from the bottom of the beaker. The solution was poured into an aluminum half-sheet pan, on a level surface, to cool. The gel cooled completely in about 15 minutes. To remove the gel from the casting pan, the edges were loosened with a nonstick spatula. Polyester film and a rigid board, cut to the size of the gel sheet, were placed on the top of the gel, then the gel was flipped out of the casting pan. A layer of lightweight *hanji* (Korean handmade paper) was selected to act as a barrier layer between the print and the gel surface in this washing method. Because the paper does not have a strong grain direction, it was expected to expand evenly when wetted out.

Washing on 2% Gellan Gum

The three prints selected for gel washing and their barrier papers were humidified together and wet out separately. The barrier paper was brushed onto the gel and then the print was placed on top of the *hanji*, recto facing up. Transparent

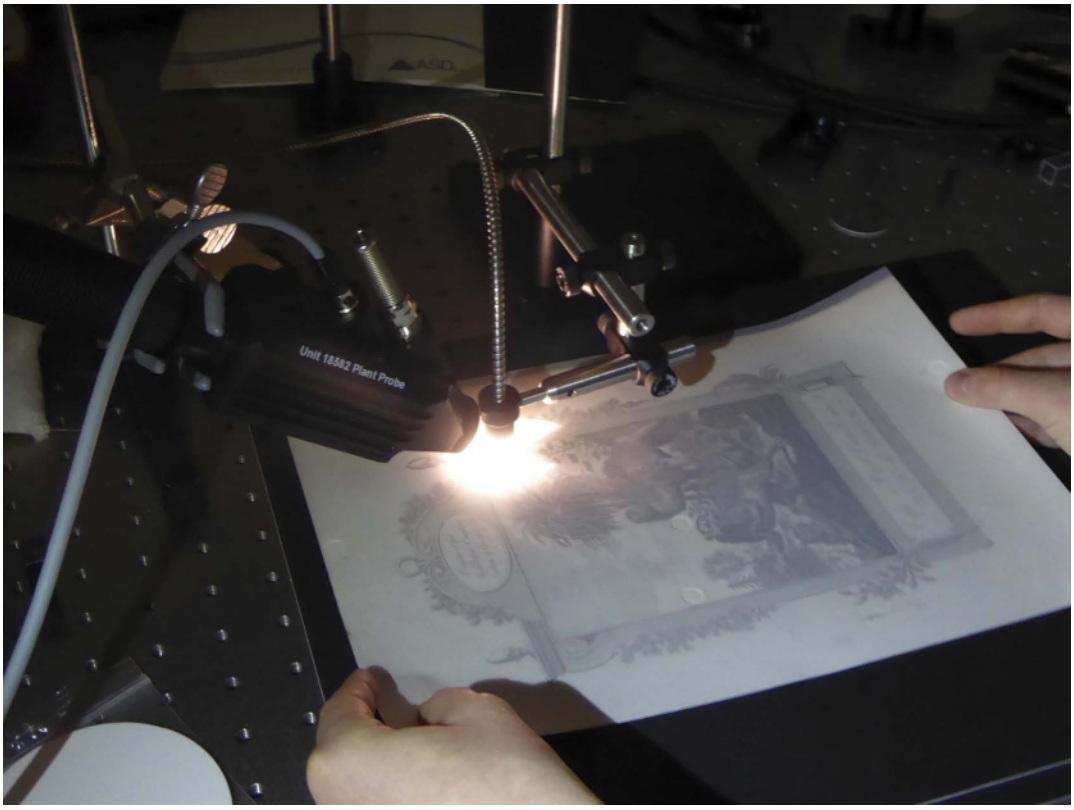


Fig. 3. FORS measurement of Print 2.2.

polyester film was placed on the print, and the package was lightly brushed to ensure good contact between the print, the barrier paper, and the gel. Two felts were placed on top of the gel/print package to provide light, even weight across the surface. The package was checked at intervals to monitor the progress of washing.

For the first print washed, the gel was noticeably discolored in the contact area after 2 hours. The print was placed on a fresh gel sheet, without a barrier layer, for an additional 1 hour 15 minutes. No discoloration was observed in the second gel sheet, so the print was removed and placed between polyester web and felts to dry. The second gel sheet seemed unnecessary, so the remaining two prints were washed on only one gel sheet, but otherwise the procedure was the same as that for the first print.

The gel sheets were examined after the washing and found to be quite yellow. Under UVA radiation, areas of discoloration products, a ghost image of the print, and the laid and chain lines of the paper were visible (fig. 4). A cross section of the gel used to wash Print 1.1 demonstrated that the products from the more degraded areas penetrated deeper into the gel, mainly in a vertical direction (fig. 5).

ADJUSTED CHELATING SOLUTION PROCEDURE

Preparation of Solutions and Agarose Plugs for Testing

Richard Wolbers developed treatment protocols using the principles of conductivity, pH, and chelation to clean paintings, and recently began applying the methods to works on paper. The protocols are based on (1) measuring the pH and conductivity of the paper requiring treatment by using agarose plugs and (2) determining the most effective of six cleaning solutions to use for treatment by comparing the results of local application of solution-infused agarose plugs.

For testing purposes, 100 mL each of six different adjusted chelating solutions were prepared according to recipes from Wolbers (fig. 6). A 4% w/v agarose sheet was prepared by adding agarose powder slowly to deionized water, then heating to 198°F while stirring constantly. The resulting solution was poured into a sterilized petri dish to set. Plugs were punched from the agarose sheet with a 4-mm dermal punch, cleaned after each use with ethanol. The punched plugs were infused in the adjusted chelating solutions overnight.

Fig. 4. Gel sheet used to wash Print 1.1 under UVA radiation (left) with Print 1.1 after treatment (right).

Measuring pH and Conductivity with Agarose Plugs

Blank agarose plugs were placed on three areas of each print to determine the pH and conductivity of the paper. All plugs were handled with sterilized plastic tweezers and were blotted first onto filter paper to remove excess moisture. Once placed on the print, the plugs were covered with polyester film to prevent drying. The plugs remained in place for 5 minutes and were then placed on the sensors of the pH and conductivity meters to obtain measurements.

Stained areas outside of the plate mark on each print were identified to test with the six solution-infused plugs. Considering that Prints 1.2 and 3.2 had significant staining, additional areas within the stains were tested as well. After 5 minutes in contact with the prints, the plugs were tested for conductivity and pH. When dry, test areas were examined and documented in both normal illumination and longwave UV (365 nm). Based on the results of the tests, solution D was selected for Prints 3.2 and 1.2, whereas solution C was selected for Print 2.2. In each case, these solutions cleaned the staining and discoloration more effectively than the others.

Calculation for Preparing the Bath

The following are steps for calculating the solutions for the adjusted baths:

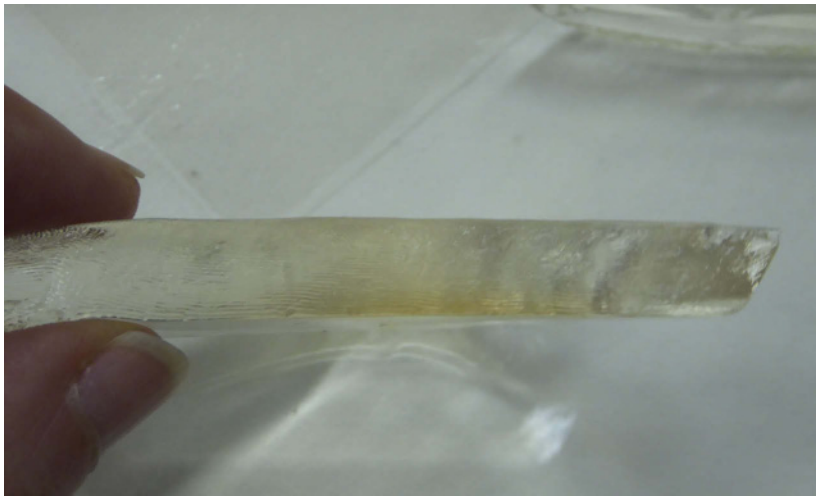


Fig. 5. Cross section of gel sheet used to wash Print 1.1. The bottom edge was the side in contact with the print.

Adjusted Chelating Solutions	Recipe
Solution A	100ml H_2O (distilled) 0.5g Citric Acid Adjust pH to 6.0 with 50% w/v 1M NaOH solution
Solution B	100ml H_2O (distilled) 0.5g Citric Acid 0.5g Tetrasodium Borate Adjust pH to 8.0 with 50% w/v 1M NaOH solution
Solution C	100ml H_2O (distilled) 0.5g DTPA (diethylenetriamine pentaacetic acid) 0.5g Citric Acid Adjust pH to 6.0 with 50% w/v 1M NaOH solution
Solution D	100ml H_2O (distilled) 0.5g DTPA 0.5g Tetrasodium Borate Adjust pH to 8.0 with 50% w/v 1M NaOH solution
Solution E	100ml H_2O (distilled) 0.5g Disodium EDTA (ethylenediaminetetraacetic acid) 0.5g Citric Acid Adjust pH to 6.0 with 50% w/v 1M NaOH solution
Solution F	100ml H_2O (distilled) 0.5g Disodium EDTA 0.5g Tetrasodium Borate Adjust pH to 8.0 with 50% w/v 1M NaOH solution

Fig. 6. Adjusted chelating solutions.

1. Determine the average conductivity of the paper.
2. Measure the conductivity of the solution that is most effective for cleaning the paper.
3. Divide the conductivity of the adjusted chelating solution by the average conductivity of the paper.
4. The resulting number, plus 1, is the total parts of the treatment solution.
5. Divide 1000 mL by the total parts of solution to determine the isotonic value for the paper.
6. For a hypertonic solution, multiply the isotonic value by 5 to 10. Wolbers recommends no more than 10x.
7. The resulting number is the milliliters of solution per liter for the washing treatment.
8. Using the total volume of each bath, as well as the number of baths anticipated, determine the amounts of adjusted chelating solution and deionized water needed to prepare washing baths.

Sample calculation:

Average conductivity of Print 3.2 300 μS
Conductivity of Solution D 2800 μS
2800 μS / 300 μS = 9.3
9:1 = 10 parts
1000 mL/10 parts = 100 mL/L (isotonic value)
100 mL × 5 (hypertonic) = 500 mL of solution D per 1 L
(500 mL of solution D + 500 mL of deionized water = 1 L of washing bath)
2 L bath × 2 baths = 4 L total
Needed = 2 L solution D and 2 L of deionized water

The same method of calculation was used to determine that 555 mL of solution D per liter of wash bath volume were needed for Print 1.2. Because of the similarity in the calculated values for Prints 1.2 and 3.2, the values were adjusted slightly to increase the efficiency of treatment by washing both prints in the same bath.

Washing in Adjusted Chelating Solutions

Print 2.2 was washed in three successive 20-minute baths of solution C (a mixture of water, diethylenetriamine pentacetic acid, and citric acid adjusted to pH 6) until no discoloration remained in the wash water. It was rinsed in a bath of deionized water adjusted to pH 6 with calcium hydroxide, then in a second bath adjusted to pH 7.5. Wolbers recommends rinsing in calcium acetate. Future treatments at the library will follow his methodology.

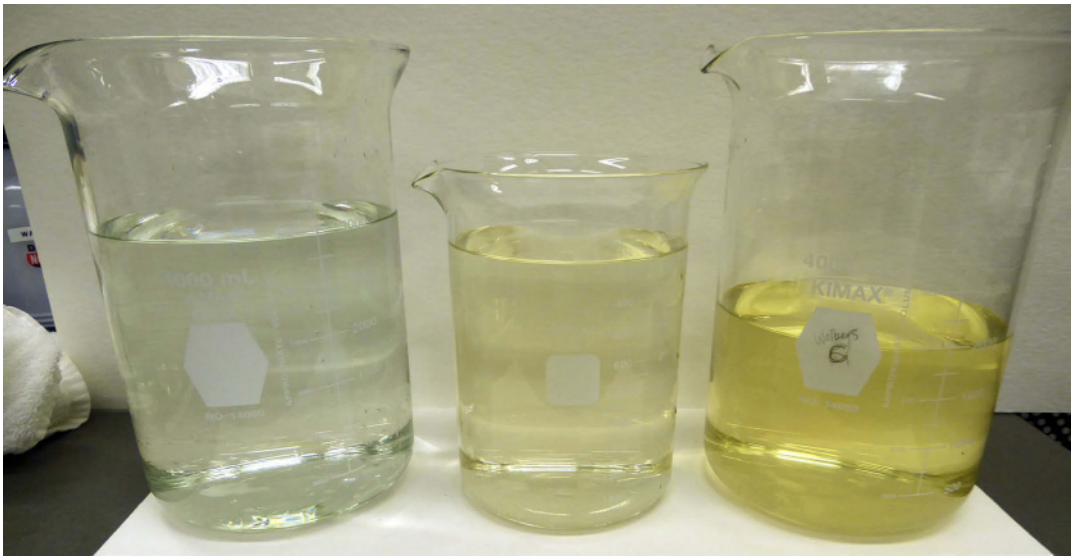


Fig. 7. Water collected from Solution D bath (right), first rinse bath (center), and second rinse bath (left).

Prints 1.2 and 3.2 were washed together in two successive 20-minute baths of solution D (a mixture of water, diethylenetriamine pentacetic acid, and tetrasodium borate adjusted to pH 8). Although slight discoloration remained in the water after the second bath, it was decided to move the prints to a rinse bath of pH 7.2 due to the alkalinity of the solution relative to the starting pH of the prints. A second rinse bath of pH 7 followed the first. Discoloration was visible in the water collected from the successive treatment baths (fig. 7). All three prints were removed from the baths, blotted, and placed between polyester web and felts to dry.

TRADITIONAL IMMERSION WASHING PROCEDURE

Deionized water adjusted to pH 7.5 with saturated calcium hydroxide solution was prepared, and the prints were washed in three successive 2 L baths for 20 minutes. As no discoloration was visible in the last bath, the prints were removed, blotted, and placed between polyester web and felts to dry.

RESULTS

After treatment, the set of nine prints improved in visual appearance: overall discoloration and localized staining were noticeably reduced (fig. 8). This was due to the removal of water-soluble degradation products and may include some loss of sizing. Gelatin sizing has a yellow fluorescence response when irradiated with UVA. The UV-vis photographs taken before treatment show yellow fluorescence, which is absent after treatment, and may indicate that sizing was removed during treatment.

Within each group of prints that were treated with the three different washing methodologies, perceivable visual differences were subtle. This was expected and indicated the necessity for objective color measurements of the papers to determine if any observable trends were present.

The visual differences are corroborated by color data collected using FORS. The total color change, or the ΔE, was calculated using the CIE2000 equation. ΔE values less than 1 represent changes in color that are considered imperceptible to the human eye. Values between 1 and 2 can be picked up by a discerning eye, and values above 2 are perceived as a noticeable change in color. All of the treated prints have ΔE values greater than 2. The ΔE values within each washing method vary considerably, but within each print group, the results are comparable. Recalling that the prints were grouped according to similarity of condition becomes helpful when comparing the performance of each washing method on prints in the same group. Occasionally, one method performs better within a group, but no methodology stands out as superior overall.

Most conservators are familiar with the shift in paper tone that can occur after an aqueous treatment. The study also considered specific color shifts, along the L* a* b* axes for each washing method. After treatment, the a* measurements shifted slightly away from red and toward green, and the b* measurements shifted away from yellow and toward blue.

All L* values increased along the L* axis or became whiter. The increase in luminance is replicated in the shift in the reflectance spectra of the paper captured with FORS (fig. 9). The spectrum is representative of the majority of prints in the set. The shift higher on the graph indicates an increase in reflectance after washing, which corresponds with the visually discernible lightening usually observed in the paper.

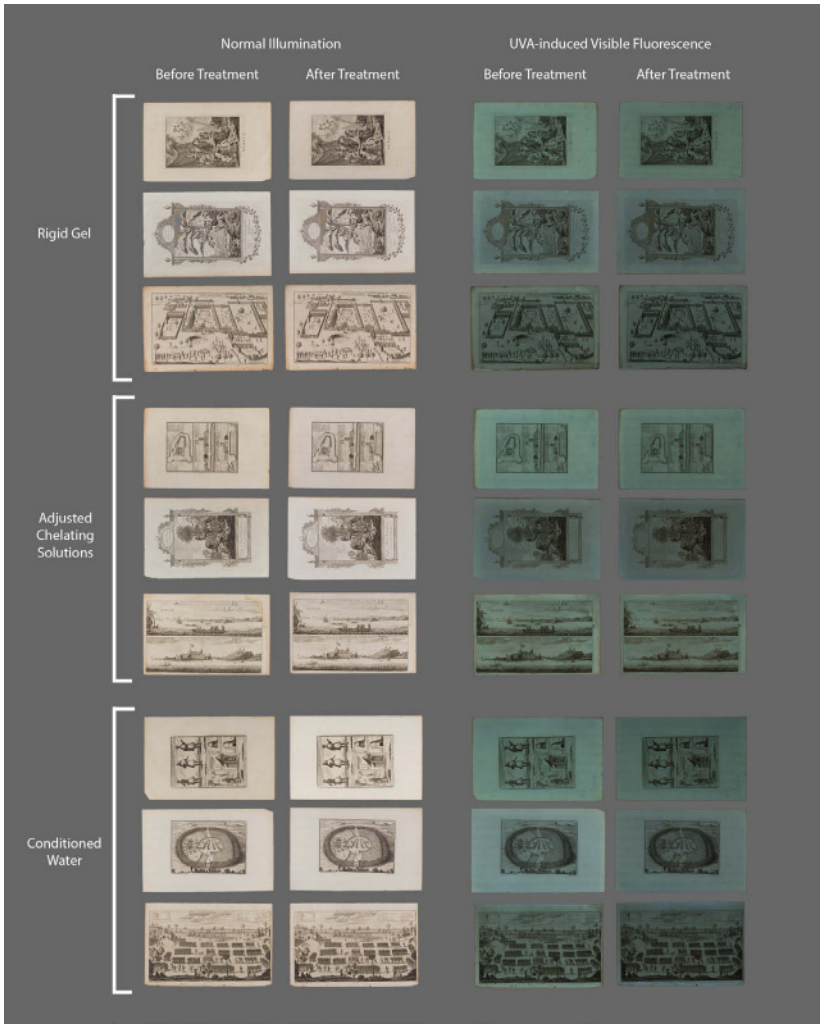


Fig. 8. All prints before and after treatment in normal illumination and UV-vis fluorescence.

All of the prints had increased luminance after treatment. At first glance, the results within each method seem quite variable, as one might expect for different papers. However, similarities within each grouping of prints were also noted. Group 1 prints showed the smallest variation in ΔE values for all areas of the papers, and the measurements are most consistent across all of the treatment methods compared with Groups 2 and 3. Group 2 readings indicate that in three out of four paper locations, the adjusted chelating solution method resulted in higher ΔE, correlating to more brightening as a result of the treatment. In Group 3, the results are the opposite of Group 2, with rigid gel and traditional immersion washing yielding significantly higher values than the adjusted chelating solutions. The reason for the differences between the prints in Groups 2 and 3 is not clear.

Testing the paper with agarose plugs, both for pH and conductivity measurements of the paper and for determining the most effective adjusted chelating solution, resulted in visible tide lines that appeared as yellow fluorescence in UV

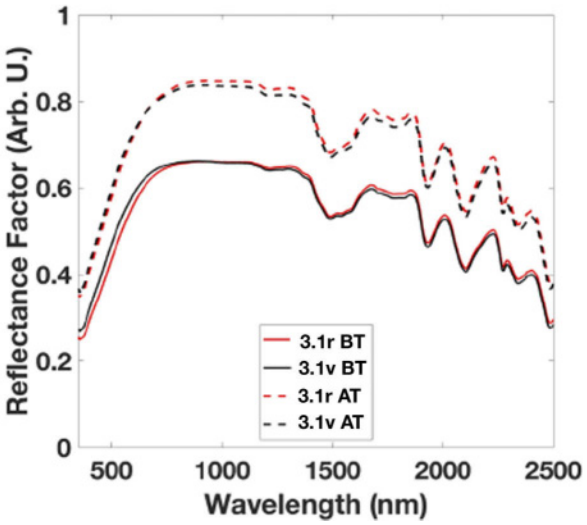


Fig. 9. Representative FORS spectrum of Print 3.1.

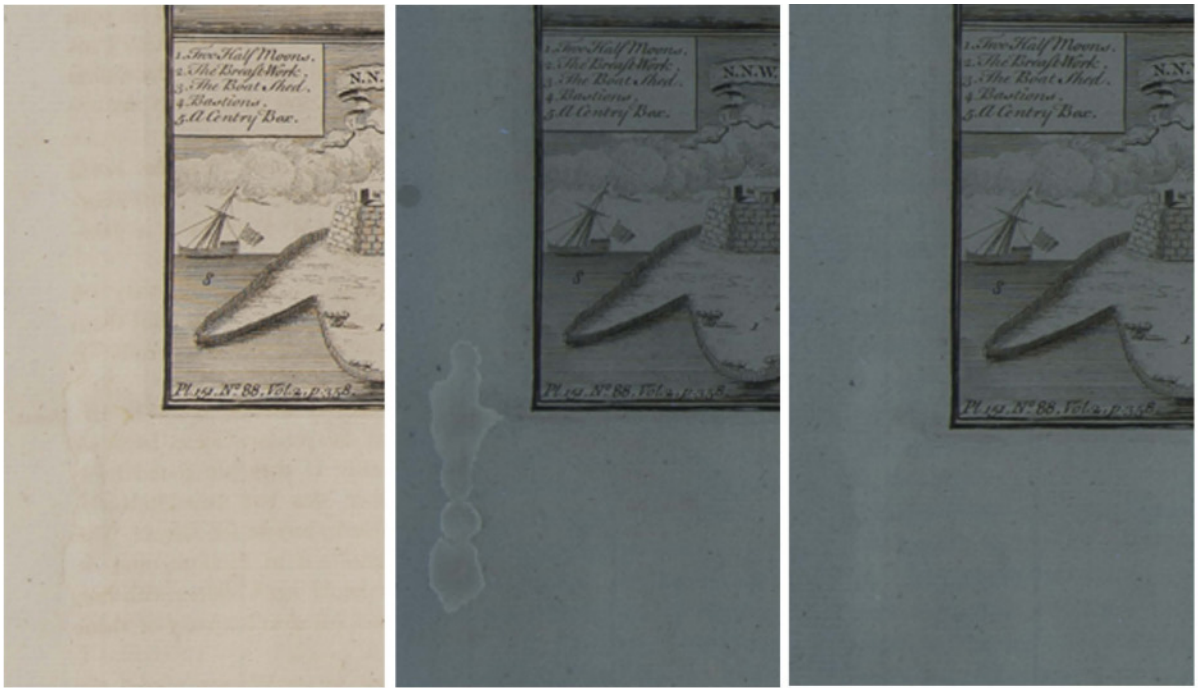


Fig. 10. Left to right: Area of testing under normal illumination after testing, UV-vis fluorescence after testing, and UV-vis fluorescence after treatment.

radiation (fig. 10). The test-induced tide lines continued to fluoresce after treatment, although they were much reduced.

CONCLUSION

Based on this study, FORS is a viable noninvasive, noncontact colorimetry method for paper, comparable with results obtained by a Brightimeter. All three washing methods are effective in improving paper brightness, and one technique may be more effective than another, depending on the paper properties and condition. Compared with traditional immersion washing, the methods of capillary washing on a rigid polysaccharide gel or in an adjusted chelating solution are significantly more time consuming and require considerably more materials and equipment.

Making a rigid gel is not difficult, but familiarity with the cooking power of the microwave is helpful. Once the gel is made up, this method of washing is fairly straightforward. The gel sheets can be prepared in advance but should be checked for microbial growth before use. A longwave UV light source may be helpful in checking gel sheets for fluorescence indicative of some types of mold. Considering that there are no baths of water to pH adjust, this method does not require the use of a sink. The size of the artwork is a consideration and may be a limiting factor.

Washing by immersion in adjusted chelating solutions requires more time and materials than the other two methods. Each test solution must be prepared and adjusted to the correct pH, agarose plugs must be prepared and infused overnight, and, after testing has occurred, the treatment bath must be calculated and prepared. Safe handling, storage, and disposal of some chemical components of the solutions is a consideration. The post-treatment tide lines and fluorescence associated with testing sites for adjusted chelating solutions warrant more investigation as they relate to long-term differential aging of the paper substrate.

The benefits and drawbacks of each washing method become important when only subtle differences are achieved. In some circumstances, the gel or adjusted chelating solution methods may be worth the extra resources, such as for sensitive media and/or delicate paper that cannot be immersed or washed on a suction table, or for staining that includes tide lines.

This study is preliminary, with the limitation imposed by variability in each historical print and does not allow for true comparison between them. A follow-up study of washing methodologies might include only one type of paper.

ACKNOWLEDGMENTS

The authors would like to acknowledge Marieta Harper, area specialist, African Section, African and Middle Eastern Division, the Library of Congress. Grace Walters would like to acknowledge the Samuel K. Kress Foundation and the Buffalo State Graduate Association for their financial support for the duration of this project.

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Wolbers, R. n.d. "General Aqueous Methods/Gel Forming Material." Library of Congress Workshops, Part 1: 2014 and Part 2: 2016.

FURTHER READING

Barbisan, S., and C. Maynor. 2017. "Rigid and Semi-Rigid Gels: Methodology for Treating Locally and Overall Stained Artworks on Paper." Lunder Conservation Center, Smithsonian American Art Museum Lecture and Workshop. Washington, DC.

SOURCES OF MATERIALS

Chartham Translucent Paper
Hollinger Metal Edge
9401 Northeast Dr.
Fredericksburg, VA 22408
800-634-0491

Brightimeter Micro S-5
Technidyne
100 Quality Ave.
New Albany, NY 47150
812-948-2884

Fiber Optic Reflectance Spectrometer (FORS): FieldSpec4
Malvern Panalytical
Grovewood Rd.
Malvern, WR14 IXZ
United Kingdom

pH and Conductivity Meters: LAQUAtwin pH Model B713; SO10 and LAQUAtwin Conductivity Model B-771; SO70
Horiba
58 Clifton Country Rd., Ste. 104
Clifton Park, NY 12065
518-280-3675

Vinyl Eraser, Grated
William Minter Bookbinding
4364 Woodbury Pike
Woodbury, PA 16695

KELCOGEL Low Acyl Gellan Gum
CP Kelco US, Inc.
Cumberland Center II
3100 Cumberland Blvd., Ste. 600
Atlanta, GA 30339
678-247-7300

Calcium Acetate, Calcium Oxide
Fisher Scientific
81 Wyman St.
Waltham, MA 02451

Silicone Floppy Lid (Charles Viancin)
Sur La Table
1101 S. Joyce St., Ste. B-20
Arlington, VA 22202
703-414-3580

Aluminum Half-Sheet Pan (interior surface 16.25 × 11.25 × 1 in.)
Nordic Ware
5005 County Road 25 Minneapolis, MN 55416
877-466-7342

Hanji (Korean handmade paper, *cham dak* fiber, 2005, 14 g^2, wooden drying boards)
Fides International
#217 Yeouido-dong, Yeongdeungpo-gu
Seoul, Korea 150-874
+82-16-9770-5433

Agarose LE
Benchmark Scientific
PO Box 709
Edison, NJ 08818
908-769-5555
Dermal Punch, 4 mm
Miltex, Inc.
589 Davies Dr.
York, PA 17403
717-840-9335

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Abstracts presented during the Book and Paper Group Session

Select Tips and Tricks in Paper Conservation

J. Franklin Mowery, Head of Conservation, Mowery Conservation

With more than 40 years of experience, it is inevitable that any conservator would come up with a variety of ways to solve problems and exercise efficiency. Over the course of my career, I have developed some tips and tricks when it comes to paper conservation, specifically with regard to solvent work and washing of paper artifacts. Pressure-sensitive tape has always been a problem. Ever since its inception, it has been used to mend tears on works of art on paper. There have been several discussions and articles exploring the history of adhesives and the processes by which to remove both the adhesive and the associated staining; Stiber Morenus and O'Loughlin's research is thorough, with a great historical and chemical overview that can assist any conservator in understanding adhesives that have presented themselves in their practice.

To this work, however, I would like to add some practical suggestions in trying to minimize toxic exposure to requisite solvents. These are techniques that I have been using over several decades and produce superior results.

The topics include the use of "Kick-a-poo juice" (a five-solvent cocktail that I developed in the 1980s), which has proven to be an efficient method to remove pressure-sensitive tape adhesive residue; the effective use of a vacuum suction platen; and the use of disposable liquid pipettes and making disposable polyester vapor chamber trays for solvent delivery. These last two techniques enable minimal exposure to handling solvents for the conservator.

Last, I want to introduce or reintroduce the use of polyester washing sleeves. The ease of their construction and the protection they offer when handling wet and fragile items is invaluable for paper conservators when conducting any aqueous treatment.

The Conservator in the Age of Digital Reproduction: Color Matching and Digital Fills for a Matte Screenprint

Carolyn Burns, Graduate Fellow, Patricia H. and Richard E. Garman Art Conservation Department SUNY

Co-Authors: Jiuan Jiuan Chen, Rebecca Ploeger, PhD, Aaron Shugar, PhD, and Theresa J. Smith

Uniformly flat screen-printed surfaces present unique filling and inpainting challenges for conservators. Research and extensive experimentation identified a successful loss compensation technique for an eight-color screen print by Noriko Yamamoto Prince entitled Horizon'72. Traditional inpainting techniques alone were insufficient to address the extensive damages to the matte-printed surface. Digital fills, already used in textile and photo conservation, provided a practicable option for treatment. However, the disparities inherent in reproducing perceived color across multiple digital color spaces requires careful consideration of color theory within the context of available digital tools. Colored inks from the original print were recreated digitally and printed on Epson Premium Presentation paper with a high-quality inkjet printer using pigment-based inks. An X-Rite spectrophotometer was used to compare L*a*b* values and reflectance spectra of the digitally recreated color and the original screenprint inks. This spectral data informed the navigation of color between digital color spaces and confirmed a successfully recreated color. Digital fills offer potential treatment solutions for treating screen prints and inspire novel considerations of current and forthcoming technologies in the service of future conservation efforts.

Combining Traditional Thinking and Innovative Methods on the Conservation of Chinese Hanging Scroll—A Case Study from the National Palace Museum Collections

Sun-Hsin Hung, National Palace Museum

One of the dilemmas encountered by paper conservators is that the traditional conservation method used in the past requires a hanging scroll to be fully stripped and remounted. This method often can cause serious damages to the painting, is time consuming, and alters the original decorative format of the art. Today, a large number of museum collections need to be conserved; however, limited human resources are available. To overcome the preceding difficulties, we brainstormed from the traditional practice and sought for the development of a new method that consists of easy-to-use materials and

Papers presented at the Book and Paper Group Session, AIC's 47th Annual Meeting, May 13–17, 2019, Uncasville, Connecticut

simple treatments. This new method was carried out on two hanging scrolls. The first piece is a calligraphy hanging scroll from the Yuan dynasty, in which creases can be found all over the artwork. Formerly, most conservators would have used paper strips to repair the creases. To avoid the shrinkage problem during the process, past conservators would have used heavy weights to flatten the paper, but this method has limited effect. Therefore, the GORTEX sandwich technique was developed and then flattened with weight. This method enables a better flattening result, but it is a time-consuming process and the blotting paper needs to be replaced multiple times during the procedure. Furthermore, phenomena such as undulation and deformation caused by incomplete drying and uneven shrinkage may occur on the painting. The new method presented in this article offers another solution to the preceding challenges. After adhering the paper strips to Qianlong Emperor's calligraphy, Fong Suei Xuan (strong pure white pineapple paper) strips are pasted on both sides of the hanging scroll to secure the artwork. The calligraphy is then completely humidified and flattened on the drying board. The advantage of this method is the simplicity of the operation and that the blotters do not need to be frequently replaced. The workpiece has a uniform pulling force and is flat after drying. The second hanging scroll is a painting that has partially creased and has severe damages on both the upper and bottom brocades. Traditionally, the upper and the bottom brocades would be exchanged with new replacements. This method is a long, ongoing tradition that has some shortcomings. For example, the connection of the old and new parts will cause inconsistent shrinkage, which results in problems such as unevenness and deformation. To solve the preceding challenges Fong Suei Xuan paper strips were pasted on the four edges of the painting. The artwork was then humidified, flattened, combined with its upper and bottom brocades, and then the entire back of the painting was lined with two layers of Fong Suei Xuan. After the whole painting dried, it was then rewetted. The painting was now flat and soft. This new method not only makes the treatment easy to operate, but, equally important, this method also allows the painting to retain a large percentage of its original decorative mounting format. Moreover, the required time for the process is greatly reduced. The preservation of cultural relics is well and effectively protected under this new conservation method.

The Queen's Bindery Apprenticeship Scheme: A New Look at Traditional Craft Training

Philippa Räder, Head of the Royal Bindery, Royal Collection Trust, UK

Before there was such a thing as "book conservation," bookbinders applied their expertise to repair and return volumes to use as an essential part of the profession. Without physical appreciation of how books have been made within their historical context, including thorough understanding of contemporary materials, best practice in book conservation-restoration is not possible but master of arts conservation graduates in the UK may have only fully taken apart and rebound one book during their training. Considerable time and practical experience is needed to acquire proficiency in the various aspects of hand bookbinding and book restoration, and from the Middle Ages, the route to this was apprenticeship training while indentured to a master, regularized in a 1563 Act of Parliament requiring all craftsmen to serve at least 7 years as an apprentice before being allowed to ply their trade. Craft and trade apprenticeships continued little changed in the UK until the mid-20th century, apart from the addition of weekly college attendance and formal examinations. However, over the following decades, academic learning became prioritized over technical and vocational training, which came to be seen as second class. Rapid changes in the pattern of education resulted in a great increase in the numbers of 17- and 18 year olds in full-time study, and this, combined with equally fast shrinking of the country's manufacturing base, led to the decline of apprenticeships across the board. In the case of bookbinding, the rising professionalization of conservation (in itself a good and necessary thing) played into this trend so that from the 1970s bookbinding apprenticeships died out, leaving no rigorous UK system of training as a bookbinder. As the last generation of apprentice-trained practitioners retire and pass away, very real danger has threatened the loss of high-level skills and technical knowledge that should underpin the approach to conservation of bound material. In response, a group of charities and commercial binderies led by Royal Collection Trust has funded a 7-year pilot of a new 5-year apprenticeship in hand bookbinding based in the Royal Bindery, Windsor Castle, aiming to revive the model of passing knowledge to new generations through practical work. Combined with structured teaching geared to recognized vocational qualifications, the goal of the Queen's Bindery Apprenticeship Scheme is to use the best of tradition to provide solid foundations for modern conservation methods. As paid employment, it provides a realistic way of gaining depth and breadth of knowledge. The Queen's Bindery Apprenticeship Scheme was launched formally in 2016 at a reception attended by Her Majesty Queen Elizabeth II. Six apprentices are currently enrolled, with the first cohort due to complete the program in 2021. Reflecting on experience gained so far, this article will describe the syllabus and discuss the theory behind the scheme, as well as its relationship to conservation training. Too often, bookbinding and book conservation have been perceived as being at odds rather than complementary: incorporating conservation ethics and techniques into the apprenticeship as one end of a spectrum of practice intends to explicitly address and make steps to resolve this tension.

Innovative Methods of Using Japanese Paper in Reconstruction of Tutankhamun Golden Open Shoes

Mohamed Ramadan, Archaeologist, Grand Egyptian Museum

Co-author: Mohamed Yosri

The discovery of the tomb of Tutankhamun in 1922 by Howard Carter is considered one of the biggest archaeological discoveries of the 20th century. Among the many thousands of finds were the sandals and open shoes of the king. Our study focuses on one of the rare and unique golden open shoes, Carter No. 4758. This pair of shoes is made of composite materials (leather, gold sheets, faience, and bark), unlike most ancient Egyptian footwear, which were usually made of bark, palm, papyrus, or leather. Furthermore, the shoes contained a lot of magnificent decorative bead works.

In this study, we focus on using Japanese paper in different shapes by adding a new technique to the regular process considered common in the most of restoration processes around the world. The object had two main problems. One of them was the separation of most of the decorative golden fragments, except for few fragments still attached to a small part of the fully deteriorated leather. Later, we used this part as a reference. The second problem was the fragility of the object, especially the sole and strap.

Our conservation challenge was to fit out the Japanese paper. As a kind of natural paper, it has the same characteristic of normal paper, so we faced a problem when choosing the suitable thickness of the paper, because if we preferred to use the thicker one due to its strength, it would not be transparent enough. However, the thinner paper was transparent but not strong enough to hold the gilded fragments. It was a great challenge, so after a lot of studies and experiments, we decided to use a thin sheet of Japanese paper coated with a low concentration of Paraloid B-72 as a film sheet to make strong transparent support. To fix the decorative golden fragments, we used small strips of Japanese paper as bridges to join the separated parts.

Using Japanese paper in the conservation field is common with similar materials like paper, photographs, and papyrus. In this work, we tried to develop the function of this material to be used not only with organic material but also with inorganic materials such as gilded fragments and beads.

Various Methods for Conservation of Chinese Folding Fans Decorated with Painting and Calligraphy

Ran Hou, Master of Arts Student/Conservator, Institute for East Asian Art History of Heidelberg University

Folding fans possess a practical use, unique mounting style, storage method, and production materials. When they are often unfolded and then used, it is not unusual for them to show more than 10, and perhaps as many as 30 to 40, creases, thus causing them to wear out and break. Folding fans are made from fan coverings and fan ribs. Of these, the making of the fan covering alone requires more than 10 procedures: the material must be cut; the surface must be prepared and smoothed; it must be shaped; glue and potassium alum water must be applied; and it must then be dried and pressed, mounted, coated, folded, cut, threaded, sprinkled with gold, the edges bound with silk thread, and so on. Therefore, choosing the most appropriate way to restore folding fans is vitally important. The approach presented here for treatment is to do so with the least intervention possible, with the methods for doing so being chosen in accordance with the level of damage or decay present in the folding fan. We first discuss a method of how to treat partial breaks in the fan covering itself. Because the surface of the fan covering is coated with a very strong glue-potassium alum water, the surface is already quite crisp and thus fragile. Water does not permeate the surface easily, so it is not easy to separate the paper layer. After many experiments, using a 10% to 20% alcohol solution to moisten the layers, and kozo paper tears with fiber to segment and reinforce the breaks, was found to be a relatively easy method of restoration. The second method is to take a folding fan that has significant damage and segment its backing paper and then remount it. This is a significant task, and before being able to master the appropriate repair techniques, one is required to first understand the process of making folding fans, as well as how to select the appropriate materials and methods for reinforcing the torn areas. The sequence of the treatment is as follows: removing the fan rib, segmenting and removing the backings of the fan covering, lining the fan covering, folding the fan covering, binding the edge with silk threads, inserting the fan ribs into the fan covering, and so on. Of these procedures, the lining of the fan covering, the folding of the fan covering, the binding with silk threads, and insertion of the rib, and so forth, are quite similar to the processes used in making folding fans. The third method is remounting the folding fan into an album. If this method is chosen, this means that the folding fan has already undergone very serious degradation, and thus it is necessary to detach the fan rib from the fan covering: it will not be possible to preserve this object as a folding fan properly considered. If this type of remounting is done, certain artistic and historical information will be lost. Conservators and art historians must come up with a better strategy for dealing with this situation.

STEPHANIE GOWLER AND AMY LUBICK
DISCUSSION GROUP CO-CHAIRS

Archives Conservation Discussion Group 2019 Addressing Challenges from Workplace Change: Conservation and Collection Care Tales of Struggle and Success

INTRODUCTION

The Archives Conservation Discussion Group hosted a panel presentation and discussion session addressing current challenges that conservators, preservation administrators, and collections care professionals are facing in times of limited resources and shifting institutional priorities, and the tactics being employed to address those challenges. Four speakers presented talks on implementing new workflows, strategic planning and capacity building for preservation departments, and utilizing survey tools to set priorities for at-risk collections—a discussion with the audience following the presentations allowed for questions, comments, and sharing of experiences.

SUMMARY OF PRESENTATIONS

ALISON REPPERT GERBER
CREATING A CUSTOM SURVEY TOOL TO MAXIMIZE ADVOCACY EFFORTS FOR AUDIOVISUAL COLLECTIONS

Generating awareness for audiovisual preservation issues can be challenging. At the Smithsonian, many audiovisual collections are tucked into boxes with paper-based and photographic materials. They may or may not be item-level cataloged, and even when they are cataloged, the information about formats, duration, and content may not exist or be accurate. Questions pile up quickly: how many copies exist within a collection, and which copy is the best? Is playback equipment and digitization infrastructure available to create preservation-level files to preserve the content found in these collections? Does the institution have the staffing capability to care for these collections properly? Are the collections in optimal storage conditions for their specific audiovisual format?

The Smithsonian began a pan-institutional survey of collections in 2010, first with photograph collections and followed by born-digital materials (Smithsonian Institution Archives 2017). Both surveys were conducted using a custom-built survey tool running in Microsoft Access. The specific tool the Smithsonian was using had much built-in functionality for analyzing survey results, but it proved challenging to modify and customize for audiovisual collections. It did not capture the type of information required to build a comprehensive narrative regarding audiovisual preservation needs. The Smithsonian-based professional group Audiovisual Archivists Institutional Leadership decided on a new approach and developed a four-component survey, which included an inventory, condition assessment, multiple-choice questionnaire, and narrative interview with staff, that would bring together data on all of those overwhelming questions.

The first component of the survey was an inventory of the Smithsonian's audiovisual assets. With 24 defined fields, the inventory provided information regarding formats, locations, content description, format base substrates, estimated length, and visible media condition. The formats field is defined based on the PBCore-controlled vocabulary with a few slight modifications (PBCore, n.d.). Due to the sheer size of Smithsonian collections and the unique way units catalog their collections, the inventory was conducted at a group level. This meant that each format type within a collection was given a line item in the spreadsheet. If a collection contained both 1/4-in. audio tapes and compact audio cassettes, two line items would be recorded with the corresponding item count. The box range where these collections were housed was then recorded in the Box field. Contracted services were used to capture all of this information in an Excel spreadsheet. This provided the most control over the data, allowing surveyors to sort, filter, and modify as needed. The spreadsheet was prepopulated with information from each unit's content management systems.

This open discussion took place on May 17, 2019, during AIC's 47th annual meeting in Uncasville, Connecticut. The moderators organized and led the discussion and recorded notes. Readers are reminded that the moderators do not necessarily endorse all comments recorded, and although every effort was made to record proceedings accurately, further evaluation or research is advised before incorporating any observations into practice.

Media condition was recorded at the group level in the same spreadsheet. The condition was rated on a scale of 1 to 5, using 1 as a baseline; the number was increased by 1 with any sign of deterioration or damage within a grouping. Some of the condition factors noted were significant dirt and grime, vinegar odor, popped strands or weak wind, and anything else that was visible (no playback was performed as part of the survey). Acid-detecting (A-D) strips were used to test a handful of acetate collections; approximately 200 strips per unit were used within the Smithsonian (Image Permanence Institute, n.d.). Every strip level increased the condition ranking by 1; mold or an A-D strip reading of 3 received an automatic 5 rating.

The next component of the survey was the multiple-choice questionnaire, whose purpose was to provide a clearer picture of each unit's areas of strength and weakness in general audiovisual collections care; it also indicated areas where more data gathering might benefit the institution. The multiple-choice questionnaire was distributed using Google Forms, which allowed responses to be aggregated into an Excel spreadsheet. It also allowed the surveyors to generate graphs and charts based on the responses automatically.

The last component was the narrative staff interview. This in-person interview was conducted by the contractor, often on the first day of the inventory in a unit. The interview served a few purposes: it oriented the contractor with the unit's history, collections, and storage spaces, and it led organically to more extensive conversations about the methodology being used for the inventory. Considering that each unit documents and stores its collections in different ways, each unit's inventory had to take that information and standardize it into the spreadsheet, which often required an in-depth conversation about the best way to do that.

The speaker emphasized the importance of presenting data, once collected, in a meaningful way. One of the easiest ways to stir up interest in a project is to create a visually appealing guide that highlights important findings; this functions as an "elevator speech" in visible form. It is essential to focus on quantifiable data: numbers are empowering and eye opening for many people. One of the most successful parts of the Smithsonian survey project has been to provide numbers on various aspects of the collections. The speaker recommended developing charts and graphs that highlight the data, using color and interesting fonts. She also emphasized the importance of clarity: remember that people who are not collections staff will see this information, so make sure that it is easy for anyone in the institution to understand the narrative being conveyed.

Considering that one of the primary goals of the survey was to quantify the Smithsonian's audiovisual assets, that data is front and center on the infographic (fig. 1). These quantities are broken down by unit, but there is an overall total as well, which provides a picture of how many items need to be cared for and could facilitate movement toward pan-institutional initiatives. The speaker also emphasized the importance of having a hard copy of survey infographics on hand; she noted multiple occasions where having the graphic to pass out at a meeting or during a conversation made an immediate impact. Making the infographics publicly available, if possible, on a website or intranet is also very useful; be sure to assign authorship so that people know whom to contact with questions.

Effective advocacy can lead to institutional support in many different forms, including new initiatives, programs, and development of access tools. At the Smithsonian, survey results caught the eye of the Digitization Program Office, which typically focuses on the imaging of collections and provides access to those digital surrogates. In 2017, the office set up a committee of stakeholders to create a project for mass digitization of audiovisual materials. Due to the large quantity and risk to the format, 1/4-in. open reel audio tapes were chosen for the first digitization project. After developing workflows for asset preparation and shipping, metadata creation and integration of files into the content management system, the first shipment of tapes was sent out in May 2019 as a pilot project; the plan was to scale up to full mass digitization of tapes in fiscal year 2020.

Advocacy can bring funding in terms of equipment, staffing, and storage spaces. The survey has been used by staff across the institution as justification for funding needs during the grant application process. Advocacy also increases the visibility of audiovisual collections, which in turn facilitates research efforts with patrons. Last and most importantly, advocacy helps collections move to a more stable, preserved state. The bottom line is that if one does not know what he or she has, then it cannot be preserved. By developing tools specific to audiovisual collections and their specific needs, staff can gather asset information, as well as information about the mission, current workflows, and their preservation capabilities.

Alison Reppert Gerber, Preservation Coordinator, Smithsonian Institution Archives

SUE DONOVAN
THE ORANGE FLAG WORKFLOW AT THE UNIVERSITY OF VIRGINIA LIBRARY

To facilitate workflows and movement of materials needing treatment between the University of Virginia's special collections library and the small, off-site conservation department, Preservation Services developed a tracking system in 2017 to monitor and manage the needs of special collections. The tracking system is a paper flag that travels with the item (fig. 2). Orange was chosen to differentiate the flag from other color-coded flags being used and to suggest the need for immediate preservation review. The orange flag went through a review

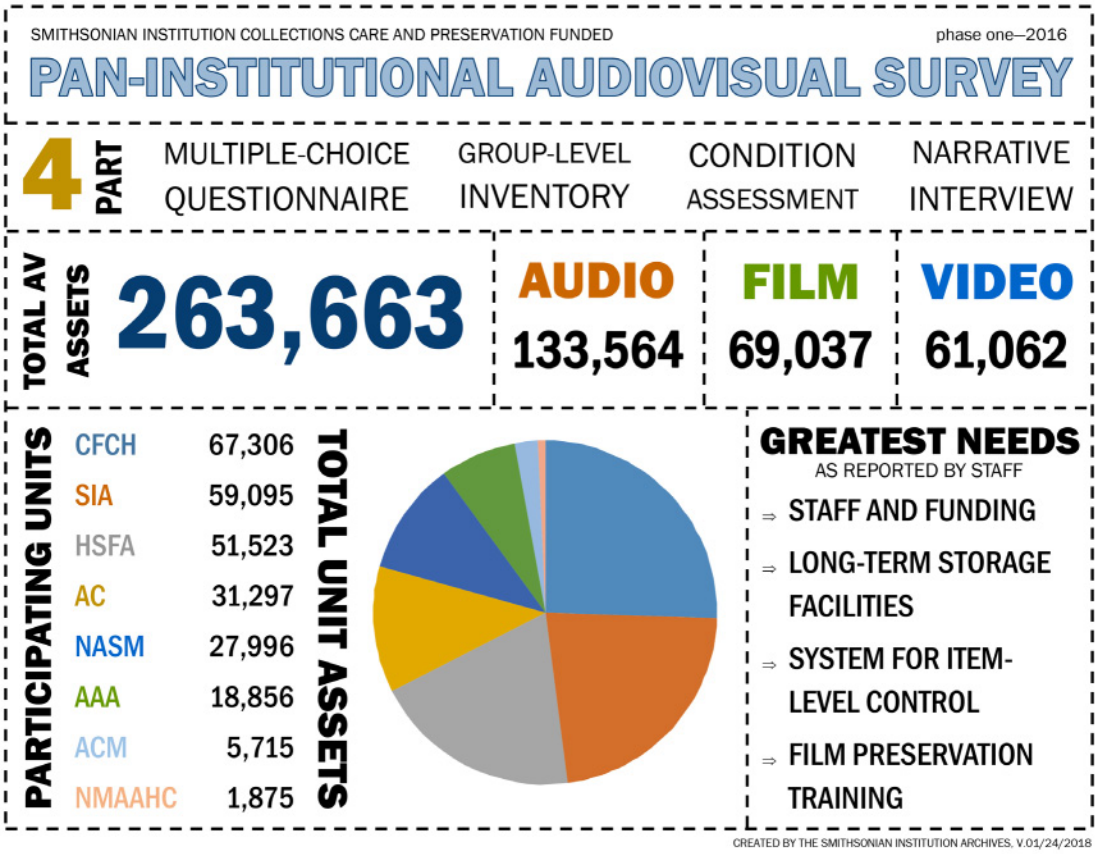
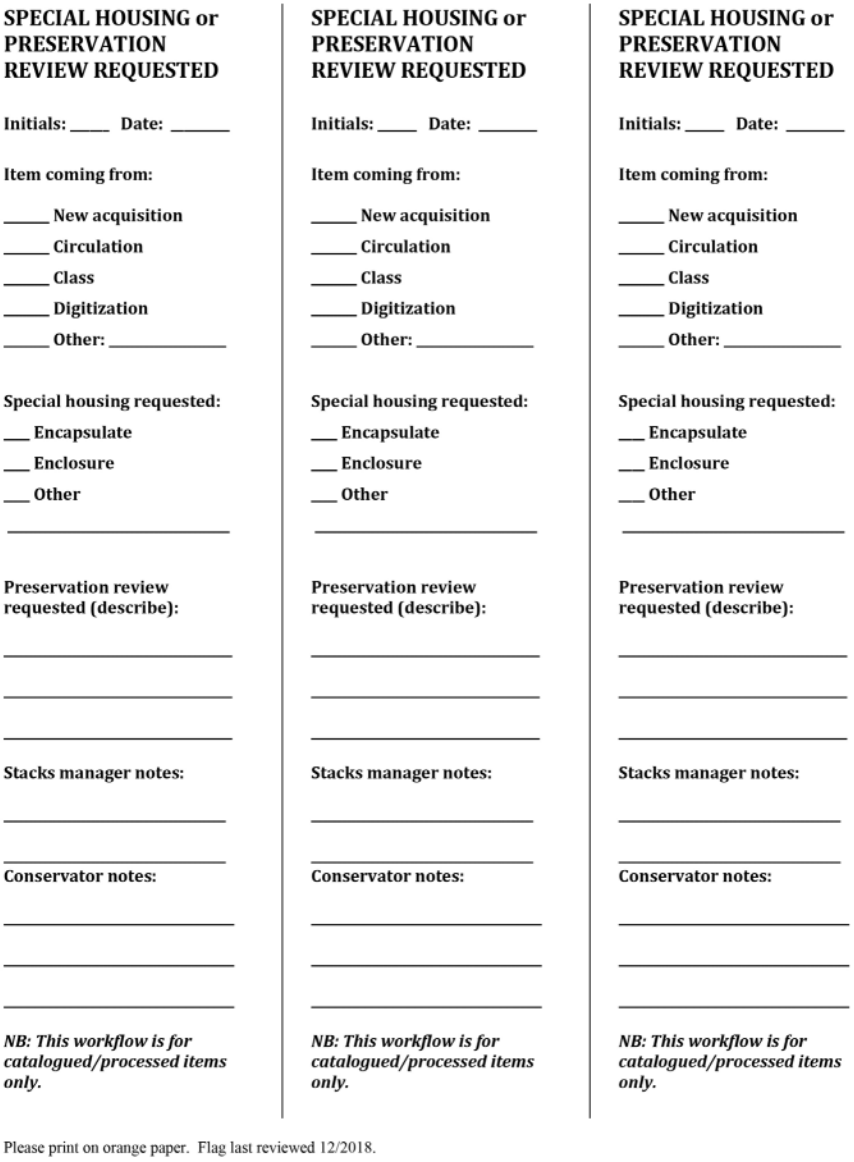


Fig. 1. Smithsonian Pan-Institutional Audiovisual Collections Survey Infographic, Smithsonian Institution Archives, v.01/24/2018

period in consultation with curators and staff in special collections to ensure that it contained information relevant to both parties. Special collections staff fill out an orange flag with information concerning damage or housing needs and the origin of the request (circulation, classroom use, new acquisition, etc.). They also include their name and date, which is very important, as many of the flags need more background information for the conservators to determine treatment or housing. After the flag is filled out, the conservators assess the items, write down the actions needed, delegate as necessary, and follow up with the concerned curator when appropriate. After the intervention, the flags are removed and collected, so the flag is not in contact with collections items for a prolonged period. The overarching idea was to create a streamlined process, so conservators can triage items with preservation concerns as they arise and be able to prioritize their treatments efficiently. A stack of orange flags is kept at the reference desk for easy access; some staff members who work with cataloging and processing keep flags at their workstations and can print them on demand.

Like any new workflow, the Orange Flag Workflow (OFW) took some time to get its sea legs. The new workflow generated some confusion over how the flags should be filled out, as well as who would review them and when. Staff were creating flags and liked using them, but the process seemed to be creating unperceived stress points. Without express instructions regarding the steps following the actual flagging, the workflow began to feel like a burden to the stacks manager. In addition, the speaker took on sole management of the OFW in 2018 after the senior book conservator departed. This required a reassessment of the OFW workflow and reconsideration of the process that would account for a single conservator.

A significant change and improvement was a designated space for the conservator to triage the incoming orange flags. One cart in the stacks is labeled as the Orange Flag Workflow Cart, and each week at a specific day and time, the conservator goes through the items to determine what is needed. Some items are kept on the cart for a few weeks as the conservator ponders over next steps. Some books arriving on the cart only need housings, so the conservator notes the housing needed on the flag and puts them on the staging cart for housings. This was something that the stacks manager had done previously, but the conservator's



SPECIAL HOUSING or PRESERVATION REVIEW REQUESTED

Initials: ____ Date: _____

Item coming from:

_____ New acquisition
_____ Circulation
_____ Class
_____ Digitization
_____ Other: _____

Special housing requested:

___ Encapsulate
___ Enclosure
___ Other

Preservation review requested (describe):

Stacks manager notes:

Conservator notes:

NB: This workflow is for catalogued/processed items only.

Please print on orange paper. Flag last reviewed 12/2018.

Fig. 2. An orange flag used for special collections conservation workflow tracking at the University of Virginia Library

intervention at this step streamlined the process. Student workers take the books from the staging cart, check them out to a dummy patron, and place them in call number order on designated housing shelves in the stacks, where they wait to be treated. When the boxes are complete, the students return them to the other side of the cart, marked "preservation completed," where they wait to be discharged and moved to a reshelving truck. Other items may need a more complicated housing or a quick stabilization that can be done without moving to a designated treatment area. Items needed for classes, digitization, and research have a higher priority, and the conservator will always try to make something available for a researcher. Items that are being considered for an upcoming exhibition also come to the OFW cart.

Anything that needs more treatment is checked out to a conservation dummy patron and placed on designated staging shelves in the stacks. Items needing treatment stay on these shelves until there are enough items to bring to the laboratory for treatment. This is another change from when there were two conservators on staff, and some treatments were performed in situ. As sole manager of the OFW, focusing on triage instead of treatment in special collections helps the conservator move items off the truck and into appropriate

workflows. Grouping items to bring to the laboratory, even items that only need small mends, is more efficient for the conservator.

As the OFW progressed, the conservator realized that items with orange flags that lived in the vault needed a slightly different approach. The vault is a small room where the most valued collections are housed. Student workers do not have access to this room, and even the university librarian would need an escort to get in. Considering that the space is so small, shelving and hold space is limited, so orange-flagged items could not wait for triage until the conservator could get to them. Instead, whoever returns the flagged item to the vault takes an extra flag from the front of the room and fills out a duplicate flag. The item is reshelved in its original location, and the duplicate flag is placed in a small box on the shelf where the conservator does triage regularly. Although items in the vault are some of the library's most valuable volumes, discussions with curators and special collections staff resulted in the acknowledgment that they do not inherently get higher priority in terms of treatment. Volumes selected for use in classes, research, digitization, and exhibitions always receive priority, so vault items with an orange flag may still have to wait a while for treatment.

Since the implementation of the OFW and the subsequent modifications, the conservator has noticed that items needing treatment or housings move along quickly and transparently. Special collections staff add things to the cart and check things out from the other locations in the workflow, leaving tracking slips. Doing this indicates that they know where to find items they are looking for, even within the workflow.

A benefit of using flags is that it includes information about where the item is coming from, which allows the conservator to prioritize treatments. The workflow has reduced the onus on the stacks manager. The workflow also helps the conservator keep up with incoming collections that are often inherently damaged, such as the Dust Jacket Collection. New additions to this collection receive an orange flag because the rare book cataloger knows there is an ongoing treatment project with the dust jackets.

There are still some issues to address with the workflow, however. The stacks manager and the conservator are still trying to figure out how to use the orange flags to help with the stacks manager's statistics. New acquisitions frequently come to the truck, even when they simply need to go straight to the shelves, which can add time to the triage step. Some staff have trouble filling out the flag entirely and legibly, which can mean having to chase down an answer. The conservator is still having to learn about other existing workflows and the limitations of catalog search engines. The special collections department is currently rolling out the AEON tracking system, which will check out books to the specific shelf numbers and other locations associated with the OFW using unique transaction numbers instead of barcodes, and which may have an impact on the OFW.

Sue Donovan, Conservator for Special Collections, University of Virginia Library

LIZ DUBE
NURTURING A FRUITFUL PRESERVATION PROGRAM BY DISTRIBUTING INFLUENCE

The speaker has been at Notre Dame for 20 years and spoke about how the institution and her own thinking have evolved over that time. She began by amending the title of her talk to "nurturing a fruitful preservation program by *allowing and trusting* influence," in recognition that influence cannot be distributed because it is by definition inherently distributed. From a perspective of openness, the speaker has come to see that her role as a preservation and conservation professional is to strategically promote and coordinate the influence that exists within her institution.

The speaker began her career in preservation in the 1990s and recalled that one of the messages she took away from her early mentors was the idea that we, as preservation professionals, must care about preservation on behalf of our institution, and that it is our responsibility to convince others of its importance. Over time, the speaker has questioned such assumptions about our role as preservation professionals, coming to view this version of responsibility as burdensome, outdated, and even counterproductive. Considering that most of our organizations articulate preservation within their mission statements, preservation is instead an institutional responsibility that is therefore shared by all library staff. As librarians educated today enter the profession with an awareness and appreciation for preservation, we are able to more naturally join them in the shared responsibility of preservation rather than perceiving that it is our burden to convince others of its value.

Framing our role as influence rather than responsibility provides access to a wealth of influence that exists naturally in our institutions. Although influence is intangible and cannot be owned like responsibility or authority, it exists naturally within all of our relationships and is inherently more dynamic and powerful. As such, the challenge is one of empowering and facilitating this influence through relationships. As part of this process, the speaker carefully examined her expectations, eliminating the word *should* from her vocabulary, focusing instead on the service imperative of preservation. Rather than viewing those in preservation as responsible for determining what needs to be done, she fosters an approach that emphasizes open questions, such as "how might we be helpful?" and listens carefully. Her unit's response is collaborative and solution focused, with an emphasis on the transparent sharing of information, expertise, and options. Priorities and strategies can then be imagined and developed in collaboration.

When administrative support was not available, the speaker returned over and over to nurturing horizontal relationships, collaborating with colleagues across the institution to identify creative ways to work toward meeting preservation needs. As limited resources are the rule, she noticed that many of her colleagues across the library were also struggling with such limits, and that rather than becoming discouraged, she found that it was often possible to work together to develop small creative solutions that over time tended to build into something significant. Notre Dame Preservation has at times further struggled with feeling disconnected both organizationally and physically: the laboratory is in a separate building. Over time, the speaker has come to see that critical work happens in informal hallway conversations and has invested heavily in relationships across the libraries to ensure that preservation staff are involved in both informal and formal conversations.

The speaker acknowledged that many of us in conservation are perfectionists by nature, and as such it can be very challenging to shift from a perspective of certainty, expectations, and goals toward one of service, transparency, and vulnerability. She found it helpful to practice recognizing and letting go of the illusion of control and instead focuses on seeing reality more clearly, letting go of ideas and stories that prove no longer valid or useful when held up to scrutiny. She described control as a paradox: by releasing the illusion of control, one achieves more profound and more powerful influence than is possible through attempts to control. She has been pleasantly surprised by the fruits of this approach at Notre Dame, where over time the preservation of the collections have become significantly more assured: staff are engaged with preservation across the institution, administrative support for preservation has grown, preservation staff are more connected and fulfilled, and there is a trust that library staff can and will work together to address preservation needs.

Central to the collaborative and distributed approach at Notre Dame has been 20 years of monthly meetings between curators, archivists, and conservators. In these meetings, curators and archivists can raise any preservation-related questions and concerns—from storage issues to environmental control to single-item treatment needs. Solutions are proposed and negotiated, and work priorities are determined as a group. Detailed investigations may be deferred for further consideration outside the meeting, and over time various ongoing workflows have been established by this group, thereby enabling appropriate investigations and developing routines where possible while ensuring strategic use of the meeting time. Because treatment capacity is always limited relative to the vastness of all potential preservation concerns, the meetings provide a process for collectively discussing needs, determining which concerns are most pressing overall, conceiving solutions, and negotiating to ensure that implemented preservation services are broadly conceived. When staff contact conservation with direct requests for service, such requests may be referred to this meeting to ensure that needs are credibly vetted and prioritized. The meetings also provide a shared mentoring experience: new curators and archivists can observe more senior curators, and archivists engaging with preservation can practice engaging their responsibility for preservation within the support of the group. The same mentorship and professional growth process occurs on the conservators' side of this important ongoing conversation, and over time we all continue to grow more skillful and helpful at engaging our collective responsibility to advance the preservation of the collections.

With resources ever limited, Notre Dame Preservation looks for creative ways to invest its limited resources for more significant gains. Locally, they engage opportunities to showcase their expertise. They promote their services each year through online and in-person exhibits during National Preservation Week, and they have hosted Valentine's Day open houses that draw community members to the laboratory, where they demonstrate the range of services offered and promote engagement with books through an interactive station where visitors can create takeaway Valentine cards. They have also successfully applied for project funding from outside organizations. Recent awards have enabled them to host a 1-year Kress-sponsored postgraduate fellowship and to build relationships with campus facilities staff and others across campus via a National Endowment for the Humanities Sustaining Cultural Heritage Grant. Most recently, the library director took notice of preservation services' need for more resources and invited them to apply for Gladys Brooks funding, which, with the creative addition of local funds, has ultimately resulted in the creation of an ongoing postgraduate 2-year Gladys Brooks Conservation Fellowship.

A collaborative strategic planning process across the libraries has raised awareness of preservation needs across the institution. As part of broader campus-wide strategic planning, the library has been compelled to demonstrate how it serves the university's mission, and the speaker notes that preservation as a strategy must similarly align in service of teaching and research. Although preservation is a part of the libraries' mission statement, on its own it is a challenging sell. Preservation needs are most compellingly articulated by tying preservation needs to the more directly compelling mission in support of teaching and research. How can this be accomplished? At Notre Dame, a collaborative strategic planning process was useful for clearly articulating the link between supporting preservation and advancing teaching and research.

In response to an invitation to engage in strategic planning, the speaker collaborated with a special projects librarian to lead a highly collaborative and extended planning process for preservation. In keeping with trends at similar institutions, the preservation unit had observed that as the acquisition of e-publications went up, demand for traditional general

collections preservation services such as commercial binding, in-house repair, and reformatting had declined. At the same time, tremendous growth in the special collections landscape meant dramatically increased demand for higher-level preservation expertise to support increased collecting and use of the collections, which was clearly shown in dramatically increased numbers associated with acquisitions, teaching use of collections, exhibitions, and digitization.

Co-leading the strategic planning process with a non-preservation librarian provided a critical measure of objectivity to the strategic planning process. The co-leaders emphasized that they were not creating a strategic plan for the preservation unit per se, but rather the goal was to collaboratively develop a preservation strategic plan for the libraries overall. Over 6 months, 23 individual interviews were conducted, followed by three focus groups with 17 subject specialists. These discussions centered around the following questions: Which preservation services are most valued? What goals and services does this valued work enable? What preservation needs are not being met? What goals and services are hindered by these preservation needs not being met?

They sought to learn what they were doing well and to learn—from the subject specialist's view—what the impact of that work was. Conversely, they wanted to hear what needs were not being met, from the subject specialist's view, and the impact of not meeting those needs. Challenging collections specialists to identify their needs and goals and articulate why preservation is important was useful. They were able to speak directly to the impact of preservation to the goals of faculty and students, explicitly highlighting which services were valued, where the gaps were, and the impact of not meeting those needs. Data gathered during this survey revealed broad appreciation for the unit's services and expertise while also pointing to the need for a significant increase in preservation staff resources, particularly additional specialized treatment capacity in support of increased usage of special collections for teaching, exhibitions, digitization, and specialized treatments.

As part of the strategic planning process, the unit was also asked to document workflows and decision-making criteria in conjunction with efforts to grow and streamline digitization and digital preservation workflows. This effort allowed Notre Dame Preservation to showcase its long experience in negotiating and establishing workflows and priorities in collaboration with subject specialists, and the data generated proved useful to project managers developing digitization workflows, as well as clarifying and evolving workflows as part of the planning process for analog preservation.

Although the final strategic planning report has yet to be written, results have been presented to library administration, and the planning process has already borne significant fruits in the form of enhanced support for preservation. Most fundamentally, the process of inviting library staff to explicitly think and talk about preservation in groups resulted in them articulating and confirming preservation needs publicly. These discussions have allowed preservation to take a more prominent seat in the zeitgeist of the libraries and affirmed preservation's place on the administration's radar, which has resulted in preservation being consulted in planning discussions earlier on, and in garnering more support generally. By demonstrating the capacity for openness and flexibility in serving the libraries broadly, including shifting some its staff capacity to the digitization unit as one outcome of this process, the preservation unit has gained greater legitimacy as a well-informed team player, which has helped bolster its case to upgrade an open position within the unit, as well as its case to secure additional funding to enable the new Gladys Brooks fellowship to become an ongoing 2-year position at a professional salary. The subtle but fundamental changes in the approach described here have led to more influence in the library-wide strategic planning process, more support for campus-wide initiatives such as environmental control and emergency response, and more people stepping up and helping out to advance the preservation of collections.

Liz Dube, Head of Preservation, Hesburgh Libraries, University of Notre Dame

ALLISON OLSON
A FUTURE FACING PRESERVATION PROGRAMS AT THE NATIONAL ARCHIVES AND RECORDS ADMINISTRATION

The responsibility of the National Archives and Records Administration (NARA; https://www.archives.gov/) is to preserve and provide access to federal government records with continuing value. NARA retains 2% to 3% of federal records deemed permanent, currently amounting to more than 15 billion pages of textual records, billions of electronic records, and millions of records in many other formats. NARA has three types of facilities around the country: archives that hold the accessioned permanently valuable records; federal record centers, where federal agencies pay to store both temporary and permanent records; and presidential libraries and museums that maintain official government papers of the presidents and other donated materials. There are 43 NARA Preservation Programs staff members located in three offices: College Park, Maryland; Washington, DC; and St. Louis, Missouri.

Even with NARA's large size and distribution of facilities to contend with, the agency faces the same challenges as other institutions, such as regularly changing technology, shifts in researchers' expectations, the impact of climate instability, and fulfilling its mission with limited resources. In response to these challenges, NARA has been proactive and hired an outside preservation expert (Nancy Bell, formerly of the UK National Archives) to evaluate the program and help inspire NARA to meet these challenges. During the past year, NARA

has developed a new preservation strategy and started revising its archival storage standards.

NARA's new preservation strategy has four goals. The first goal is to predict, understand, and act to mitigate the risks to NARA's holdings. To meet this goal, NARA will establish a Preservation Strategy Board led by the agency's chief operating officer and coordinated by the director of Preservation Programs. The board will include executives with preservation responsibilities such as custodial unit heads and business support leaders with control over facilities. A variety of Preservation Risk Guidance Groups will be established on specific topics such as guidance and training, exhibits, and environmental management. Each guidance group will be led by a preservation staff member and include people needed in decision making on that topic. In addition, environmental performance at select NARA facilities will be evaluated under the first goal. This has already been done at Archives II in College Park, Maryland, to reduce energy consumption while improving the preservation environment. Last, NARA's at-risk dynamic media will be managed to prevent loss in audio, video, and motion picture film holdings.

The second preservation strategy goal will deliver products and services to stakeholders to support access to NARA's holdings. Preservation staff will deliver practical, risk-based guidance and best practices by revising the NARA website and rebranding it as the Preservation Commons. This will result in a single source where NARA staff and the wider archival community can access the information they need. NARA's preservation program will support access through conservation, exhibition, and digitization. Conservation project planning will include a 2-year cycle to ensure that institutional priorities are addressed. Instead of large series projects spanning 10 to 15 years, a few select large projects will be completed in shorter periods. In their daily work, archival staff indicate the preservation actions that a series requires and the priority level. To meet this second strategy goal, conservators will review and validate urgent priority–level needs for planning purposes. To grow NARA's capacity to support digitization, the St. Louis facility, which primarily has been focused on creating records from a 1973 fire, will begin treating and digitizing materials from field archives. An additional supervisory conservator will be hired to support that effort.

The third goal of NARA's preservation strategy is to exploit science and technology for improved practice. NARA will hire a new head of science and build the agency's research profile. Research collaborations will be supported and built to magnify staff impact. NARA currently has three scientists and does not expect additional hires soon, so identifying new funding opportunities is critical in meeting program goals. In addition, NARA is taking a leading role in developing a Washington, DC, Heritage Science Network. Scientists in the area have been getting together to establish a database of scientific equipment at various institutions and discuss topics for possible collaboration between members. NARA's own Heritage Science Research Strategy will be finalized and will result in support from management on NARA research topics. Accelerating research knowledge to practice and translating research findings into the right language for the appropriate audience will aid NARA decision makers in understanding the impact on holdings. NARA scientists are working as part of established networks for material testing standards to share research and gain. Last, to enhance NARA's reputation, there will be a renewed focus on publishing in peer-reviewed journals.

The final goal of the strategy is to define the competencies and skills NARA's Preservation Programs staff need to deliver the strategy. These might include areas such as conservation techniques, digitization, preservation risk management, project management, communications, and data analysis. NARA has a talented staff, but they are being asked to take on new and different roles, requiring skills that may need to be refreshed or acquired.

The new preservation strategy was distributed for agency-wide comment until May 15, 2019, and has already been approved by NARA's Executive Leadership Team. The Preservation Programs staff have been working on developing implementation steps for each year of the strategy. Steps will be assigned to specific staff members to lead and complete.

The review of NARA 1571: Archival Storage Standards is still under way, updating the standard based on research published since the last revision in 2002. Changes include consideration of holdings' significance when standards cannot be met. There is also the addition of explanations for requirements and the inclusion of a bibliography. The standard always allowed for fluctuations within the temperature and relative humidity range, but this was not well communicated or understood. Rewriting the standard to make the language clearer and easier to interpret, as well as updating and revising charts in the standard, has been a priority. A change has been made in the standard to the required relative humidity for black-and-white prints, polyester negatives, electronic media, and audiovisual media. The standard used to require a range of 30% to 40% RH, but it has been updated to the same range required for textual materials (30% to 50% RH). The published literature was reviewed, and the potential change of NARA holdings over 500 years with an expanded range was considered and deemed acceptable. NARA recognizes this may not be appropriate for other institutions. Another significant change to the standard recommends color prints for cold storage based on significance. The standard no longer reads that all color prints must be kept in cold storage. Most color photographic prints at NARA are interfiled with textual records and are not separated to maintain the archival association. NARA does not have enough space to store all color photographs and associated textual materials

in cold storage. Last, the revised standard raised air pollutant thresholds for acetic acid and removed specification for formaldehyde. Research since 2002 has shown these pollutants pose less of a risk to paper-based holdings than believed previously. Nitrogen dioxide is NARA's biggest concern for paper-based holdings. Focusing on nitrogen dioxide allows NARA to get more tailored air filters to meet the agency's needs. When NARA's preservation strategy and archival storage standard are finished, they will be posted to https://www.archives.gov/.

Allison Olson, National Archives and Records Administration

DISCUSSION SUMMARY

After the last presentation, the moderator opened the floor for questions and comments. The contents of the discussion are summarized and paraphrased in the following.

Commenter: Question for Olson. How are you monitoring acetic acid and formaldehyde in the air?

Olson: Our scientists conduct periodic testing. We can provide additional information on equipment upon request.

Commenter: Question and comment for Dube. We noticed a trend we would like to take advantage of in the use of primary resources in undergraduate research and teaching. There is an interest in conservation's knowledge of the object's history, the object's materials, and our treatment records. With the possibility of our treatment records becoming part of the catalog, have similar institutions experienced similar trends and found ways of responding in a positive way to these opportunities?

Dube: I am also interested in what others are doing. Teaching has brought greater emphasis to us at Notre Dame and has resulted in our department bringing in a lot of undergraduates and graduate students. Graduate students are helping process the collections. It will be interesting to see where that goes. We are not sharing treatment records, but we are being asked to give presentations on the history of the book and similar topics. There is a sense we will be asked to do more of that. Does anyone else have answers to the documentation question?

Commenter: I have a comment regarding the flag system. We have a similar flagging system at our library. Initially, every staff member could flag something and bring it to the laboratory. We discovered that staff members were not talking to each other, so different staff from the same division might bring us multiple copies of the same edition. As a result, we moved to a triage system. Staff now have to approach their division heads, and the division heads decide what needs to go to the laboratory. I am the only conservator, so we would often end up with a year's worth of backlogged books. We do not know the value of the items brought to the laboratory, and we would have books that could be replaced for $30. As conservators, we do not often know the context. Librarians know the context, so our new system has meant that individual librarians and department heads became the funnel points instead of conservation.

Commenter: Is this a circulating collection? Is the orange flag used for special collections?

Commenter: Yes, one of the tricks to this system is that the books do not go to the laboratory. That was why Donovan put the map in her presentation. The choke point is in the special collections stack area. The stack manager takes the orange-flagged item from the circulation desk and places these books into different piles. If a reader comes and requests a book with an orange flag, the stack manager can go find it and pull it out of a pile. The book stays accessible until the very minute it goes to the laboratory. The majority of the books remain in special collections stacks because most need housing and will require follow-up discussion with the curators. I also wanted to follow on to the point of the earlier commenter regarding documentation. At our university, one of the archivists started archiving the conservation documentation. The laboratory keeps a paper copy for reference, but we were given our own record group. There is a note in the item record that states it received conservation treatment and that the documentation is available. If a reader wants to see it, someone can pull the documentation. The digital imaging staff captured the photodocumentation, and so it was part of their workflow. The raw images and associated files were given the same metadata as every other digital image in the digital image library. This was part of the more extensive process where the documentation was backed up, made available, and became part of the library collection. If anyone wants access to the images besides library staff, it could be made available.

Commenter: Yes, I do want to comment on this. I have not done this yet, but I intend to do something similar. I talked to our university archivist, and these are essentially university records, so we have a pathway to move our treatment documentation to our university archives. We have a series for the library, and there may already be a preservation subseries. You may want to investigate this if you are part of a university.

Question for Liz Dube: We recently reorganized our whole library. We have been working on more strategy-focused projects and big picture matters for preservation throughout the library. Do you have any comments on the location of the preservation department within the library organizational

structure? How have you felt it has affected your strategy and your ability to be nimble to respond? Has it helped or hindered this ability? If you could be in a different part of the organizational structure, would you? Do you like where you are? I am also interested in where other preservation departments are located within their organizational structure if you are in a library or archives.

Dube: It can be hard to tell. I love where we are and the way we ended up there. Part of me thought we should be higher in the organization and have our own reporting line to the university librarian or associate leader to the librarian, but this has worked out well in our situation. Every place is a little different. There were two phases of reorganization. During the first phase, I was not so happy with where we were. During the second phase, they looked deeper into the organizational chart and got into the interstices. They did not know where to put us initially. During the second phase, they asked everyone whom we work most closely with, and we ended up exactly where we needed to be, with the people we serve most directly. There was some thought we should be in technical services, but in the end, we ended up with the folks who are our constituents, our direct stakeholders, which is a nice fit for what we are doing. It has allowed us to be integrated into their work and be seen as necessary for their work. We are working collaboratively and really having good conversations about what we are doing. It has been great.

Commenter: Our preservation department is under collection services, although previously we were under special collections. It has been under collection services since I started, and I have heard it is a better fit.

Dube: I like our situation. We are horizontal with special collections, and with digitization, it is ideal.

Commenter: At my university library, it is a bit of a split. I am a tenure track librarian. As the head of preservation/conservation, I am part of tenured support services. Through me, the department reports to our associate deans, who also oversee shared collections storage and digitization. We are two separate groups, but not part of collection services in any way. The collections report through a different associate dean. I have seven libraries that I am responsible for and pay attention to all equally.

Question for Allison Gerber: Is your audio survey attached to CMS (Cataloguing and Metadata Services) in some way, or is it completely separate? Is this functional, or do you see it causing problems down the road for reformatting things based on the survey that are not reflected in CMS? Did you find anything interesting or unexpected across the repositories during the survey?

Gerber: The data was kept separate from CMS. We formatted the survey in a standard way. We pulled information out of each unit's CMS and then codified it to our needs. We have to go back through the data and do that. The units each got a copy of their own data. They were kept separately and aggregated into one spreadsheet. There is flexibility in that individual units do what they want with that data. There was no institutional effort to integrate that data back into CMS. Everybody has a different CMS at the Smithsonian, so it would be impossible to do that. The numbers, in general, were an interesting find. Many people were surprised since the archives are not cataloged at the item level. I would love for that to change. Typically, they are not. Now we have the numbers and a breakdown of the formats. Even the media types were eye opening for people, as they just had no idea how much they had. We also discovered we have 60 different formats in our collections. What are we going to do with 60 individual formats that require specific playback equipment, specific workflows, and specific conservation treatments? It definitely started a big conversation.

Commenter: A comment about the organizational chart issue. We have moved any number of times in my 11 years at my university. We started under a collection development umbrella that included subject specialists. The department was later changed and moved under the head of a particular library's special collections, but not all special collections. Now we are part of a new division that includes collections development. This includes folks who oversee the budget and are involved in a lot of high-level negotiating. It is interesting to hear Liz Dube state that you are in a group you regularly work with. I am not. We do not interact with any of those groups much at all. That is an interesting thing to think about in terms of an organizational chart.

Dube: You want to keep your stakeholders close to you.

Commenter: Question for anyone using a flag or some identification method where others, like archivists or librarians, are identifying things for you. Do you have any kind of program to create a shared understanding about what and what is not a preservation priority? That is something we struggle with, and I feel we need to take a more active role engaging in the dialogue to define. Does anyone have any ideas or ways that you are dealing with that?

Commenter: At our university, some people get things right away and have enough to do that they check the boxes and let you do the rest. Other people get very engaged and require a conversation regarding low processing priorities they have made into an emergency preservation priority. We are not going to preserve it until it has been cataloged. We try to get that sense of emergency dialed back a little

bit. Sometimes it is a particular staff person, and meetings and training do not help. You just have to keep trying and hope the other people in the room are staying consistent and engaged.

Commenter: We do not actually have a flag program for special collections. There are multiple flags for circulating collections. For general and special collections, we built this understanding that if people think there is a problem, my door is open and they can send me whatever they want. Ultimately, my department has the final authority on what is and is not a priority and what will and will not get treated. For circulating collections, it is harder to agree because new books can be purchased or there is data to support a book that did not circulate for 10 years and can be let go. For special collections, I have told the curators to talk to me before they send me anything. We are in a temporary space and do not have a lot of storage. I do not want objects piling up for 5 years like they have in the past. I do not know if there is a way to indicate information on the flag itself, but there should be a conversation when you are building a system to ask the intended use. Why do you think this is an emergency? We have many things that need repair, so that cannot be the only reason why we are going to treat something. Are you using it for a class next week, or is there an exhibit next month? We have so many big picture issues to focus on right now. We have been doing an archives survey of all accessions that have not been processed for years. A team of students is going through all the boxes and capturing information on what state the description is in, the state of the housing, and the preservation issues. At first, the students started putting things aside to be looked at by a conservator. We then told them to note issues, and we would look at the information later and develop a strategic approach. This will help us identify problems in groups.

Commenter to Allison Olson: My experience at my institution is that the power of precedent is strong among state archives, and many are looking to NARA. When I need to advocate for preservation and conservation, it behooves me to have examples I can point to at other archives and NARA to illustrate what others are doing. Will you all be able to make portions of your final preservation strategy and other plans public? It would be great to set NARA up as a leader and enable some discussions.

Olson: Absolutely. The preservation strategy will be on our website and is pretty much final. The archival storage standard has only been reviewed in preservation programs. It will also be on our website once it has gone through the review process. It may take some time, but we are very interested in sharing our work.

Dube: To the previous question, we have some standard workflows that have routine processes that can be left off discussing during the monthly meeting. The conversation regarding flags is always happening. The curators keep learning more about what is appropriate after seeing the work that comes back and gaining a better understanding of what is possible.

Commenter: Our workflows for both special and open general collections are triggered by use. We do not go through the stacks and pull things because they are in poor condition. The items must be used. The work generated can be for a class or a patron, but it must be someone other than a curator looking at an item and stating it is in need of repair.

ACKNOWLEDGMENTS

The co-chairs of Archives Conservation Discussion Group would like to thank BPG Program Chair Jen Hunt Johnson and Assistant Program Chair Eliza Spaulding for their assistance in planning and organizing this session. They would also like to thank Melina Avery for presenting on behalf of Sue Donovan. They 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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Art on Paper Discussion Group 2019
Expanding the Toolbox: Making Artists' Materials Reference Collections Relevant to Conservation Practice

INTRODUCTION

As conservators we are drawn to artifacts, whether for their beauty, their spiritual or intellectual significance, or the tactile qualities they display. Most conservators can also attest to their love of art-making materials, and many of us have personally amassed or enjoyed collections of beautiful papers, pigments, pastels, ink, and paint. This year's Art on Paper Discussion Group program examined how conservators build and utilize reference collections of artists' materials to inform conservation practice, our understanding of works of art made with them, and our treatment of these objects. The session began with an introduction to current collection initiatives. This was followed by seven presentations by paper conservators, scientists, and educators on their personal and institutional approaches to collecting, using, and organizing these materials and associated data.

The topic is relevant today for several reasons. First, the proliferation of Internet resources for historical specialized artist materials has facilitated direct relationships with vendors and manufacturers, making it possible for individual conservators to build significant collections of these items. In addition, as our colleagues begin to retire, they are considering steps to organize and share the valuable study materials they have amassed over long careers. This also holds true for collectors outside our field who have extensive collections of materials that would be of great interest to paper conservators. Recent examples include study collections such as the Berger-Cloonan Collection of Decorative Papers at Texas A&M University, or more data-driven resources such as the Paul Messier Photographic Papers Collection, purchased in 2015 by Yale University for its Lens Media Lab.

The process of forming these two collections was presented to raise several points that were addressed by our speakers: How does one determine where their collection goes? How are these collections being cataloged and accessed? What are the most basic solutions for organization? Is the collection static or evolving? How is the collection made most useful? The topic resonates as our colleagues at several institutions have begun the Herculean task of determining cataloging methods to systematically organize and describe artist materials reference collections on a large scale. With these thoughts in mind, the first three speakers, Michelle Facini, Marjorie Shelley, and Jodie Utter, presented significant institutional reference collections developed by paper conservators, outlining their current organization and use. Our second group of speakers, Amanda Hunter Johnson, Margaret Holben Ellis, and Joseph G. Barabe, addressed the topic of making reference collections relevant to conservation practice, and our last speaker, Andrew Davis, addressed issues of accessibility and complex data management. What follows are summaries and/or excerpts from their oral presentations, revised into the third person for clarity and ease of reading.

SUMMARY OF PRESENTATIONS

MICHELLE FACINI
THE PAPER COLLECTION AT THE NATIONAL GALLERY OF ART

In the opening presentation, Facini introduced the audience to the paper sample collection at the National Gallery, describing it as a collection of mainly 20th- and 21st-century paper samples. Criteria for acquisition require that the sample papers be intended for making works of art; that they be dated; and that any information about the manufacturers, distributors, and merchants associated with the paper samples be provided. To date, there are approximately 3000 pieces in the collection that comprise booklets, bound volumes, and

This open discussion took place on May 17, 2019, during AIC's 47th annual meeting in Uncasville, Connecticut. The moderators organized and led the discussion and recorded notes. Readers are reminded that the moderators do not necessarily endorse all comments recorded, and although every effort was made to record proceedings accurately, further evaluation or research is advised before incorporating any observations into practice.

whole individual sheets from approximately 160 different companies. A database of the collection includes information regarding country of origin, manufacture date, papermaking process, and watermark. Those interested are encouraged to examine the collection firsthand so that they can get an aesthetic and tactile sense of the samples; examine color and texture; and, if so desired, also consult the National Gallery's volumes on paper history, its watermark publications, and its extensive collection of paper trade directories.

Paper conservator Judith Walsh, who had forged a relationship with the Strathmore Paper Company (purchased by International Paper in 1986), conceived of and started the paper sample collection. Walsh negotiated that any duplicate paper samples that Strathmore had would be put together as a group and donated to the National Gallery. Today, the Strathmore donation comprises 30% of the paper sample collection. Perhaps better known is the collection that was acquired when New York Central Art Supply closed in 2016. The owners of the store were true curators of paper and had acquired many special 20th-century papers over a period of 70 years. For the owners of the store, it was important to know that the collection would be preserved for posterity. And as various smaller art suppliers close, they too have made donations to the National Gallery's collection. Facini showed a 1982 example of an Arches paper sample book that includes valuable information on the production method, fibers, sizing, weights, dimensions, color, and watermarks of each paper in the volume. Gallery paper conservators Marion Dirda and Kim Schenck are constantly looking for materials to add to the collection from online sources and eBay. One example of a recent acquisition is a two-volume sample book, dating from 1914 and 1916, that includes samples and a price list.

Users of the paper sample collection include everyone from historians to curators to paper conservators. More often, a curator will be interested in a watermarked print or drawing, and using the collection, the conservators are sometimes able to find an exact match and follow the trajectory of its use over a period of years. For paper conservators, the collection provides several significant uses. In one example, Facini cited a treatment carried out at the National Gallery that involved comparing an exact match of a *gampi* paper used for a print that the conservator hoped to treat using gels and acetone. Before using these materials on the work of art, she was able to use the sample as a surrogate to ensure that her treatment protocol would not alter the surface sheen of the delicate *gampi* paper. In another example, a conservator from another institution contacted National Gallery conservators regarding a Jasper Johns print that was thought to be discolored. A matching paper sample located in the collection showed that the current paper tone was accurate, and was then successfully used to prove that the print was not at all discolored and actually in very good condition. Comparison with another impression of the same print on the same paper in the National Gallery's collection made it clear that the paper tone was intended by Johns and that no aqueous treatment was necessary. And in a final nod to artists' intentions, Facini cited a Picasso collage entitled *Cup of Coffee*, in which the tone of a central collage element of Fabriano paper had discolored. Using a sample of the same type of paper from the collection, she could ascertain what the color of the collage element was intended to be—and this visual information, of course, could be readily used as a baseline to digitally color correct an image to create a surrogate that more accurately reflects the original tone of the paper.

Looking to future development of the paper sample collection, Facini emphasized that relationships are everything. Paper conservators from the National Gallery actively take oral histories from manufacturers, papermakers, and suppliers in the US and abroad. They visit paper mills and are active in the International Society of Paper Historians. Outreach is very important to continue to actively build the collection. And with new digital initiatives at the National Gallery, they hope to make their database more dynamically searchable. They will be checking content for accuracy and ascribing authorship to comments. They are pondering how they might incorporate images, and, most importantly, how to link this data to works of art to provide broader context. Hoping to make the database more versatile, they know that they will need to migrate data from platform to platform as new technologies arise. They also wish to make the database open access, and for this they need to determine what kind of coding platforms are needed. Although there is a lot of work ahead, there is no doubt that the National Gallery's paper sample collection will continue to grow and remain an important resource for scholars and paper conservators.

Michelle Facini, Paper Conservator, National Gallery of Art, Washington, DC

MARJORIE SHELLEY
THE METROPOLITAN MUSEUM OF ART HISTORIC ARTISTS' MATERIALS COLLECTION

Shelley began her presentation by noting that there are many different ways of forming and interpreting a collection of important historical art-making materials and summarized the Metropolitan Museum of Art's criteria for collecting these materials, the condition issues that they present, and their connections to the arts practices and cultural milieu in which they were produced. She started by emphasizing that most are rare, unique objects for which there are no precedents or bodies of information. They are cultural and utilitarian tools. They reflect historical practices and lend themselves to interpretation by conservators, as well as to collaboration with art historians, curators, and scientists. Shelley

has had ongoing success since starting the collection, deepening the Met's holdings and spreading the word about these materials through presentations, essays, and visits to the paper laboratory where they are stored in cabinets and displayed in vitrines. However, access is limited, as the paper conservation department is not open to the public. The collection has not been included in the museum's online database because it is considered nonaccessioned material; this is something that Shelley wishes to change with the hope that the collection will get more use. To do so will require hiring a collection manager to prepare an exhaustive inventory. Until then, the materials are listed in a FileMaker Pro database. Nevertheless, the collection has proven highly valuable for studying and teaching the history of materials to art conservators and art historians. It comprises fascinating examples of material culture; the tangible evidence of the equipment and tools that have shaped our artistic heritage and speak to the interwoven network of discovery, trade, and the transmission of ideas. Its diversity also provides possibilities for analysis and identification.

Shelley assembled objects and apparatus associated with the European and American works on paper from the 17th through the early 20th century in the collection that are part of her department's purview. The collection encompasses materials and tools used in studio and *plein air* practice. She has been able to acquire or purchase them from art dealers, flea markets, and eBay, and is supported by departmental funds, gifts from friends and dealers, and remarkably from strangers who have only heard about the collection. Among her first challenges in making an acquisition is determining its worthiness—how it fits into the collection, the story it tells. Typically, lacking provenance and substantive information is the case. A range of resources are consulted to justify a purchase or to accept a gift. Background checks include finding comparable objects in painting, drawing, and print descriptions, as well as in encyclopedias, artist manuals, memoirs, and the art-historical literature. A thorough examination is also undertaken to determine the authenticity of the component parts. Another issue that is considered is condition. Frequently, such objects are in poor shape from the ravages of time and generations of use. Conservation of these objects usually is not undertaken apart from the repair of small elements.

Many of the issues that Shelley faces are exemplified in a French 18th-century manikin that was a gift from a portrait painter—and there was no question as to its importance to the collection. Manikins were part of artists' workshops from the 14th to the late 19th century, serving as surrogates for sitters. Although far from paper (apart from the removable papier-mâché head), it was an appropriate acquisition because such objects served as models for drapery and figure studies drawn on paper. In addition, this example is notable because it is life size, fully articulated, and signed, which is a great rarity. Technical examination reveals that it is composed of metal, bast fiber stuffing, and silk stocking coverings. X-rays show an armature that is in extraordinarily good shape and in fact corresponds to the illustrations in Diderot's encyclopedia. Its external condition, however, is very poor. Because this and the other objects in the collection are not works of art, acquisition criteria are not based on aesthetic or pristine appearance but on how they were used and what they can tell us about the artistic process and other related information. Here, conservation intervention was a necessity. The damage distracted from the manikin's visual integrity, and it could not be handled safely. To prevent further damage and preserve the original silk coverings, the textile, upholstery, and ethnographic conservators agreed that a nylon fabric covering should be used to protect the silk coverings. This precaution was successful in that the original fabric remained visible and the nylon fabric covering can be removed at any time. As a result of successful conservation intervention, the manikin was included in an exhibition at the Met and recently has been requested for loan, making it possible for more and more people to see objects like this—ones they may not know even existed.

Among the many riches in the collection, Shelley showed examples of a colorman's sample kit dating from ca. 1900, a box containing vials of pigments with the label Sewell; a *plein air* set with a collapsible paint box, stool, and mahl stick; and 19th-century pastel boxes, including one owned by Mary Cassatt dating from ca. 1893. Lightweight tinned containers that became popular in the 19th century are well represented, as are geometric and drafting tool sets. An 18th-century painter's table intended for studio use contains two drawers and a wooden palette. Some of these objects are luxury goods replete with sterling silver and ivory tools, whereas others are more humble, ordinary examples. Shelley pointed out one simple tool known as a grainer intended for decorating paper—and as luck would have it, she was able to determine that in a collage in the collection, artist Juan Gris used a similar tool! Another box that is of particular interest was custom made in the 18th century and contains what Shelley believes is the atelier of an itinerant artist, including powdered colors, hard cake colors, and ivory palettes. But what is most interesting is that it corresponds to a painting by Rembrandt Peale in which he is seated at a similar paint box and on which he has placed miniatures with the lid serving as an easel for his work. Also interesting is that one of the vials of powdered pigment contains the label of a Baltimore colorman, with Baltimore being the very city in which Peale worked as a miniaturist. Today, this box is on permanent display in the Met's American Wing, in the miniature gallery.

As for the future, in addition to building the collection further—it presently comprises 200 objects–Shelley hopes to continue to link these materials with works of art and to see them included in more of the museum's exhibitions. She

hopes to encourage greater use of media samples for analysis and, most importantly, to wholesomely catalog and inventory the collection.

Marjorie Shelley, Sherman Fairchild Conservator in Charge, Paper Conservation, The Metropolitan Museum of Art

JODIE UTTER
ARTIST MATERIALS AT THE AMON CARTER MUSEUM OF AMERICAN ART

Utter has been dedicated to building the Amon Carter Museum of American Art's study collection of artists' materials, cataloging and making them accessible for many years. The collection includes examples of materials from the late 19th to the early 20th century. Utter started the collection as part of her research on the artist Charles Russell, hoping to replicate his methods and better understand his materials and techniques on a visceral level. From that beginning, she has been collecting for close to 10 years, with funding provided by the museum. The collection includes watercolors, sample booklets, different types of papers, and advertisements that are particularly important for the addresses they include. Recently, she has started to collect French trade manuals. In her presentation, Utter discussed cataloging the collection as a nonarchivist and trying to think about a numbering system as an archivist would. With the guidance of the museum's archivist, they established "family numbers" that, although long and cumbersome, reflected the year the object was acquired and what number object it was in that given year. From there, any additional elements are "children" that are further numbered. Luckily, Utter was able to bring in a master's student in library sciences to catalog about 3000 discrete objects. Each object is numbered together as a group, and because it has family and children numbers, discrete parts can be separated if necessary and then put back into place. The cataloger took detailed photographs of the materials in their boxes, with the numbers of each item visible in the picture. All of this was entered into an Excel spreadsheet.

Early on in her collecting, Utter paid a visit to Michael Skalka at the National Gallery, where he oversees an enormous collection of artist materials. His database was built in FileMaker Pro, as was Marjorie Shelley's at the Metropolitan Museum of Art. And although the information technology department at the Amon Carter did not wish to, they allowed Utter to retain access to FileMaker Pro so that she is able to retain access to the National Gallery's database. However, at the Amon Carter, Utter used Excel to build the bones for her cataloging, and at some point this information will be uploaded to the museum's collection database (developed in New Zealand and called *Ke Emu*). The fields she established in Excel will have a place within that database, and considering that it was built for natural science collections, it will be well suited to her needs.

Hand in hand with cataloging the artist materials, Utter had to give serious consideration to how and where the collection would be stored. In the early days of collecting, the materials were stored in the paper conservation laboratory; however, as the collection grew and once it was cataloged, Utter turned it over to the archives department. The various materials are stored there in archival boxes. And instead of numbering each object individually, each small package within a box is numbered. For example, a watercolor tin will have a family number and children numbers on it, using labels adhered to the outside of the wrapping tissue. These numbered packages are photographed in situ and can be consulted in the event that one element within a larger box is misplaced. Utter also took the precaution of putting individual paints into small sample bags in the event that they begin to ooze or fall apart. She makes sure that there is not a lot in each archival box so that boxes do not become cumbersome or too heavy.

Ultimately, Utter's goal was accessibility. Once the artist materials were cataloged in a searchable database and properly stored so that they could be handled and cared for, she realized that they were useless to anybody else unless she could share them. Her goal was to share items from the collection with the education department, her exhibitions department, and with her curators as didactic teaching tools. Even though the database currently resides in the Excel spreadsheet, the archives department has made it a goal to upload the information into the collection database in the coming year. The museum will also be getting a new website in which the artist materials collection will be completely accessible. Her hope is that this will be welcoming not only to outside scholarly researchers but also to teachers all the way from grade school to the graduate level. Increasingly, classes are being offered on historic artist materials, and her collection is a perfect fit for this kind of class. Finally, the museum has undergone a major remodel that includes a new permanent collection area in which the curators are now routinely incorporating various tools and materials alongside works of art to demonstrate how these objects and artworks were made. This drives interest as well, and with the interest garnered, Utter anticipates that the collection will become more and more accessible in the future.

Jodie Utter, Senior Conservator of Works on Paper, The Amon Carter Museum of American Art

AMANDA HUNTER JOHNSON
THE ARTIST MATERIAL COLLECTION AT THE SAN FRANCISCO MUSEUM OF MODERN ART

As a conservator working in a museum of modern art, Johnson continued the discussion by presenting her museum's unique perspective on the artist materials collection at the San Francisco Museum of Modern Art and how they are

using it. The museum's mission states that they believe the art of our time is vital and shared with passion and purpose. Each year, the museum works with 30 to 40 living artists through exhibition, acquisition, or loan of art. Building trusting relationships with artists over time leads to better stewardship of their art. And this dynamic is one of the biggest contributions that conservators can make to the future care of contemporary art. This working relationship often results in tangible evidence of an artist's practice, and this is what they are including in their artist materials collection items that help to illustrate practice. The Artist Material Collection (AMC) is constantly growing and includes approximately 300 objects. These could be objects used by artists to create artworks, such as Jay Defeo's painting tools or fragments from an Yves Klein sponge. Items may also be given by an artist or an artist's estate to help inform a treatment, such as mock-ups and tools from Robert Gober used to treat one of his beeswax sculptures. The collection also includes mock-ups created by conservators to better understand techniques, such as those made to study Robert Rauchenberg's process. Sometimes there are formal donations, such as a recent large donation from the Frederick Hammersley estate that includes many unfinished paintings and tools.

Over the years, the conservators turn to these objects during tours and presentations because they help tell the story of their work as contemporary art conservators. When planning began for their new building, they knew they wanted to make the AMC a focal point. Samuel Andersen Architects designed many of the nongallery spaces in the new building, and they designed a two-story tower to display and store the AMC. The tower became the central integrating feature of the conservation studios and extends from the seventh floor, through a hole in the ceiling, to the eighth-floor studio. All objects on that central tower are artists' materials. Having a two-story tower to display materials that deepen knowledge about an artist or work in the collection is a whole other arena for engagement. The tower has different surfaces, painted drywall to pin objects, steel to hang works with magnets, light boxes, and many drawers.

Currently, the objects in the AMC are in a database that is in the process of being linked to the museum's collection management system to provide more access. The aspiration for these materials is for them to be available to staff, scholars, students, and the public for research or study to deepen appreciation and awareness of an artwork by illustrating the artist's process, materials, or ideas; to help preserve an artwork; and to create a record of iterations of conceptual works. Conservators at the museum are using these materials and making them relevant in three different areas: incorporating artist materials into gallery spaces, hands-on engagement, and creating a record of conceptual art iterations. Artist materials are routinely incorporated into exhibitions in an interpretive gallery on the second floor. A recent rotation included tools and sketchbooks from Ruth Asawa's studio. A recent exhibition of Wayne Thiebaud's work was complemented by materials from his studio that included brushes loaded up with paint; paper plate palettes; or, Johnson's favorite, palettes made from the lids of tennis ball cans. Staff from the Content Strategy and Digital Engagement team managed the case in the exhibition.

One of the beautiful aspects of the AMC is that these objects can be handled. As part of the Artist's Initiative Program funded by the Andrew W. Mellon Foundation, several workshops were held in the seventh-floor workroom to complement a Vija Celmins retrospective. One of the main goals was to provide the means and access for close looking and discussion of Celmin materials and techniques. One session explored Celmins' drawing process by testing different grades of pencils on papers with an acrylic ground and papers without a ground. This activity led to a rich discussion about the physical interactions of materials and how the ground layer changed the sensation of drawing. It is a fairly simple exercise, but it led to a nuanced discussion and observations that probably would not have been arrived at without physically handling the materials. In a similar activity, the group looked at Celmins' *To Fix the Image in Memory I-XI* (1977–1982) in the gallery. The work consists of 11 found stones and 11 painted bronze casts of those stones, created by Celmins over 5 years. The participants made several bronze casts of found rocks that they could hold and feel and learn about from tactile means. When in the galleries, participants commented that they really wanted to touch the rocks and feel them and turn them over and look closer. This exercise provided that opportunity.

Perhaps some of the most relevant objects in the AMC are the objects that relate to conceptual works in the collection. Adrian Piper's installation *Art for the Art World Surface Pattern* is a good example. The work is dated 1976, as that is the date the work was conceived. As a conceptual work, honoring the intentions of the work and experiencing the installation are paramount, and the work is remade as needed. The artist provided written instructions, a digital file of the wallpaper image, and audio recordings. Due to the nature of the instructions, slight variables arise in its design and appearance every time the work is remade. An opportunity to learn more about the work by discussing it with the artist and the curator to further refine acceptable parameters of variability takes place each time the work is recreated. The work has been loaned three times in the past 15 years and is remade each time. The iterations were each approved by the artist's studio. After each exhibition, the San Francisco Museum of Modern Art requested that the borrower send a sample of the wallpaper for the AMC, as well as installation photographs, to add to the record. Then the work was destroyed. In the few iterations of wallpaper, you can see slight variations each time, and review with the artist or studio can lead to a fuller record

of acceptable variability. Considering that these iterations were destroyed after exhibition, if a staff member wanted to learn more, he or she would have to turn to the content management system, archives, photographs, and instructions, so having a physical record, even if just a fragment, of the various iterations becomes very valuable for reference. In this way, the AMC is a complement to the museum's current documentation system and an ever-growing part of the museum's resources.

Amanda Hunter Johnson, Conservator, San Francisco Museum of Modern Art

MARGARET HOLBEN ELLIS
EXPANDING THE TOOLBOX: MAKING REFERENCE COLLECTIONS RELEVANT TO CONSERVATION PRACTICE

Ellis began by stating, "By now it should be clear that our interests in historic artist materials extends far beyond a natural attraction to mysterious substances and gadgets found in antique wooden boxes and shiny black japanned tins. Be it teaching, research or treatment, reference sets of historic artists materials can inform daily conservation treatment." Rather than showing an assortment of beautiful 18th- and 19th-century watercolor sets and oil painting kits and their related paraphernalia, Ellis concentrated on just three types of artist materials introduced in the early to mid-20th century. Although less photogenic, mid-century porous pointed pens, water soluble pencils and crayons, and optically brightened papers can all serve as examples of how we can expand our conservation toolbox by making use of these collections. Ellis has found that an in-depth study of historic artist materials can lead to many positive outcomes when it comes to conservation practice, and she cites just four: they can more accurately be used to identify media and techniques, they can better inform our conservation decisions, they can guide preventive conservation strategies, and they can encourage something she calls *technology transfer*. Ellis goes on to share her findings about the three groups of materials: the porous pointed pens, the water soluble pencils and crayons, and the optically brightened papers.

Porous pointed pens were first introduced to the American public during the Second World War. However, they were far different from the markers we use today. Advertised as a new way to write, even in rain and snow, these pens were quite primitive, mechanically speaking. An empty metal barrel served as a reservoir for xylene-toluene—based inks that contained highly saturated, light-sensitive dyes. Exchangeable felt tips allowed for a variety of lines ranging from bold italics to a standard pen line. A valve controlled the amount of ink flow. Ellis asked, "How does the study of early porous pointed pens produce the outcomes listed above?" She showed that the width of lines produced in a ca. 1960 drawing corresponded with a range of nib profiles that were available with a Flowmaster pen, all of which she had. The saturated colors corresponded with those for sale with the Flowmaster pen. The solvent caused the inks to immediately penetrate the paper and dry quickly, allowing for overlap and making is possible for the scribbled colors to not bleed or blend. The uneven deposition of ink indicated an inconsistent release of ink due to faulty valve control and pressure, a problem overcome in later pens by the insertion of a controlled fluid delivery system using Teflon and polyester nibs. By carefully comparing the characteristics of the drawing's lines and colors with the actual implement and its inks, she could more precisely identify the media and technique. This knowledge contributes to what she knows about the artist's studio practice and potentially aids in dating. Because Ellis knew that the inks were solvent based, she was pretty sure that the water stain in the drawing could be safely reduced with water, whereas Scotch tape residue would require a careful solvent application. Thus, by having a reference set, Ellis could make better treatment decisions.

Ellis goes on to state that it is now known that drawings done in these early porous point pens suffer from poor light stability and that certain colors, especially the blue ones (as seen in a drawing she showed as an example), mysteriously transfer from one sheet when in direct contact with another in storage. This is a phenomenon that is called *color transfer*, and it can continue for more than 25 years. Thus, based on this knowledge, she asserts that conservators can suggest limited exhibition and no contact between drawings while in storage. Therefore, knowledge of the properties of the solvents and dyes of these inks results in better preventive conservation strategies.

In addition, conservators can apply a higher understanding of the technology of porous point pens to conservation-related uses, again something she refers to as technology transfer. For example, a contained and controlled flow of solvents is useful for spot testing. Easily obtainable barrels and nibs can be assembled and filled with solvents or water. This reduces the amount of expensive and toxic solvents that we typically pour out for spot testing, plus it limits our exposure to them. Spot testing pens are also very portable. The plastic components of Flair pens are not compatible with solvents but can easily be converted into water tear pens. And she showed two spot testing pens for use with acetone and toluene. The reserve materials are called the *fluid delivery system*. This is something found in later pens and has potential for use as poultices or to control the directional flow of liquids.

The next category of artist reference materials that Ellis discussed is water-soluble pencils and crayons, and by carefully studying these materials she stated that many of the same desirable outcomes could be achieved. No surprise to veteran paper conservators, Mephisto copy pencils look like graphite but bleed bright purple at the slightest hint of moisture. The ability to accurately identify copy pencil as a

medium reflects studio practice and dating but also alerts us to avoid the application of water in any manner, and knowing the light sensitivity of methylene purple also warns against a prolonged display. Other dry media that easily solubilize in water include colored pencils and crayons. When used in a dry manner, these media are virtually indistinguishable from regular colored pencils and crayons. However, Jackson Pollock used both water-soluble and regular colored pencils indiscriminately on the same sheet of paper. A drawing by Joan Mitchell can be more accurately identified as being created in water soluble wax crayons, not only through close examination but also because the Joan Mitchell Foundation has scrupulously saved Mitchell's studio materials, allowing for easy comparison.

Finally, Ellis discussed her new, groundbreaking research on papers containing optical brightening agents (OBAs) that were introduced in the mid-1950s. Ellis showed a selection of printed greeting cards by Milton Avery dating from the 1950s. Under visible illumination, they are similar in color—a fairly consistent white. Although the properties of paper are rarely, if ever, mentioned in gallery labels or catalogs, the knowledge that a paper contains optical brighteners explains its appearance and potentially informs dating, thus satisfying our objective of more accurately identifying media and techniques. She goes on to show that under UV radiation, the Avery papers differ greatly in their fluorescence. Going back to one of the cards, she shows that the front of the card no longer fluoresces, whereas the back of the card that was protected from light still fluoresces brightly. Although the color of the paper may persist, the brightness decreases over time. The knowledge that a paper contains OBAs thus can influence our preventative conservation strategies for its exhibition. But how does the presence of OBAs inform our treatment decisions? We know from previous research that OBAs are soluble in water. As part of a broader investigation of OBAs, New York University students tracked their migration during a typical washing and drying process. Reference sets of popular contemporary printmaking papers containing OBAs were assembled and documented using UV targets, and a range of fluorescence was visible. Samples were washed, and the amount of OBAs released was measured over time using a colorimeter. After washing, samples were transferred onto nonoptically brightened blotters for drying. Significant migration of the OBAs occurred! In addition, the OBAs that remain on the conservator's hands can migrate and deposit onto other nonoptically brightened papers, such as in an example of a 16th-century antique laid paper that she showed the audience. The knowledge that OBAs can migrate during treatment will certainly demand different treatment protocols in the future. With just three sets of artist reference materials used in her presentation, Ellis articulated how substantial study of these materials can inform conservation practice.

Margaret Holben Ellis, Eugene Thaw Professor of Paper Conservation, Institute of Fine Arts, New York University

JOSEPH G. BARABE
ARTISTS' MATERIALS REFERENCE COLLECTIONS: HOW TO CREATE AND USE THEM AND WHY THEY ARE ESSENTIAL IN ANALYSIS

As a private consultant in art materials and document analysis, Barabe has created several reference collections to aid his work. Barabe's main tool for analysis is the polarized microscope, a tool that he favors as an analytical method because it is a very fast way to identify a wide variety of materials. His large pigment collection includes both mounted samples and dry samples, and having both provides him with the versatility to use additional analytical methods. He has found that the reference samples that he has collected over the years are especially important in teaching pigment identification and in the identification of printing processes. Now that he has retired after a 25-year career at McCrone Associates, he is taking selected materials, creating sample sets, and sharing them with others who have similar interests. In his laboratory, he has a vast collection of mounted pigment samples, as well as samples of drawing materials. From Dr. Walter McCrone, Barabe received significant examples from the Forbes collection, the Doerner collection, and the Cornell collection, where McCrone had access to some very early industrial and commercial pigments. Over the years, Barabe has also developed a relationship with Dr. Georg Kremer and has a comprehensive collection of his company's materials, as well as a collection of pigments manufactured by *Aus Eigener Herstellung*. Barabe's collection continues to grow as he receives sample collections from friends and colleagues.

To organize his collection, Barabe collects and stores his pigment samples in small capillary tubes, then numbers and catalogs them using an Excel database. His records include source information for each sample, as well as the original classification system that he received from Dr. McCrone, which he believes originally came from colleagues at Harvard University. Barabe noted the value in collecting similar pigments from difference sources, citing the mineralogical and visual differences, for example, in lapis lazuli sourced from Chile versus Afghanistan. This emphasized the importance of provenance and the benefit of understanding variability of a pigment from a range of samples.

In addition to pigment analysis, Barabe has extensive experience in forensic document examination that involves the study of various printing processes. As an instructor, teaching workshops in pigment identification and printing process identification for the Hooke College of Applied Sciences, he has created affordable reference collections of 70 artist pigments and 45 printing process exemplars chosen to provide good-quality samples with characteristics that are

typical for the materials. He recommends photomechanical and photographic reference materials compiled by photo conservator Gawain Weaver, as well as the *New Zealand Police Printing Process Manual*, as valuable references for print process identification.

Joseph G. Barabe, Research Microscopist, Barabe & Associates LLC

ANDREW DAVIS
PRESERVATION REFERENCE MATERIALS: PHYSICAL COLLECTIONS AND DIGITAL INFRASTRUCTURE

Dr. Andrew Davis introduced the Center for the Library's Analytical Scientific Samples (CLASS), of the Library of Congress, established in 2008 to collect scientific reference materials that would support research and reflect the diverse range of materials in the collections. CLASS includes William James Barrow's 1000-book collection, modern and historic paper samples, parchment, textiles, plant and synthetic fibers, pigments, modern media, wax cylinders, photographs, and modern artists' and conservators' materials. Advancing from the physical collation was the digital infrastructure to collect, track, and link scientific analyses to the original reference samples (CLASS-D, "D" for digital). This database includes baseline characterization data for all the reference samples, aiding the selection of the best reference sample that matches collection items. The reference sample from CLASS can be used for destructive and predictive testing in research projects to support assessment of conservation treatments and impact of environmental parameters. CLASS-D has been structured so that research projects can be created by linking multiple reference samples and multiple analytical techniques to each reference sample—a unique aspect of the infrastructure. Standardized file formats and protocols have been established for open access and sustainability of the research data.

To increase accessibility of the reference materials within the Library of Congress, the Preservation Research and Testing Division established protocols for barcoding and cataloging all items within CLASS to ensure tracking and provenance. All information is uploaded into CLASS-D, and a system is in place for tracking and linking any extracted smaller "child/sibling" samples taken from the original "parent" reference sample. This allows for linking of temporal data and changes due to both natural and accelerated aging between different research projects. When new reference collection materials come into CLASS, they are assessed, cataloged, and collated into either a new or existing CLASS collection material type, then rehoused for ease of access and longevity with storage materials that meet Library of Congress quality assurance specifications. One procedure that has been established for new reference samples is to extract a small "pure" sample that is not used for testing. This helps ensure that there are pure, uncontaminated reference samples stored separately from frequently accessed items, such as pigments.

CLASS is continually expanding to include additional reference materials that are needed to aid preservation of Library of Congress collections. The reference samples have been imperative for providing historic materials of known origin and/or composition, needed for various research projects. The baseline characterization of all reference samples through both destructive and noninvasive testing has greatly assisted the application of noninvasive testing on Library of Congress collection items by being able to link the noninvasive with the destructive testing on reference samples. Having an extensive characterization of the reference materials' composition from chemical, mechanical, and optical analyses significantly expands the cross utilization of the data from these samples for research. Research projects include linking the destructive and nondestructive analytical techniques for assessing organic and inorganic materials, and from the creation of replicates of potential conservation treatments, researchers can use these with accelerated aging for predictive testing. Additionally, the continued repeated analysis of the reference materials allows for assessment of the natural aging of the reference materials, which can then be aligned with results of their accelerated aging. This component is expanded further by then linking this information with the natural aging found in Library of Congress collection items. A proactive aspect of CLASS is the creation of new composite materials that better assist research into collections. For example, those in the Preservation Research and Testing Division staff have actively been creating pigment samples using original historic recipes on a range of substrates (papers of different sizes, parchments, glass slides, etc.) to best replicate historic materials within Library of Congress collections. Considering that many modern pigment manufactures are creating pigments and colorants that are not the same as historic examples, this set of reference samples has been invaluable. Part of the new reference materials' creation process includes creating mock-ups with different binders and concentrations, as well as multiple sets, so that a "pre" reference set can be kept in cold storage while other replicates from the set can undergo various analyses and aging. These samples have also been useful where it is necessary to determine possible impurities from the original material to ensure an accurate mock-up. CLASS and CLASS-D have expanded and supported research into preventing degradation of Library of Congress collections. The research projects including the use of the reference samples has allowed for more informed use and interpretation of nondestructive analyses of organic and inorganic Library of Congress collection items.

Dr. Fenella G. France, Amanda Satorius, and Andrew Davis, Preservation Research and Testing Division, Library of Congress

DISCUSSION

After the last presentation, the moderators opened up the floor for questions and comments. The closing group discussion reiterated the value of reference material collections to inform conservation treatment decisions, to educate colleagues and the public, and as a vital record of material culture. Institutional conservators with established collecting practices encouraged colleagues in smaller institutions and in private practice to seek support for acquiring any potentially valuable reference materials, with a consensus that these materials are quickly disappearing from the market as specialty manufacturers close and dealers retire. Challenges regarding cataloging and access were also expressed, with a collective desire for a simple open source platform as a place to start compiling a record of existing reference collections of any size. Book and Paper Group Wiki volunteers expressed vocal support to create a basic searchable repository to which individual conservators could submit a description of available materials so that colleagues can more easily locate and utilize material information. Even if only a general description of a collection can be publicly shared, an appropriate contact may be established to facilitate greater access to materials. Another viable open source platform was shared by Sarah Reidell, conservator at the University of Pennsylvania libraries, who suggested Shared Shelf Commons, now JSTOR Forum, as a potential platform for this information.[1] Reidell also mentioned a unique collection resource at the University of Pennsylvania—the Fisher Fine Arts Materials Library that offers three-dimensional scanning of collection reference materials and other unique resources.[2] As organizers, it is our hope that the presentations were engaging and helpful in offering a survey of current technical resources and initiatives for reference materials that, as the presenters have shown, clearly support and can be integral to paper conservation research and treatment.

NOTES

1. JSTOR Forum is web-based software for managing, describing, and delivering library and museum collections: https://www.artstor.org/jstorforum/.
2. The Fisher Fine Arts Materials Library: http://www.library.upenn.edu/finearts/materials-library/

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A Case for a New Case Paper: From Farm to Table to Desk to Bench

INTRODUCTION

In March 2018, two library conservators from the University of Illinois at Urbana–Champaign brought a class of information science graduate students on a field trip to the Fresh Press Agricultural Fiber Papermaking Laboratory. The field trip was part of the curriculum for their course, titled "IS 590PC: Preservation and Conservation for Special Collections Care." The scope of this class was to introduce burgeoning library and archives professionals to the material and technical underpinnings of the objects that they eventually will be stewarding in their collections. Considering that a good portion of the syllabus for 590PC is organized around a foundation in the history of papermaking and book binding, it was fortunate to find that there was a papermaking studio just up the street from the conservation laboratory, where the students could experience pulling their very own sheets of paper. As the students got elbow deep in paper pulp and experienced the challenges of building a post (fig. 1), Eric Benson, the co-founder of Fresh Press, discussed the studio's mission while passing around finished papers made from a variety of agricultural fibers (agri-fiber). Handling the papers as they circulated, the conservators thought that the color, weight, and overall feel of the agri-fiber paper was reminiscent of another material that many book conservators know and love—University of Iowa Center for the Book (UICB) PC4 flax case paper. At the conclusion of their visit, the conservators were struck by an idea—what if a cross collaboration between the Fresh Press and Library Conservation could yield a new source of sustainable, locally sourced paper for conservation use?

Fresh Press

The Fresh Press at the University of Illinois was founded in 2011, with their mission always having been focused around studies into sustainability. Since their founding, they have been conducting research on how to change the paper supply chain from forest to farm—including a campaign for a new system in which otherwise unused agricultural fibers may be sold to paper mills to significantly reduce carbon emissions and curb deforestation. By replacing wood fiber with "agricultural residues" (or the crop materials leftover after a harvest), they also consequently replace forests with farms in the paper industry. To that end, they have pioneered the production of a variety of papers and products for artistic use, as well as packaging and building materials.

Kimberly-Clark demonstrated that wheat straw and other agricultural fibers have a smaller environmental footprint than tree fiber in a 2018 life cycle analysis externally reviewed by a panel of experts from the World Wildlife Fund, Canopy, and sustainability consulting firm Quantis. Partnering with the University's Sustainable Student Farm, the Biofuels Energy Farm, and the local Prosperity Gardens farm, Fresh Press uses seasonal agricultural residue—namely stalks and stems—to create handmade artisanal paper. Typically, these agricultural residues would be burned in the field at the end of harvest, contributing to air pollution. In North America, more than 200 million tons of agricultural residue goes unused, as reported by the US Department of Energy Bioenergy Technology Office (2011).

Agri-papers can be made with an extensive array of fibers: from corn and soybean sourced from the larger agriculture industry farms in the area to native Illinois prairie grass and even sunflowers and tomato stems grown in a backyard. Each fiber is significantly different and provides a unique set of working characteristics—for example, some are more flexible or rigid, and some are soft or woody. To produce a more robust paper, the agri-fibers are sometimes combined with a percentage of recycled cotton to add flexibility and strength. The cotton is also sustainably sourced from old papermaking blotters and cotton linters, which are recycled trimmings from the textile industry.

The use of regional agricultural fibers can be (as demonstrated by the new Columbia Pulp Mill in the State of Washington) an economic boon to the local area and, by keeping the harvest and manufacture in close proximity, can reduce the overall transportation carbon footprint of paper manufacturing. Agricultural fiber will become a

Papers presented at the General Session, AIC's 47th Annual Meeting, May 13–17, 2019, Uncasville, Connecticut

Fig. 1. Students learning to pull sheets of agr-fiber paper at Fresh Press

faster-growing industry as the 2018 American Farm Bill provides a path forward for industrial hemp. The Canadian nonprofit group Canopy is behind this idea of agricultural fiber with its Second Harvest Pulp and Paper project.

As innovative as Fresh Press Studio is, they are not the first to propose the use of fibers alternative to bast and wood pulp for paper production. Book and paper conservators may be familiar with the 19th-century British papermaker, Matthias Koops, who Dard Hunter, in his seminal publication on papermaking, described thusly:

> In the search for new papermaking materials the work of Matthias Koops towers above all of his predecessors, for Koops is responsible for the growth of the paper industry as it is today . . . It was Koops . . . who first made use of various vegetable fibers on a large commercial scale. (Hunter 1943, 332)

Koops developed and advocated for processes that substituted vegetable fibers for the ever-decreasing supply of cotton and linen rags. With the rise of education and literacy by the end of the 18th century and into the 19th century, papermakers were confronted by an acute and quickening scarceness of domestic rags, barely enough, in fact, to keep pace with the mass production of newspapers, schoolbooks, business papers, pamphlets, and works of literature (Baker 2010). Although the notion of wood as material for paper came first from René de Réaumur in the first decades of the 18th century, Koops was the first papermaker to be successful in making paper from virgin fibers on a commercial scale (Baker 2010). As early as 1800, Koops secured several English patents related to papermaking, including one for removing ink from used paper before repulping for recycling into new sheets, and two for producing paper from "straw, hay thistles, waste and refuse of hemp and flax and different kinds of wood and bark" for printing (Hunter 1943). Koops believed so deeply in the potential of bark, straw, recycled waste paper stock, wood pulp, and any other vegetable substance that he printed a treatise on the subject of papermaking materials on a golden-hued paper made from straw from his own recipe, with an additional index made from wood alone (fig. 2).

The modern conservator is, of course, disappointed that in the arms race of paper fiber sources, it was inexpensive groundwood papers that historically won out—as so much of

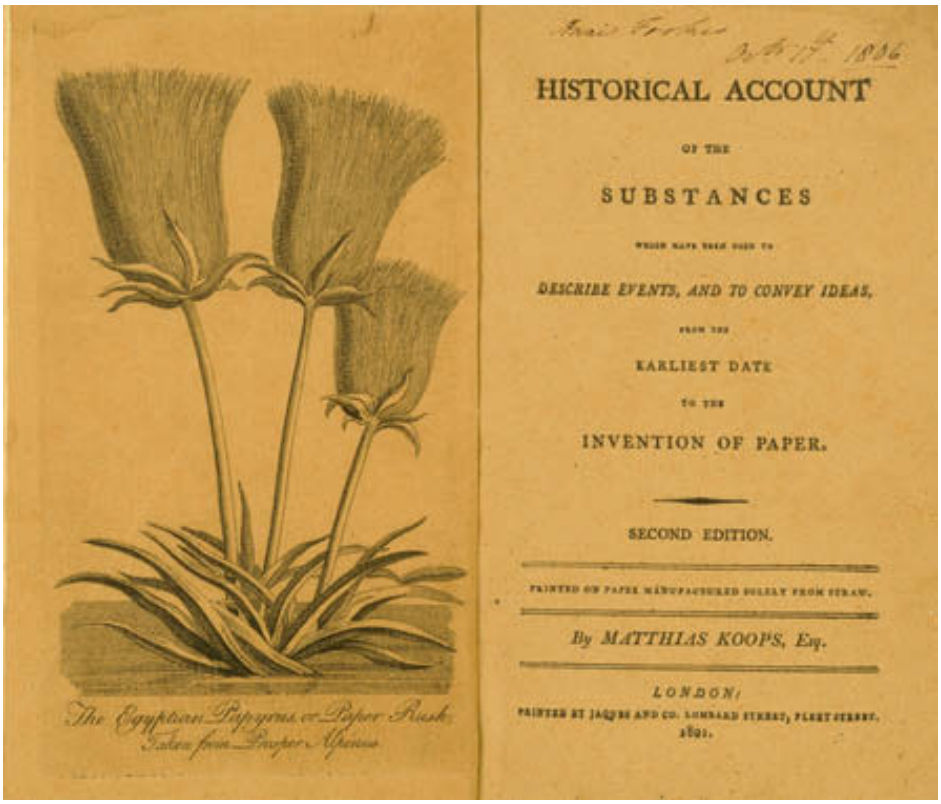

Fig. 2. Title page and frontispiece of Matthias Koops' treatise on papermaking substances, printed on paper made from straw

conservation work attempts to overcome the challenges presented by older wood-based papers. Additionally, with such a significant impact to environment having been made over decades of deforestation and commercial waste, it is strange to imagine what might have been if Koops' straw paper became the mainstream after all. Inspired by the work of Koops and colleagues at Fresh Press, the conservators at the University of Illinois could easily see the benefits and research interest in exploring the potential of alternative fibers for use in conservation papermaking, especially given the ever-increasing need for sustainability in production and industry.

Case Paper: an Ideal Material

As conservators interested in developing the Fresh Press' agri-fiber papers for book conservation, it is important to touch on what makes an ideal conservation material, especially in the context of using laced paper case bindings for conservation treatment. Paper case bindings are largely based on the structures of 17th- and 18th-century Italian limp paper and vellum imprints that historically have proven to provide a versatile and enduring structure (Barrios 2006). Paper cases modified using conservation-friendly materials have been championed by notable book conservators from Christopher Clarkson to Gary Frost as an alternative to using environmentally reactive parchment (fig. 3), as well as a generally pleasing option for rebinding when necessary (Frost 1979; Clarkson 2005). Although not necessarily a "conservation binding," the construction of a laced case binding made of limp paper meets the requirements for durability, stability, and nondestructiveness, as it offers ease of opening and is inexpensive. Furthermore, it is adhesive free, customizable, and reversible if needed. Regarding rare books that have lost their contemporary bindings, it also offers a historically sympathetic binding without either obfuscating or assuming an original binding structure (fig. 4).

"Case" paper—that is, a paper that is designed specifically for use in the creation of paper cases for books—is something of common parlance now for book conservators but has not always been a material at our disposal. Its development came from several studies conducted by papermaker Timothy Barrett as he investigated revived methods of European papermaking using high-quality unfermented flax fiber to provide maximum strength (Barrett 1989). As the director of the UICB papermaking facility, Barrett and his students produced a long-fibered flax case paper, called *PC4*, that had characteristic good tear resistance and high fold endurance. The UICB later made it available for sale directly through their campus facility, as well as through third-party sellers such as Talas Supplies for Bookbinding and Conservation in

Fig. 3. Example of the more severe environmental degradation in a small limp vellum Spanish prayer book. Image courtesy of Marco Valladares.

New York, New York. It has grown in popularity steadily over the past two decades, having applications in both conservation and in artist and fine bookbinding.

A desirable conservation case paper such as UICB PC4 flax paper would be a heavy cartonnage-like paper that could withstand scoring, folding, punching, and other manipulation to create a secure, one piece cover that could be laced onto supports (which are often made of parchment or alum-tawed skin). Once laced on, the cover can be either adhered to a pasted down end sheet or not, depending on the treatment necessities. In addition to this use of case paper, conservators also find it useful as a more stable but still aesthetically accurate replacement for parchment in bindings, fills, repairs, and the creation of slipcases and portfolios, as well as bespoke laminated paper boards.

Fig. 4. Model of a limp laced case binding, sewn on alum tawed supports and covered with University of Iowa PC4 flax paper. Image courtesy of Marco Valladares.

For many years, the most preferred paper available was that of the PC4 flax paper from UICB. As mentioned, PC4 is a strong, 100% flax paper that is close textured, externally sized, and relatively rigid. It takes and holds a fold exceptionally well and, up until recently, came in a small range of subdued colors that were both appealing and appropriate for conservation use. In recent years, PC4 flax paper has become harder to source, presumably due to a shift in focus and supply production at the University of Iowa program.

Twin Rocker has been suggested as a possible substitute case paper source, and although Twin Rocker does produce fine text-weight paper for use in bookmaking, most of their heavier stocks are art and watercolor papers, which do not have the same characteristics as PC4. Cave Paper, a material by an artist papermaking studio out of Minneapolis, Minnesota, and produced by UICB-trained papermakers, has been considered another feasible alternative to PC4 because it is similar in makeup and physical characteristics.

Although these various papermaking sources offer a diverse array of potential case papers, this project aims to focus on creating a more sustainable alternative by cutting down the carbon footprint of papermaking and transportation. Conservation papers require high-quality materials, such as flax and cotton, most of which are only grown in certain areas of the world and have a high carbon footprint. In publishing our testing criteria and a detailed research plan, the authors hope to model and encourage other conservators to explore the potential benefits of using locally sourced papers and materials in their work (fig. 5).

A Cross-Campus Collaboration

Starting in the summer of 2018, a small group of colleagues—consisting of two conservators, a graphic design faculty member/papermaker, and a research assistant with a strong chemistry background—met to discuss the potential for a shared research partnership. Early on, several of the fundamental goals and desired outcomes of this research were immediately apparent:

- To collaboratively work across multiple disciplines to create a new, locally sourced paper that could be manufactured at the University of Illinois and be used in book conservation

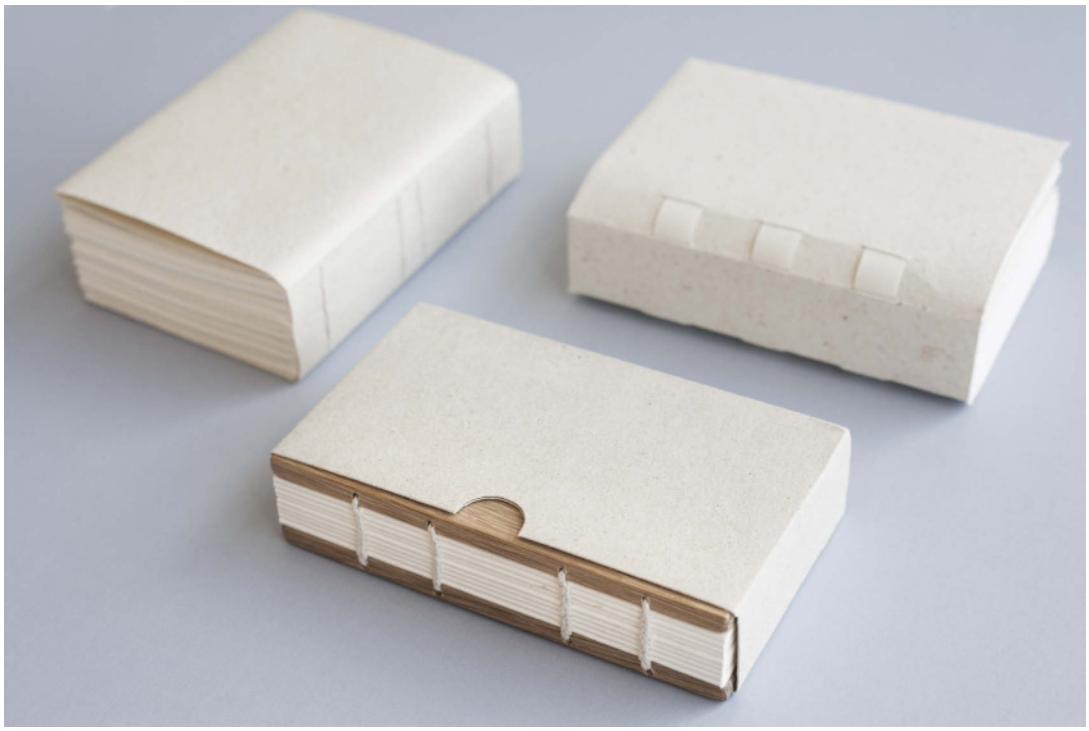

Fig. 5. From left to right: A long-stitch binding using University of Iowa PC4 flax case paper, a similar model prepared using University of Illinois Fresh Press' corn/rye/cotton blend, and a slip case made with Fresh Press rye/cotton paper

- To methodically test material and chemical characteristics of the papers to determine the best fiber combinations and production details
- To disseminate outcomes with an eye toward open source, enabling others to try the same or similar locally minded approaches and promote sustainability

Less clear, however, was how to begin achieving those goals. After a brief literature review, the authors used any and all information at their disposal to form a research plan and move experiment design forward. This included, but was not limited to, conservation science studies of paper and aging, TAPPI guidelines for paper testing, articles on plant fiber classification and morphology, histories of papermaking, and pilot experiments in paper.

As conservation professionals, the authors had a personal and professional idea of how this new paper needed to work and feel. However, to achieve these characteristics, it was necessary to investigate how the paper handled and to develop some means of quantifying the nonquantifiable attributes such as folding, scoring, and rigidity. Other variables, such as internal and external sizing, ideal weight and adhesion, and especially how these new papers withstood aging, were also characteristics that were prioritized in testing.

The resulting research plan loosely outlined two phases for the creation of a sustainable conservation case paper. In the first phase, the collaborators would produce an initial set of papers using commonly available and locally source fibers and recipes, followed by basic chemical and working characteristic tests. Much of this phase of the research was designed to rely on what was already available without external funding, such as raw material, sheets of paper from successful fiber combinations, and laboratory/studio setup. The second phase, based on the results of the efforts of the first, aimed to hone the paper recipe, consistently produce sample papers, select a final fiber combination, and carry out full analytical testing protocols to inform decisions for future production implementation.

Between the Fresh Press' studio space and extra inventory of a wide variety of materials, the conservation laboratory's access to basic scientific setup and instrumentation, and the mutual excitement between the four authors to move forward on this goal, the setup for the initial phase of work was not a challenge. However, it was clear that to undertake the high-level technical analyses, perform accelerating aging tests, and produce more standardized papers than what was already in stock would require additional funding. Using unrestricted gift funds, the conservation laboratory was able to purchase an accelerated aging oven with controlled temperature and relative humidity. The research partners also established an agreement with Dr. Sameh Tawfick from the University of Illinois' Department of Mechanical Engineering, who was willing to perform the

Fiber	Details
Miscanthus/Cotton	50/50 miscanthus/cotton linters, 3 hour cook, + soda ash, beat time unknown
Corn/Cotton	50/50 corn/cotton linters, 3 hour cook, + soda ash, 45 min beat
Rye/Cotton	50/50 rye/cotton linters, 3 hour cook + soda ash, 1 hour beat
Corn/Rye/Cotton	50% cotton/unknown rye and corn ratio, 3 hour cook, + soda ash, beat time unknown
Tomato Vine/Cotton	50/50 tomato vine/cotton linters, 3 hour cook, + soda ash, 1 hour beat
Soybean/Cotton	50/50 soybean/cotton linters, 3.5 hour cook, + soda ash, 75 min beat
Eggplant/Cotton	50/50 eggplant/cotton linters, 3 hour cook, + soda ash, 35 min beat
Big Blue Stem/Cotton	50/50 big blue stem/cotton linters, 3 hour cook, + soda ash, ~1 hour beat
Sunflower/Cotton	50/50 sunflower/cotton linters, 3 hour cook, + soda ash, ~1 hour beat
Hemp/Cotton	50/50 hemp/cotton linters, 3 hour cook, + soda ash, ~1 hour beat

Fig. 6. Table detailing the fiber mixes and recipes used for papermaking

TAPPI testing protocols on our samples for a modest fee going forward. Dr. Tawfick had already done some analysis of previous paper stocks with Professor Benson before this project began. Throughout the first phase, the authors additionally applied for grants and funding sources to later be able to afford the second phase of the project.

MATERIALS AND METHODS

Papermaking

At first, the team took previously made papers from the Fresh Press' inventory for comparison. These papers had been made with all different recipes, which led to a review of previously published recipes to base future work and standardize methods. With Research Assistant Anneka Vetter and Papermaking Assistant Veronica Steffen, 10 different fiber blend papers were cast in small batches. To start, all papers were blends of agri-fibers and cotton, as these were papers with which the authors were familiar. Additionally, previously gathered analytical data suggested positive outcomes with cotton blends—which was, of course, unsurprising given that cotton rags were a source for historic papermakers.

Each blend had a 50% cotton linter content and 50% varying agricultural fibers e.g., 50% rye with 50% cotton), and one combination fiber that was approximately 33% corn, 33% rye, and 33% cotton. These were cooked for approximately 3 hours with soda ash, rinsed, and beaten for approximately 1 to 2 hours with a Hollander Beater (although the beat time was variable from fiber to fiber), then internally sized with premade Carriage House Paper internal sizing. Beating time was the hardest step of the recipe to standardize across the different fibers, as the softer fibers took much less time to beat and vice versa. The agricultural fibers we used were miscanthus (a native prairie grass), corn leaves, rye grass, tomato vine, soybean stems, eggplant vine, big bluestem grass (a native prairie grass), sunflower stems, and hemp (not agricultural waste in the state of Illinois yet likely to be more available in the near future with recently passed legislation) (fig. 6).

Basic Analytical Testing

For the initial analytical experiments, the authors relied on the TAPPI Standards, which has official published guidelines on what tests should be conducted to produce an archival-grade or conservation-grade paper. Although many of these analytical and mechanical tests were beyond the conservation laboratory's capacity, the authors were able to conduct a few basic tests, specifically average fiber length, grammage, caliper, and pH before and after artificial aging. Average fiber length was determined by using a Leica S8AP0 microscope with an MC170 HD camera attachment and the integrated Leica Application Suite 4.0, utilizing raking light and illuminated light to differentiate fibers. Average caliper (or thickness) was tested using a standard micrometer, and grammage was measured using an analytical scale and ruler. Aging tests were carried out in a Memmert Humidity Chamber 2 with accelerated aging conditions set at 90°C and 55%RH for 14 days. On both aged and unaged samples, pH tests were performed, having been adapted from ASTM Standard Test Methods for Hydrogen Ion Concentration (pH) of Paper Extracts, cold-water extraction method (ASTM 2007). Measurements of pH were taken using an Oakton pH meter with a standard wide range pH probe (figs. 7, 8). Color analysis

Fig. 7 & 8. Cold extraction pH testing of various paper samples

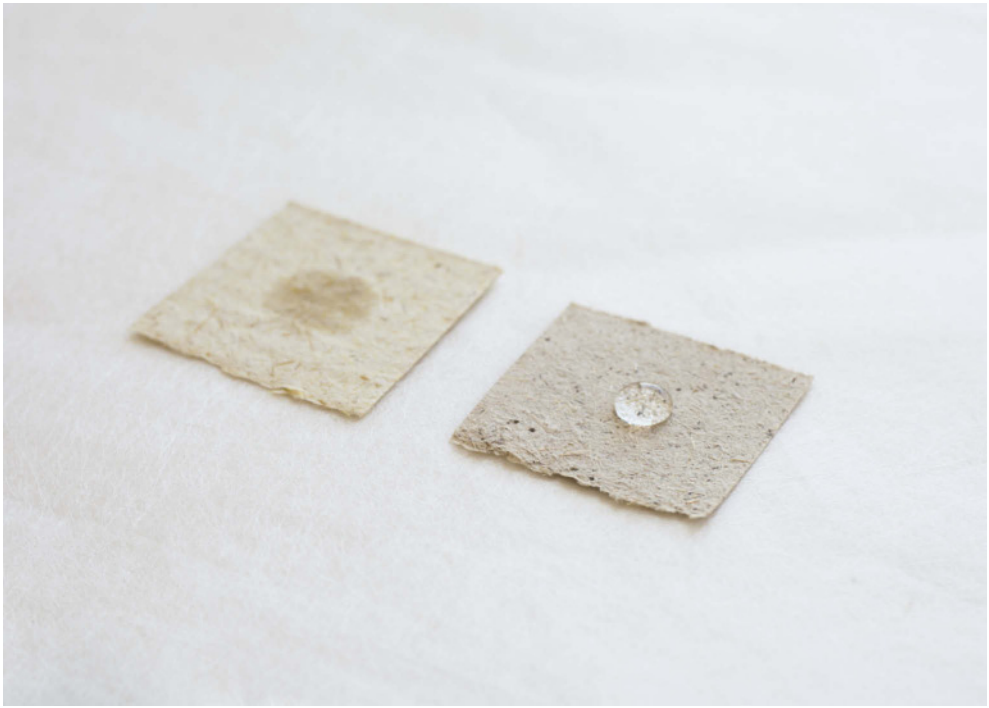

Fig. 9. Wettability testing on paper samples that have been externally size with 2% gelatin solution (right) and unsized (left)

was measured using a ColorMuse digital color matching device that provided us with basic RGB and L*a*b*color space data.

Workability Testing

Each paper sample was evaluated for wettability using deionized water, as well as acceptance of the common conservation adhesives wheat starch paste and polyvinyl acetate (PVA), with both externally sized and unsized papers (fig. 9). It should be noted that all papers except hemp were made with premade internal sizing, produced by Carriage House Paper. Before the paper samples were exposed to water or adhesives, samples were externally sized with a 2% gelatin solution. Wettability tests were performed by placing a droplet of distilled water on the surface of the paper, observing and timing how quickly the droplet was or was not absorbed. Adhesion tests were performed by lightly applying the adhesive (either PVA or wheat starch paste) to a small area of the paper sample, lightly pressing another piece of the same paper onto the area, observing the samples as they actively dried, and examining after drying.

Qualitative Testing

The authors designed a ranking system in which paper samples were lettered and ordered randomly to conduct a double-blind study to quantify information about how the papers subjectively felt and performed. The characteristics evaluated were color, speckliness, texture, flexibility, opacity, scorability, foldability, and burst, without using any formal analytical measurements. The authors all had the same instructions and paper samples, which they individually ranked from least to greatest for each factor (e.g., least flexible to most flexible) and were asked to list their top three personal favorites for each characteristic. This qualitative testing was an important way to compare and evaluate our papers from a more realistic perspective by mimicking what might normally be done to the papers on the conservator's bench.

RESULTS

During papermaking, the fibers were chipped, cooked, and beaten as similarly as possible, although quite a bit of differentiation in length and thickness from fiber to fiber was noted during the papermaking process, and was later confirmed by our basic analytical testing and measurements (see fig. 9). This obviously affects working characteristics like folding and flexibility, and thus recipe development will be a crucial step to moving forward to be able to truly compare the papers analytically.

After the aging tests, a slight to moderate darkening of nearly all paper samples was noted (including samples of the Iowa PC4 case paper and Cave Paper samples, which were included in the tests). Papers made from tomato, corn, and rye fiber papers showed the highest level of discoloration from accelerated aging. The 50% rye and 50% cotton paper

Fiber of Paper (with Cotton)	Grammage (gsm)	Fiber :ength (mm)	Thickness (mm)
Rye	238.1	1.466	0.201
Corn	236.3	1.285	0.237
Miscanthus	276.2	1.869	0.347
Big Bluestem	391.4	2.035	0.417
Sunflower	115.8	1.661	0.156
Hemp	276.2	1.424	0.351
Soybean	79.9	1.419	0.13
Eggplant	159.7	4.952	0.234
Tomato Vine	195.7	1.954	0.265
Corn/Rye	196.5	1.742	0.19

Fig. 10. Summary of basic analytical measurements

sample did show some spotted discoloration that could be foxing, although other rye papers from multiple batches were tested and still others did not show any observable discoloration, and thus the issue is most likely batch related (fig. 10).

Cold extraction pH tests were also performed before and after aging (fig. 11). All unaged samples produced pH results in acceptable ranges (7.8 to 8.6); however, after aging, we found that the pH increased on all of our samples except big bluestem and the corn/rye blend. This finding was not anticipated, although we hypothesize that the increased pH may be related to residual soda ash in the papers that was not thoroughly rinsed after the cooking process. This can have an effect on the surrounding matrix when the temperature and moisture increase during aging studies, although further investigation is needed to confirm.

Evaluating each paper's wettability and acceptance of conservation adhesives was an important part of testing that

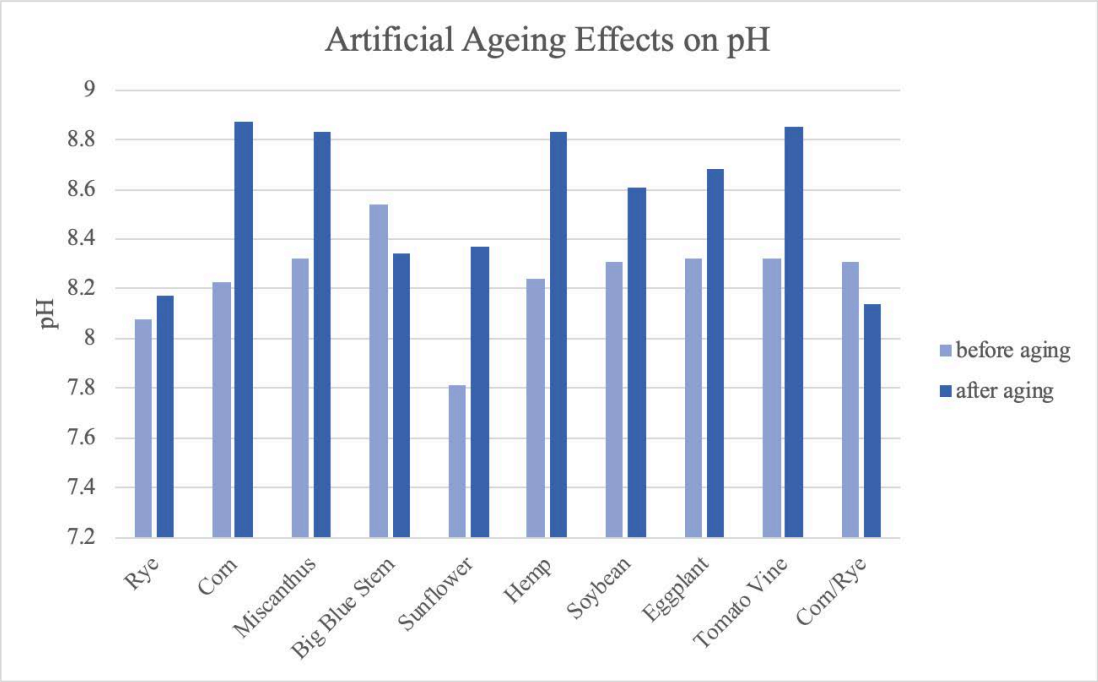

Fig. 11. Chart displaying pH test results of aged and unaged paper samples, showing an increase in pH after aging in most samples

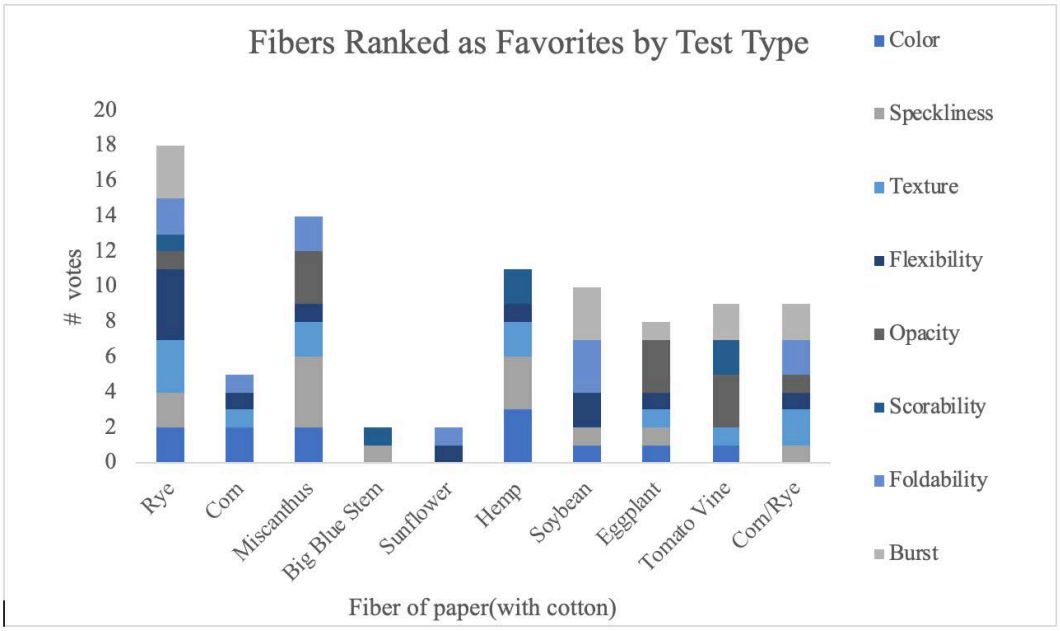

Fig. 12. Chart depicting cumulative results of the research team's ranked favorites during qualitative tests

added to our knowledge of how our papers perform in more specific ways. Although some papers (corn/rye both sized and unsized, and unsized big bluestem) showed rapid absorption, sized samples of big bluestem, tomato, sunflower, soybean, and eggplant all slowly absorbed the water. Only the sized and unsized rye, corn, miscanthus, hemp, and unsized tomato showed little to no absorption.

Each paper's acceptance of the two most common book conservation adhesives (PVA and cooked wheat starch paste) was also evaluated. Overall, little reaction, other than a slight sheen, was found in the acceptance of the papers to the application of PVA, except for a slight curling of the soybean paper. However, significant warping after the application of wheat starch paste (after complete drying) was found in rye and soybean samples, with moderate warping observed in corn and sunflower (fig. 12).

In the qualitative double-blind testing, the ranking of "favorites" was found to be the most helpful in selecting the most promising fiber sources. Of the 10 samples evaluated (Iowa PC4 and Cave Paper were not ranked), rye and hemp were clear front-runners, with miscanthus and soybean also garnering several votes in multiple categories.

DISCUSSION

The interdisciplinary nature of this project makes it an interesting representative of cross-campus collaboration, as well as a good candidate for discussion and presentation in multiple academic venues; however, the specificity of the reasoning and goals of the project actually make it a difficult project to fund. As a research project, "A Case for a New Case Paper" is not entirely scientific or purely sustainability focused, nor is it exclusively art based, nor conservation oriented. Many of the applications that have been submitted on behalf of this project have come close to acceptance but ultimately were unsuccessful. The authors speculate that this may be because their project narrative is so interdisciplinary that it can be somewhat hard to specifically tailor to any singular facet that might appeal to traditional funding bodies. Until funding is secured, the more formal analytical testing will have to wait.

Practically speaking, designing experiments with consistent controls was a little challenging throughout the course of this research—Fresh Press is a papermaking "studio" and not an industrial papermaking laboratory, so ensuring exact replication of processes across paper production was a challenge. Especially when considering that many fibers in use are not usually found in papermaking, it should be no surprise that it came as a challenge to form consistent sheets of paper using different fibers. For example, eggplant has different optimum chip length than hemp or sunflower; therefore, creating an experimental paper that is conformant for the purposes of having a control standard is not easy.

Regardless of these challenges, by the conclusion of the first phase, the authors felt encouraged about their progress and future directions. Most encouraging, of course, was that the accelerated aging tests did not yield any obvious

exclusions due to any dramatic shifts in pH. Future paths of inquiry include additional experimentation to see how adjusting rinsing methodology, the balance of internal/external sizing, and decreasing the proportion of cotton linter to agricultural fiber mixes will influence the ultimate results of the paper.

Surprisingly, all of the paper sets are very close to a material that would be appealing to use as conservation case paper, especially from a handling perspective. All of the agri-fiber papers were in the same basic family of the University of Iowa PC4 case paper in appearance, weight, and texture. Even more surprisingly, none of the samples were totally eliminated based solely on performance—although there were some, such as soybean and sunflower, that were removed from consideration due to specific qualitative characteristics. Although test results varied from fiber to fiber, several fibers (hemp, rye, corn, big bluestem, and miscanthus) all showed promising results in different areas. For this reason, the authors feel strongly that they are headed in the right direction.

Research will continue toward creating more paper samples with blends of these fibers, hopefully maximizing the respective positive characteristics of each. Additionally, subsequent efforts toward this research will focus on greater standardization in the papermaking process, as well as more thorough testing to clarify some of the more interesting early data, such as the pH testing results.

Perhaps even more importantly, our research has been a great cross-campus collaboration that has garnered a good deal of interest from our campus sustainability program, the library's Innovation and Seed Funding Initiative, and the Department of Art + Design. The University of Illinois is generally a collaborative environment, but such a unique collaboration has attracted the attention of multiple on-campus news outlets, which has resulted in articles featuring this work. Therefore, our hopes are high that our work can continue forward with some additional financial support. The authors will continue to pursue funding opportunities and, pending success, hope to partner with the University of Illinois Department of Mechanical Engineering, as previously mentioned, to collect more analytical data on the papers' performance.

Additionally, the authors are looking forward to producing consistent, high-quality papers that can actually be integrated into laboratory use. Long term, they would like to see the creation of a variety of agri-fiber paper made available for purchase by interested parties outside the University of Illinois to provide both a new material with many potential applications in the field of conservation and a source of revenue for Fresh Press Studio to continue their efforts in sustainability.

The ultimate hope for this research is to find a successful way to share it for implementation outside the community of artists and conservators. Paper for conservation use is a niche market, and it is highly unlikely that this very specific shift in the supply chain for conservation case paper would be enough to offset the environmental impact of the entire paper industry. However, it does not seem unreasonable to aspire to the creation of a practical setup and production methodology that could be open sourced and reproducible by other communities. Conservators, papermakers, or artists who have access to their own locally sourced agricultural waste could then consider producing their own papers for use and cut out the immense carbon footprint that comes just from shipping materials from one coast of the US to the other. By extension, these grassroots (pun intended) efforts at replicating the research undertaken at the University of Illinois with native waste fibers further Fresh Press' mission of changing the paper supply chain from forest to farm.

ACKNOWLEDGMENTS

The authors would like to thank Veronica Steffen, Marco Valladares Perez, Jody Waitzman, Heidi Looker, and all the students of IS 590PC, as well as the AIC Sustainability Committee and Leadership, for accepting this paper.

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MADISON BROCKMAN AND EMILY FAREK

Investigation into the Reduction of Foxing Stains in Paper

INTRODUCTION

The treatment of two water-sensitive chine collé lithographs by the famed French painter Pierre Puvis de Chavannes prompted an investigation into the reduction of foxing stains in paper using agarose gel to restrict moisture. Foxing is pervasive in works on paper and is difficult to reduce or remove, especially when full aqueous treatment is not a feasible option. Previous Winterthur/University of Delaware Program in Art Conservation student work has explored the use of combinations of chelators and enzymes; this is the first study to incorporate a novel reducing agent that targets the metal component, reducing Fe^{3+} to Fe^{2+}. This reduction renders iron into a more soluble form, enabling the use of common and accessible chelators for its removal. Preliminary testing indicated that sodium hypophosphite and the enzyme lyticase were highly effective in reducing foxing discoloration, and thus became the treatment protocol for the two prints. The prints were bathed differently—one on the suction table and one on TEK-Wipe, as a variant of blotter washing—to test the efficacy of the solutions in a variety of delivery methods. Treatment of the prints was safe and successful, significantly reducing the widespread foxing discoloration on both prints while preventing the delamination of the chine layers. This new protocol will provide wider applications for works on paper that cannot withstand aqueous treatment via full immersion bathing by using rigid polysaccharide gels.

TREATMENT OF CHINE COLLÈ LITHOGRAPHS

Each of the authors received one of a pair of chine collé lithographs, entitled *Le Ballon* and *Le Pigeon*, from the Winterthur/University of Delaware Program in Art Conservation study collection (fig. 1). The prints are reproduced paintings from the Franco-Prussian War, and much of their imagery was obscured by pervasive foxing. The original paintings were created in 1870 and 1871 by de Chavannes. They were immediately reproduced for distribution as lithographic prints by printmaker Emile Vernier, who also lived and worked in Paris during this time (Lacambre 2006).

In the chine collé technique, the primary support is commonly a thin Asian paper, *chine* in French. It is pasted on the verso and placed on a thicker secondary support; simultaneously, the two layers are fused together, and the image is printed as they go through the press. Chine collés can be difficult to identify and may be treated improperly, causing bubbling or complete delamination of the chine layer.

Looking at these objects with different illumination sources provides a wealth of information about their condition. Foxing can be organo-metallic in nature, with fungal components and metallic components that cause localized discoloration in the paper support. These discolorations appear as spots, yellow to dark brown in color, and diffuse to concentrated in shape. But what appear to be faint, rust-colored spots in normal light are typically brighter and more numerous when viewed in long-wave UV and in transmitted light.

Developing a treatment protocol that addressed the dual nature of foxing in a water-sensitive object was an interesting challenge. Preliminary testing of novel reagents began during an elective seminar on aqueous cleaning methods, building off of student research undertaken in previous years (Van Dyke 2004; Sullivan and Taira 2014; Sullivan, Brogdon-Grantham, and Taira 2014).

PRELIMINARY TESTING

To address the metallic foxing component in the primary support, two different reducing agents were tested: ascorbic acid and sodium hypophosphite. Reducing Fe^{3+} ions to Fe^{2+} ions would eliminate the need for dilute hydrofluoric acid or strong Fe^{3+} chelators like hydroxybenzyl ethylenediamine diacetic acid, allowing for the use of diethylenetriamine pentacetic acid (DTPA) or ethylenediamine tetracetic acid (EDTA). Two different enzymes were also tested to address the fungal component of foxing by targeting the chitin in the cell walls of the fungal growth. These included lyticase and a commercial blend of lysing enzymes.

These various combinations were tested with expendable foxed prints in full immersion baths in three steps. In

Papers presented at the General Session, AIC's 47th Annual Meeting, May 13–17, 2019, Uncasville, Connecticut

Fig. 1. *Le Ballon* ("The Balloon," (a)) and *Le Pigeon* ("The Pigeon," (b)), by Pierre Puvis de Chavannes. Before treatment, recto, normal illumination.

the first step, the sample was placed into a deionized water bath containing the reducing agent and chelator. Second, the sample was rinsed in a bath of plain deionized water to remove excess reducing agent that would be harmful to the enzyme used in the next step. Third, the object was placed in a deionized water bath containing the enzyme. This preliminary testing showed that by visual analysis, sodium hypophosphite with DTPA proved to be more successful in stain reduction than ascorbic acid with EDTA. Lyticase was more successful than the lysing enzyme blend. Sodium hypophosphite has a higher reduction potential than ascorbic acid, and the lyticase enzyme is cheaper, purer, and not as sensitive to heat as the lysing enzyme blend. They also visibly appeared to reduce the foxing stains the most out of the reagents tested. This combination formed the foundation of the treatment protocol for the Balloon and Pigeon prints.

The treatment protocol developed begins with a pre-rinse step to remove easily water-soluble degradation products, followed by the steps tailored to reducing foxing discoloration. These include the reducing agent and chelator solution, followed by an intermediate rinse step. The enzyme solution comes next, with a final rinse to remove residues. This general treatment plan can be used for full immersion treatments or controlled applications of moisture.

METHODOLOGY

Agarose and other Gel Treatments

Gel treatments are currently in vogue in conservation, with good reason, although they may not be necessary in all applications. These two prints were excellent candidates for a gel treatment due to their inherent water sensitivity and need for aqueous cleaning solutions.

Many forms of gels are commonly used in art conservation, with polysaccharide gels such as agarose, gellan, and methyl cellulose most often used in paper conservation. Each gel has specific rheological properties that can act as a reservoir for solutions, restricting the flow of moisture into the paper support, while also acting as a poultice to draw water-soluble components out of the support. Some papers, such as the Balloon and Pigeon prints, readily absorb water, so controlling the amount of moisture is paramount. Rigid polysaccharide gel sheets also provide the benefit of physical restriction of the two chine collé paper layers during treatment, as the

weight of the gel sheet may help prevent separation caused by the differential expansion of the two layers when subjected to moisture.

Agarose was necessary for this particular treatment because it is a neutral gel—it carries no electrostatic charge. Gellan is a polyanionic molecule and could interact unfavorably with any ionic and enzymatic solutions added to it. Agarose does not have this issue and can carry solutions with aqueous chemistry like reducing/chelating and enzyme solutions. Agarose provides the additional benefit of strong capillary action, which is determined by its concentration.

Testing Different Delivery Methods

Given that the two objects were so similar in composition and condition, it was a unique opportunity to test the same treatment protocol using different delivery methods. The Pigeon print was bathed on a suction table, and the Balloon print was bathed on TEK-Wipe. TEK-Wipe is a highly absorbent, nonwoven fabric that is a blend of polyester and cellulose, and is a more sustainable choice than single-use blotter, as it can be washed and reused. The same aqueous solutions in agarose gel sheets were used in both treatments. In the suction table method, all rinse solutions were sprayed on the object while it was under suction, and each gel sheet was applied to the recto of the object for a total of 20 minutes. In the TEK-Wipe method, the TEK-Wipe was saturated with the rinse solutions, and each gel sheet was applied to the recto of the object for a total of 30 minutes. These treatment protocols were tested on expendable foxed chine collé prints to ensure they were safe and effective and to determine the gel dwell times for each method.

EXPERIMENT

Materials Preparation

The bathing portion of each treatment required the same aqueous solutions:

1. A pre-rinse citrate solution for the first and intermediate rinse steps
2. One phosphate buffer and reducing/chelating solution to be turned into a 3% agarose gel
3. One phosphate buffer and enzyme solution to be turned into a 3% agarose gel
4. A calcinated, alkaline solution for the final rinse step

These materials must be prepared immediately prior to treatment due to their limited shelf life, as otherwise they will oxidize with exposure to the air. First, create a buffered solution of sodium phosphate and citric acid, to be used for the two gels. Add DTPA and sodium hypophosphite to half of the buffered solution for the reducing and chelating gel, and add the lyticase enzyme to the other half of the buffered solution for the enzymatic gel. Add 3% weight by volume of agarose to each of the solutions. Dry agarose powder is insoluble in water at room temperature and must be heated to solubilize it. Cook each gel solution, then pour out into a Mylar tray to form a gel sheet large enough the cover the object. A plastic squeegee is a useful tool to help evenly spread the gel and ensure a consistent thickness of approximately 0.25 in. The agarose gel sets as it cools, forming a rigid sheet. Although large sheets can be difficult to handle if they are too thin or too thick, rolling the gel up like a rug makes them easier to handle.

Citrate rinse solution recipe: Use deionized water. Add enough sodium citrate salt (or citric acid and sodium hydroxide) to reach a conductivity of the solution that is within one order of magnitude as the conductivity of the object being bathed. Readings can be taken from the surface of the object with an agarose plug and a conductivity meter. Adjust the solution to pH 6 with citric acid.

Gel solutions recipes: Gel solutions recipes are shown in table 1.

Treatment of the Pigeon Print via Suction Table

Treatment of the Pigeon print began with surface cleaning (fig. 2). After humidifying the object overall in a Gore-Tex package, the print was pre-rinsed with a buffered solution of sodium citrate and citric acid at a pH of 6, with a conductivity close to that of the print. Conductivity and pH readings were taken from the surface of both prints with agarose plugs and digital meters. The rinse solution was sprayed with a Dia sprayer while the object was under suction, helping to pull water-soluble degradation products down into the blotter beneath it. After changing the blotter and applying a *gampi* barrier layer on top of the object, the first gel sheet was applied, which contained

Phosphate Buffer Solution	Reducing/Chelating Gel	Enzyme Gel
Per 300 mL of deionized water:	*Per 150 mL of phosphate buffer:*	*Per 150 mL of phosphate buffer:*
1.5 g sodium phosphate	Add 1.5 g of DTPA	Add 1.5 g of lyticase enzyme
Adjust pH to 7.5 with citric acid	Add 2 g of sodium hypophosphite	Add 4.5 g of agarose powder
Divide solution in half	Adjust pH to 7.5 with sodium hydroxide	
	Add 4.5 g of agarose powder	

Table 1. Gel solutions recipes

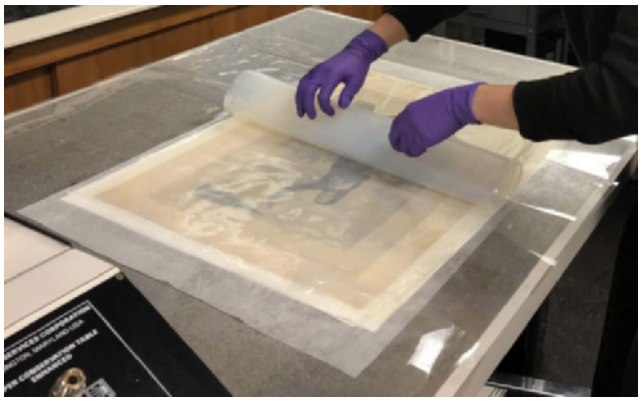

Fig. 2. "The Pigeon" being treated with reducing/chelating solution in agarose gel on the suction table.

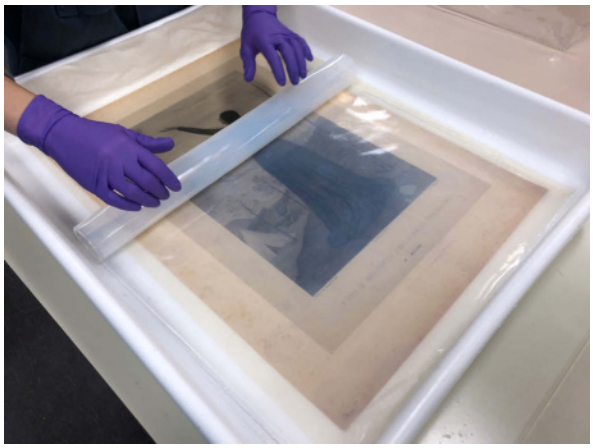

Fig. 3. "The Balloon" being treated with reducing/chelating solution in agarose gel in a TEK-Wipe bathing chamber.

the reducing and chelating agents. The gel sheet had a total dwell time of 20 minutes, after which the gel and *gampi* were removed and a new blotter was placed on the suction table. The object was rinsed again with the same buffered citrate solution as in the pre-rinse step. The blotter was changed again after rinsing in preparation for the next gel application.

The enzyme gel was applied to the object (with *gampi* barrier layer), and the same treatment steps were followed as for the reducing and chelating gel. Again, the gel had a total of 20 minutes dwell time, after which the gel was removed and the blotter changed. The object was rinsed with a final calcinated water solution of filtered water adjusted to pH 8 with calcium hydroxide. After aqueous treatment was complete, the object was placed in a drying stack of polyester interleaving, blotter, and felts.

Treatment of the Balloon Print via Tek-Wipe

The TEK-Wipe method proceeded similarly to the suction table method (fig. 3). The bathing chamber was prepared by saturating the TEK-Wipe with the pre-rinse citrate solution. A squeegee proved useful again to ensure even saturation and planarity of the TEK-Wipe. After surface cleaning and humidification in a Gore-Tex package, the print was placed onto the saturated TEK-Wipe and sprayed lightly overall with the same citrate rinse solution to ensure even wetting.

To prepare for the first gel application, a new layer of TEK-Wipe was put down and saturated in the rinse solution. The object was covered with a *gampi* barrier layer and the reducing and chelating gel. Air bubbles were pressed out to ensure overall contact, and the gel was left on for a total of 30 minutes of dwell time. The print was rinsed after removing the first gel by changing the TEK-Wipe again, spraying the print overall with the rinse solution using a Dia sprayer, and then letting the print bathe for 20 minutes. A new *gampi* layer was laid down and the enzyme gel was applied in the same way as for the reducing/chelating gel. Treatment was finished with a final rinse solution of calcinated water, adjusted to pH 8 with calcium hydroxide. After the final rinse, the print was placed in a drying stack like the Pigeon print.

RESULTS

Visual Observations

Overall, these treatments proved successful in reducing overall and local discoloration and did not result in delamination of the chine layer from the secondary support. Examination in UV light indicates a more drastic reduction of foxing spots in the Balloon print, although there is a visible reduction of the Pigeon print's foxing as well (fig. 4). The treatment was more successful in reducing the discoloration caused by the pale, diffuse form of foxing, but severe foxing spots show a dramatic improvement after treatment as well.

After treatment, the Pigeon print is visibly brighter overall and appears slightly less yellow (fig. 5). More diffuse areas of foxing appear to be reduced more significantly than more concentrated areas of foxing, especially in the upper right corner. The overall brightening and stain reduction are easily visible on the verso, where there is no media. Examination in UV light also shows overall brightening and the slight reduction of foxing spots, although it is evident that foxing is still widespread, if not visible in normal illumination. There is also a rectangle of brighter fluorescence visible on the verso, addressed in the Discussion section.

The Balloon print also brightened overall and appears slightly less yellow after treatment (fig. 6). This object had a paler, more diffuse form of foxing than the Pigeon print and thus exhibits a more drastic stain reduction, easily visible on the verso. Under UV light, the foxing appears to be reduced but is still present in some areas. On the verso, it is evident that the foxing spots that remain are less sharply defined.

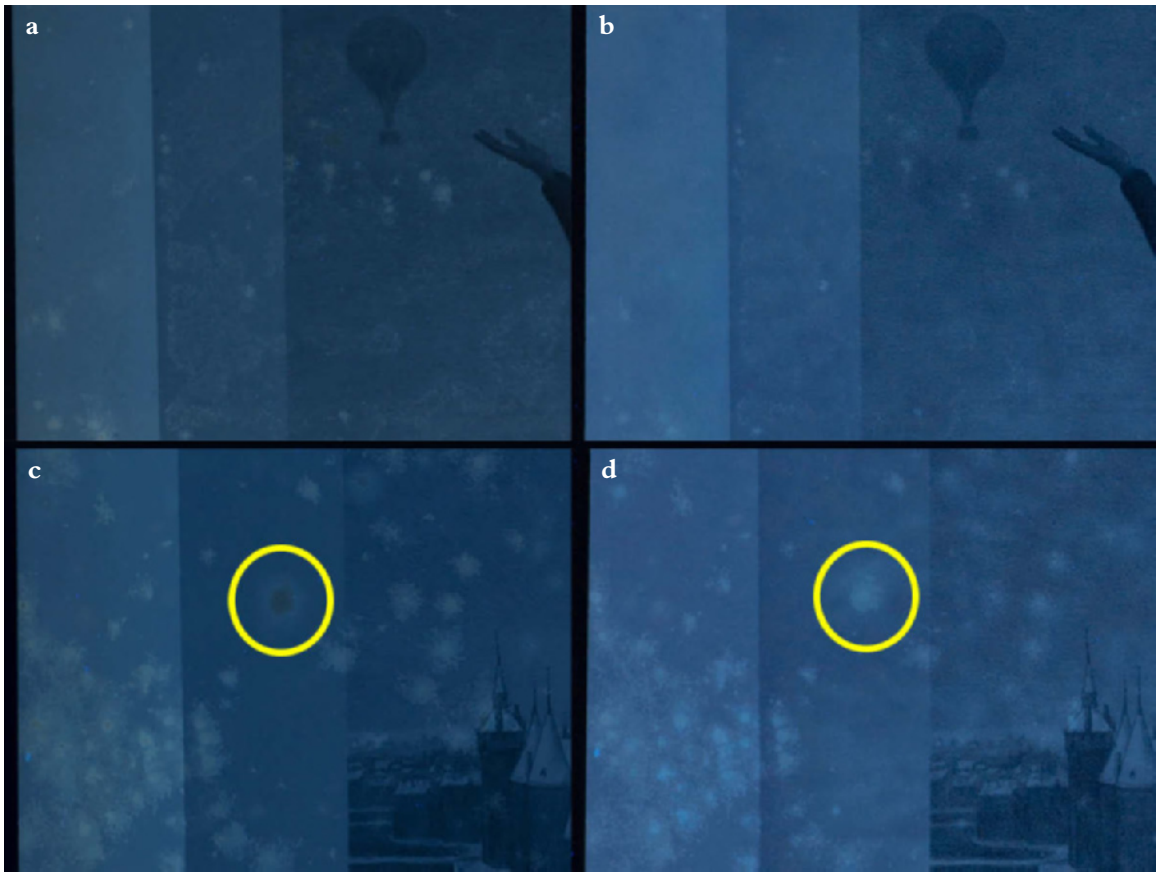

Fig. 4. Details before treatment of "The Balloon" (a) and "The Pigeon" (c), compared with after treatment (b and d, respectively). Reduction of severe foxing spots especially is visible in longwave UV illumination in "The Pigeon" (circled areas).

Quantifying the Results

The extent of foxing reduction and overall brightening is recognizable in visible examination, but quantifying these changes with colorimeter readings provides data to support the observed success of the treatment. A Minolta CR-221 colorimeter was used to take measurements of representative areas of each support, including foxing, and the minimum and maximum densities of the printed image (Table 2). The secondary supports of both prints appeared significantly brighter, with a $\Delta L^\star$ value greater than 2 for each. The human eye can detect a change in $L^\star$ value greater than 1, which explains why the overall brightening is so apparent. Furthermore, the $b^\star$ value decreased remarkably for both, indicating a reduction of the supports' yellow hue. Tracking the $\Delta L^\star$ and $\Delta b^\star$ values of foxing spots also indicates the efficacy of the treatments. The foxing spots measured on the Balloon print had a much greater degree of brightening and reduction in yellowing than the Pigeon print. This may be because of differences in the type of foxing found on the two prints, and their response to the treatment protocol and delivery method.

DISCUSSION

There is a great deal to discuss in regard to the success of these specific treatments, as well as their wider applications. A comparison of the two delivery methods yields some interesting factors to consider, which will guide the conservator in choosing between them.

The most apparent difference between these methods is the equipment necessary. The suction table is a common feature in paper laboratories; however, it does require an investment in a large, expensive piece of equipment. Laboratories without this specialized equipment can get good results with smaller, more easily available supplies such as absorbent material, like TEK-Wipe or blotter. The conservator must also consider the amount of time each treatment requires. The suction table has a quicker total treatment time, whereas the TEK-Wipe treatment is much longer. Each treatment has a different level of intensity, in which the suction table requires full attention and active participation

Fig. 5. "The Pigeon" before treatment (a) and after treatment (b), recto, normal illumination.

Fig. 6. "The Balloon" before treatment (a) and after treatment (b), recto, normal illumination.

	The Pigeon				The Balloon			
	ΔL*	Δa*	Δb*	ΔE	ΔL*	Δa*	Δb*	ΔE
Primary Support	+1.79	−0.30	−2.60	3.17	+1.92	−1.19	−2.10	3.08
Secondary Support	+2.03	−0.33	−3.23	3.08	+2.09	−0.58	−2.3	3.16
Primary Support Foxing	+3.06	−0.76	−4.09	5.16	+5.76	−1.62	−3.84	7.11
Secondary Support Foxing	+1.03	−0.16	−0.91	1.38	+4.94	−1.57	−4.63	6.95
Dmax	+0.75	+0.11	−0.88	1.16	−1.77	+0.23	−0.12	1.79
Dmin	+1.82	−0.23	−2.07	2.77	+1.41	−0.35	−1.52	2.10

Table 2. L*a*b* results.

throughout the entire treatment. Conversely, the TEK-Wipe treatment proceeds more slowly, so the conservator has more time to monitor the treatment or make changes.

Although the agarose gel sheets control moisture in both treatments, the gel used in the suction table method acts as a reservoir to slowly dispense the aqueous solutions while under suction. The gel used in the TEK-Wipe method functions as a poultice as it dries, actively drawing up water-soluble components into the agarose matrix. The amount of pressure exerted on the object also differs between the two techniques. The pull from the suction adds to the weight of the gel sheet in the suction table method, whereas the object in the TEK-Wipe method has only the weight of the gel on it. The needs of the object will dictate what treatment method to pursue. The suction table offers greater physical restraint and control of moisture but does exert more pressure on the object. Thus, the TEK-Wipe method may be more suitable for delicate objects or those that are not relatively planar.

The degree of rinsing varies greatly between the two delivery methods. The suction table allows for more rinse solution to be sprayed overall in multiple passes, whereas the amount of solution necessary to saturate the TEK-Wipe is a limiting factor. Similarly, the uniformity of rinse solution application also varies. The suction table relies on a sprayed application

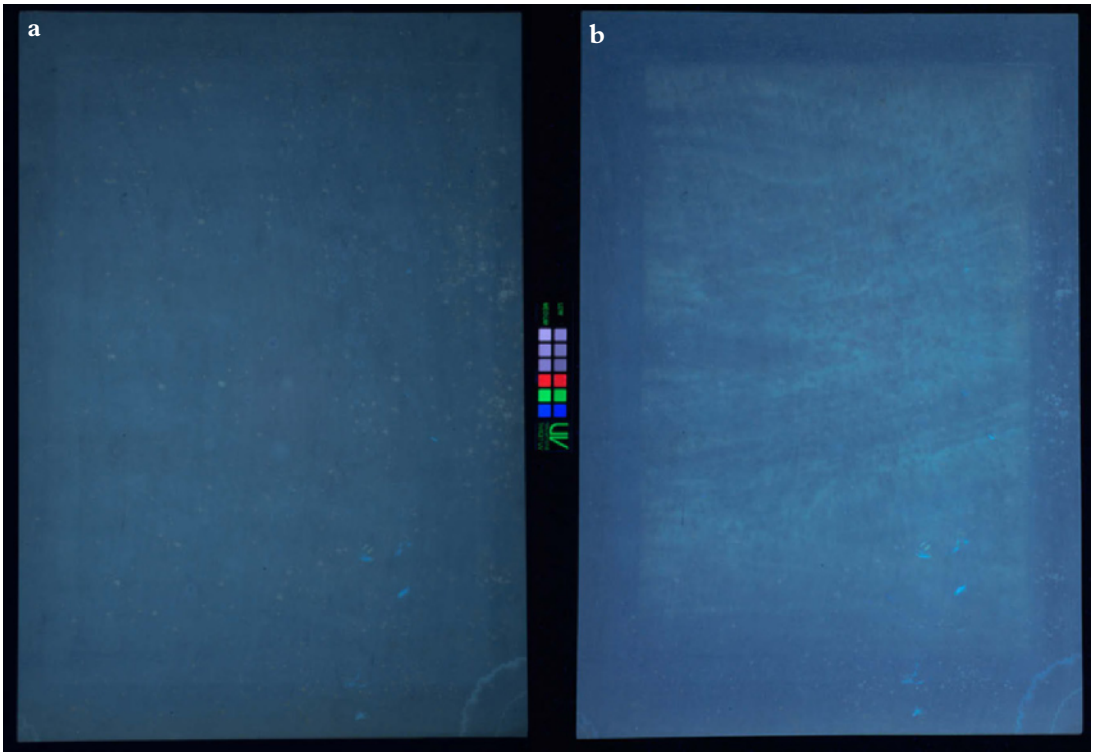

Fig. 7. Details of "The Pigeon" before treatment (a) and after treatment (b) in longwave UV illumination, showing the rectangle of autofluorescence that may be adhesive that migrated into the secondary support during treatment.

of the rinse solutions, which has the potential for unevenness due to human error. The TEK-Wipe method provides more even wetting because the absorbent layer is saturated overall with the rinse solution before the object is placed on it. This could be a reason the Pigeon print was brighter than the Balloon print after treatment: more solubilized products were moving out of the Pigeon print on the suction table. It could also appear brighter because it is cooler, due to the greater reduction of yellow hue reflected in the $\Delta b^{\star}$ value. An examination of their versos in UV light displays another result of rinsing (fig. 7). The Pigeon print, on the right, has a rectangle of brighter fluorescence, which may be the chine collé adhesive migrating through the secondary support matrix. Although the chine layer did not separate from the secondary support, some of the adhesive may have moved in the rinsing steps due to the pull of the suction. This degree of adhesive movement is not seen on the verso of the Balloon print.

Finally, one topic of particular interest is sustainability, both environmental and economic. The suction table requires electricity, whereas the TEK-Wipe method does not. TEK-Wipe can be washed and reused, and may be a more sustainable choice than blotter, which cannot be reused after it is saturated with degradation products. Although blotter was used in the suction table protocol, TEK-Wipe could be used instead. Similarly, this gel treatment protocol strove to use relatively inexpensive materials that did not have adverse environmental effects.

Future Research

It is the authors' hope that this is only a first step toward an increase in research led by other conservators and students. This general treatment protocol for the stepwise reduction of foxing stains can be applied to a variety of delivery methods based on the needs of the object in question. These include full immersion baths or more controlled applications of moisture such as gels or blotter washing. Further testing can be done with enzymes that have a higher activity level than lyticase, which may further reduce discoloration from foxing. Similarly, repeated steps or multiple applications of the reducing/chelating and enzymatic solutions may provide better results. One could also undertake other paths of research and analysis such as residue studies and artificial aging experiments.

CONCLUSION

The treatment described is an innovative one, which provides a method for overall aqueous treatment of foxed chine collé prints, including the use of a new reducing agent, enzyme, and gel delivery method. The combination of sodium hypophosphite and DTPA reduces and chelates the metallic component of foxing, whereas the lyticase enzyme targets the chitin of fungal cell walls in the fungal component of foxing. A dilute citrate rinse solution, used together with the aforementioned reagents, works to reduce both overall and local discoloration in the paper supports. A gel delivery method enables the application of aqueous solutions to objects that are extremely sensitive to moisture. Furthermore, this stepwise treatment protocol can be adapted to other delivery methods, for either controlled or overall stain reduction. Having multiple delivery methods to choose from allows laboratories with varying resources to execute a treatment with the same basic chemistry and allows for customization for each object that needs treating. The conservator has many options that each have their own advantages; it all depends on the needs of the object and the resources available.

ACKNOWLEDGMENTS

The authors are deeply indebted to their Winterthur/University of Delaware faculty members, advisors, and classmates, without whom this research could not be possible. Madison Brockman would also like to extend gratitude to Debra Evans and Victoria Binder at the Legion of Honor, and Michelle Sullivan at the J. Paul Getty Museum, for their support during internships and eagerness to experiment with similar treatments. The authors also sincerely thank the National Endowment for the Humanities, the Office of Graduate and Professional Education at the University of Delaware, and the Winterthur/University of Delaware Program in Art Conservation Student Professional Development Fund Committee for valuable educational and conference travel funding.

APPENDIX

Case Studies at Other Institutions

In the past year, variations of this treatment were tested on several other objects at two different institutions. These investigations continue to add to the authors' collective understanding of how the chemical reagents synergize with each other in different delivery methods.

During a 2018 summer internship at the Fine Arts Museums of San Francisco, Madison Brockman (co-author) assisted with a similar foxing reduction treatment that had good results. The print in question had pervasive foxing in the secondary support and was unexhibitable in that state. Brockman and Fine Arts Museums of San Francisco conservator Victoria Binder carried out the same reducing/chelating and enzymatic protocol, this time using ascorbic acid and EDTA. As an important note, sodium hypophosphite is rather difficult to obtain for those not located in large research institutions due to its DEA class 1 protected status. Ascorbic acid is an excellent alternative, as it is economical,

easily obtainable, and produces satisfactory results. Sufficient rinsing is needed to clear ascorbic acid residues that discolor when oxidized. The print was bathed on TEK-Wipe and then rinsed on the suction table in a hybridized delivery method. After a first round of agarose gel bathing, the print was brighter overall and the foxing discoloration was greatly reduced.

Brockman also completed a special treatment project in early 2019 with Michelle Sullivan, Associate Conservator of Drawings at the J. Paul Getty Museum. This treatment involved the gellan gum gel–based aqueous treatment of a large chine collé photogravure with a stretched canvas lining. Gels were an excellent tool in this case given the inherent water sensitivities of the object and the necessity of moisture in the majority of the main treatment steps. The treatment protocol called for enzymatic adhesive reduction, overall bathing, and local stain reduction, all using gellan gel sheets. Gellan was selected over agarose due to the amount of gel needed for the entire multistep treatment, which would have been cost prohibitive given the higher price of agarose. The compatibility of enzymatic solutions and the gellan sheets were investigated prior to treatment. Despite commonly held beliefs, it appeared that the enzymatic solutions were not adversely affected by the polyanionic polymer structure of the gellan gum. The combination worked to successfully soften the thick adhesive, which was partially solubilized and imbibed by the gel matrix and largely removed mechanically from the paper support. The end results were similar to those seen in other prints mentioned in this article: the supports were brighter, local discoloration was reduced, and the chine layer remained in place.

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PRODUCT INFORMATION

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Edison, NJ 08818
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KELCOGEL Gellan Gum Book, 5th edition; KELCOGEL CG-LA Gellan Gum Product Information
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Atlanta, GA 30339
800-535-2687
https://www.cpkelco.com/

Sodium Phosphate Tribasic
Fisher Scientific
81 Wyman St.
Waltham, MA 02451
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Citric Acid, Diethylenetriamine Pentacetic Acid, Lyticase Enzyme Product, Sodium Hypophosphite Monohydrate
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CATHIE MAGEE

High Acyl Gellan Gum for Parchment Conservation

INTRODUCTION

About Gellan Gums

The water-soluble anionic polysaccharide known as gellan gum comes in two forms: the more commonly known low acyl gellan gum (LAGG), which is frequently used in paper conservation, and high acyl gellan gum (HAGG). The main difference is the naturally occurring presence or artificially induced absence of an acyl group that repeats on the polysaccharide chain (fig. 1); the high acyl polysaccharide can be "de-acylated" by an alkaline process, producing LAGG (CP Kelco 2007). The presence or absence of that acyl group significantly changes the properties of the gels.

LAGG forms a clear, rigid gel (fig. 2). The polysaccharide chains form a helix around divalent cations such as calcium that allow for a controlled release of moisture and, simultaneously, the removal of solubilized material through capillary action (Iannuccelli and Sotgiu 2010). This action makes the gel useful in cleaning art on paper through both overall bathing and targeted stain reduction. The gel can be soaked in an organic solvent such as ethanol to replace some of the water in the gel, allowing for the delivery of solvent to the object. Paper conservators have also successfully used LAGG to deliver enzymes and chelators to art objects (Iannuccelli and Sotgiu 2010).

In contrast, HAGG is opaque, flexible, and rather elastic (fig. 3). Despite a drapey and soft texture, it maintains its structural integrity. This malleability is key to its success on uneven surfaces, as the softer gel is better able to make the surface-to-surface contact that is required for the gels to function. HAGG retains the ability to disperse liquid and absorb through capillary action (Peranteau 2013). Unlike LAGG, HAGG can be cooked with a component of organic solvents; rather than soaking the made gel in solvent and replacing the water content through solvent exchange, solvent is added to the gel as it is cooked. Moreover, HAGG does not become rigid upon the addition of organic solvents. In theory, the features of flexibility, liquid dispersion, and solvent capacity make HAGG ideal for working on parchment.

Papers presented at the General Session, AIC's 47th Annual Meeting, May 13–17 2019, Uncasville, Connecticut

About Parchment Substrates

Parchment, which is proteinaceous in content, is hygroscopic and very sensitive to moisture. Even slightly elevated relative humidity can cause parchment to cockle. Prolonged exposure to water can cause severe planar distortions, such as overall cockling, pleating, and shrinkage, and cause the membrane to become brittle and difficult to handle. Tide lines form very easily. In the worst-case scenario of moisture and elevated temperature, parchment can become transparent and even gelatinize (Woods 2006). The planar distortions are somewhat reversible, but tide lines and gelatinization are not. In short, wet treatment on parchment is very tricky.

Conservators who work with parchment typically use nonaqueous treatment strategies. Adhesive on book spines is picked off dry with tools, unfortunately resulting in the removal of any parchment fibers stuck in the adhesive. Surface cleaning is done with abrasive methods, such as cosmetic sponges and white plastic erasers. Although loose dirt and grime are easily removed, much remains ingrained and the overall appearance of well-used parchment is rarely improved after dry cleaning. Tide lines generally are left as they are. These common condition issues can be treated with water or humidity, but very often the risk of damaging the parchment substrate is too great. However, when the use of moisture cannot be avoided, adding an organic solvent to water can be one way of introducing small amounts of moisture to parchment without causing damage. Solvents like ethanol and acetone seem to reduce the appearance of tide lines and discoloration.

MAKING HAGG GELS

HAGG with Water

HAGG has a hydration temperature range of 70°C to 75°C, meaning that HAGG powder will not dissolve in water below this range (CP Kelco 2007). Even within this range, vigorous stirring is required to get all the powder into solution. A

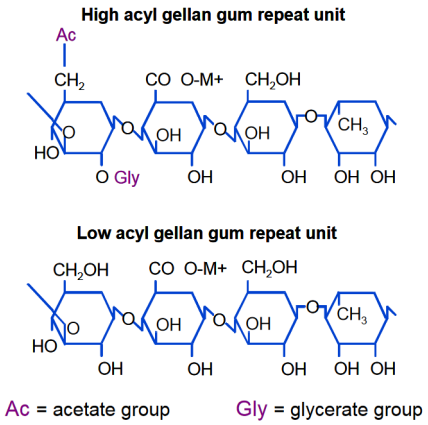

Fig. 1. The gellan gum polysaccharide chain (CP Kelco 2007, 4)

small whisk is a particularly useful tool in breaking up clumps of gellan powder. Cooking HAGG on a hotplate with a stir bar allows for monitoring the cooking gellan for clumps, although HAGG can be made in a microwave.

A divalent cation must be added to the deionized water (before the addition of the gellan) to help the gel keep its structural integrity. A solution of .4 g/L of calcium acetate in deionized water is commonly used in LAGG and is adequate for HAGG.[1] A saturated solution of calcium hydroxide and deionized water seems to be less effective in achieving structural integrity. HAGG made with .4 g/L of calcium acetate in deionized water typically has a pH of 5 to 6 and a rather low conductivity of about 1 mS/cm[2].[2] The pH and conductivity of the gel can be manipulated via the addition of buffering solutions and salts. HAGG can also accommodate chelators and enzymes.

The gelation temperature is about 70°C, meaning that the cooked slurry achieves gelation within seconds of being removed from the hot plate (CP Kelco 2007). The gels can be refrigerated for a few weeks in sealed plastic baggies and still be usable, although they do eventually get moldy. Finally, HAGG almost certainly leaves a residue. A barrier of Japanese paper can be used to mitigate residue, but it will limit the effectiveness of the gel.

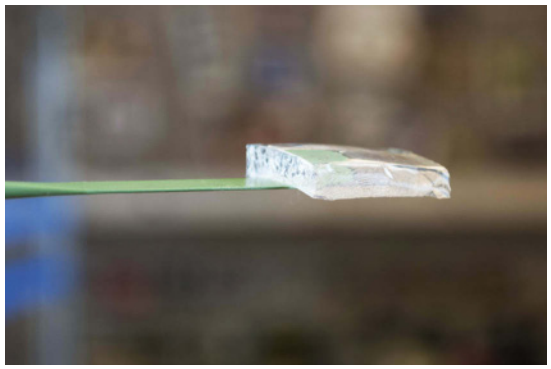

Fig. 2. A 1% LAGG in deionized water (.4 g/L of calcium acetate)

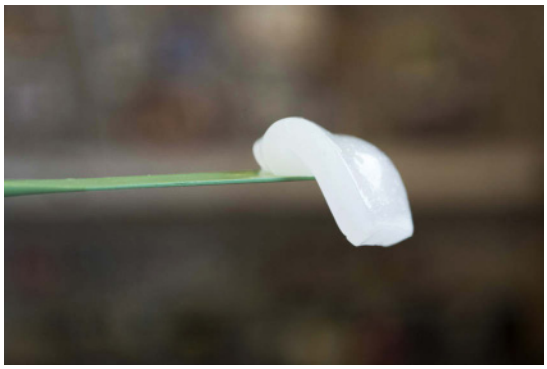

Fig. 3. A 1% HAGG in deionized water (.4 g/L of calcium acetate)

Recipe for Gel A
50 mL deionized water with .4 g/L calcium acetate
.05 g NaCl
.5 g HAGG powder

Instructions: Preheat water in a microwave or on the hot plate to above 70°C. Add the NaCl to the water and dissolve. Add the HAGG powder and stir vigorously with a whisk to break up clumps. Insert the stir bar, and cook/stir until completely dissolved. Pour the gel into a Mylar tray. (A total of 50 mL seems to fill a 3 × 5 in. Mylar tray, forming a gel approximately 3 mm thick.)

HAGG with Water and Ethanol
HAGG can accommodate up to 50% ethanol—that is, a 1:1 mixture of ethanol and deionized water (with a divalent ion component)—without losing its flexibility or structural integrity. However, HAGG is insoluble in ethanol, and it can be challenging getting the gellan powder to dissolve. Furthermore, if all of the ethanol is added to the gel slurry at once, very large congealed lumps of gel form and take a while to cook down. The author found success in dividing the powder and the ethanol in half and adding the components in stages. Minimizing the cooking time is to be prioritized, as the longer the gellan takes to dissolve, the more solvent is cooked off and lost. (Solvent loss has not yet been quantified.)

Recipe for Gel B
25 mL deionized water with .4 g/L calcium acetate
25 mL ethanol, divided
.5 g HAGG powder, divided

Instructions: Add half of the gellan powder to the water on the hot plate. Whisk to break up clumps. Insert the stir bar, and cook/stir until completely dissolved. Add the other half of the gellan powder to half of the ethanol. Slowly add this mixture to the water/gellan on the hot plate. If clumps form, pause and let them cook down. After the ethanol/gellan is sufficiently integrated, use the rest of the ethanol to rinse the gellan powder residue from the little beaker. Again, add this ethanol slowly. It may take 5 to 10 minutes for the gellan powder to fully dissolve. Once there are few or no clumps, pour the gel into a Mylar tray.

CASE STUDY 1: GEL FOR LIFTING ADHERED PARCHMENT

The first case study is a medieval codex treated by the author as a Mellon Fellow at the Walters Art Museum. The Saint Francis Missal (W.75) is a 12th-century Italian illuminated manuscript that had been rebound during the 15th century into a quarter leather binding with beach wood boards (fig. 4). The spine leather was replaced in the 19th century. The codex was beset by an insect infestation sometime before the spine leather was replaced and required complete disbinding to repair much of the damage. The wooden boards had extensive tunneling and losses, especially to the back board at the spine edge, and required consolidation and some reconstruction.

Standing in the way of that process were two pastedowns adhered to the inside faces of the boards (fig. 5). To have complete access to the damage, these pastedowns needed to be removed. The pastedowns were parchment manuscript waste: two bifolia from a pocket missal that dated to the 11th century. Both sides of the bifolia have writing in iron gall ink and rubrication in red lead. Microchemical tests indicated that the adhesive used to adhere these bifolia overall was animal glue with a starch component. When manuscript

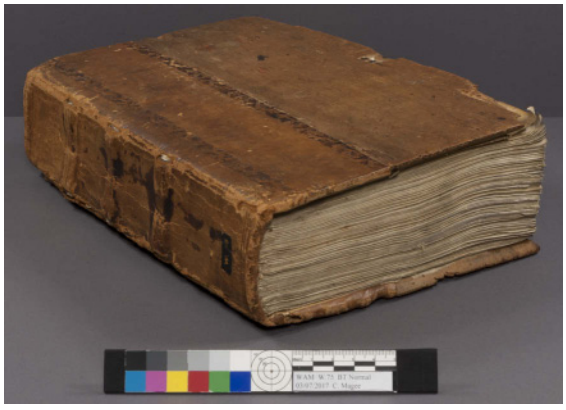

Fig. 4. The Saint Francis Missal (W.75), a 12th-century illuminated manuscript. Before treatment. Image courtesy of the Walters Art Museum, Baltimore.

Fig. 5. The front pastedown of the Saint Francis Missal (W.75) is 11th-century manuscript waste, which is adhered to the wood overall with an animal adhesive that has a starch component. Before treatment. Image courtesy of the Walters Art Museum, Baltimore.

waste pastedowns are removed by lifting with a knife or spatula, skinning of the adhered surface of the parchment often occurs, and ink, paint, and the surface layer of the parchment are left behind in the adhesive residues. The pastedowns of W.75 had been partially lifted when the leather was replaced, and some skinning and loss of media had already occurred.

After some trial and error, HAGG with 50% ethanol was determined to be the most effective in lifting the pastedowns (see the preceding Gel B information). The gels were applied directly to the face of the parchment, humidifying the adhesive through the membrane (fig. 6). The flexible, soft texture of this gel ensured sufficient surface contact, which is necessary for the gel to function efficiently. (Feeding the gels underneath a lifting edge of the parchment did not allow the humidity to reach the adhesive still adhering the parchment to the wood.) After allowing the gels to sit on the parchment for about 5 minutes, the gel was removed and pieces of Hollytex and wool felt were placed on the humidified area with a weight on top. This allowed time for the adhesive to become softened

Fig. 6. HAGG with ethanol was applied directly to the face of the parchment without a barrier layer.

while the parchment began to dry. After approximately 10 minutes, the weight, felt, and Hollytex were removed and the parchment could be lifted with a spatula (fig. 7).

Throughout the pastedowns were dozens of overlapping circular cuts, the presence of which has not yet been explained. These cuts presented a challenge during lifting, as dampened parchment is extremely malleable and can be forced out of plane by even gentle manipulation. To prevent distortion, areas with the cuts were temporarily faced with remoistenable tissue before lifting. The parchment was still damp after the initial gel application, and the tissue was set in place and pressed on with finger pressure, then dried under felt and a weight for 10 minutes. This technique was effective in keeping the parchment in plane during lifting.

Fig. 7. After humidification, the parchment was lifted with a Delrin spatula.

Overall, the parchment lifted quite well (fig. 8). Most of the ink was recovered, and the text was in a readable state. The nerve-wracking prospect of using opaque gel over writing media (none of which was observed to be water sensitive during pretreatment solubility testing) was tempered by the ability to effectively deliver moisture and solvent combination without causing tide lines or discoloration.

CASE STUDY 2: GEL FOR ADHESIVE REDUCTION

The second case study is a medieval codex treated by the author as a Kress Fellow at the Walters Art Museum. The 11th-century German Gospel Book (W.14) is an illuminated manuscript that was also designated to undergo a complete disbinding (fig. 9). After the 19th-century parchment spine lining was removed, it became apparent that the excellent condition of the parchment spine folds provided a good

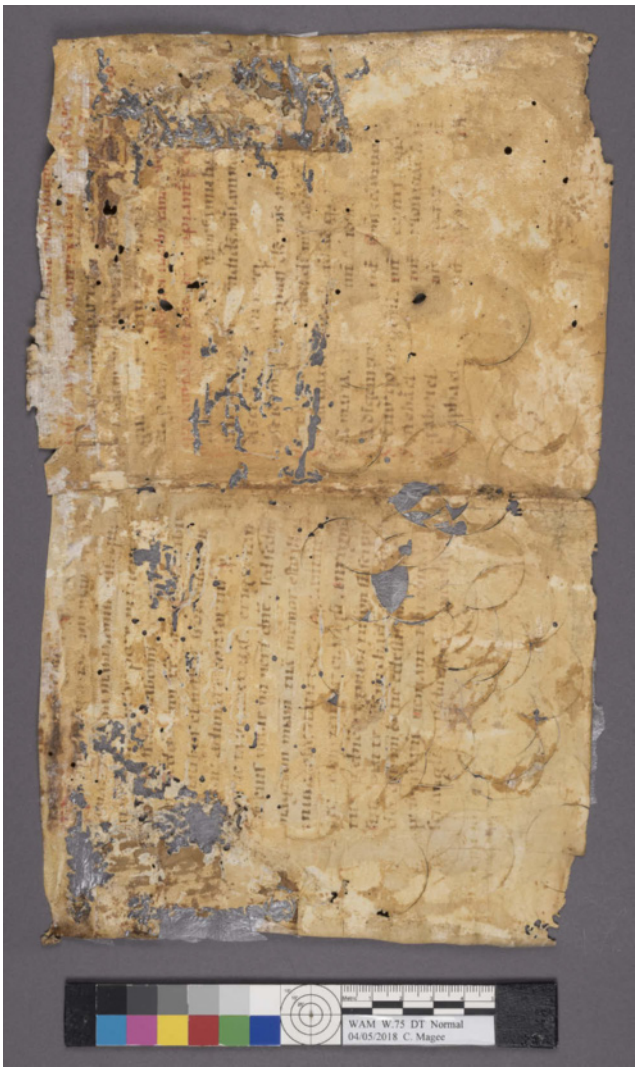

Fig. 8. Adhesive side of the front pastedown after lifting with gels. Image courtesy of the Walters Art Museum, Baltimore.

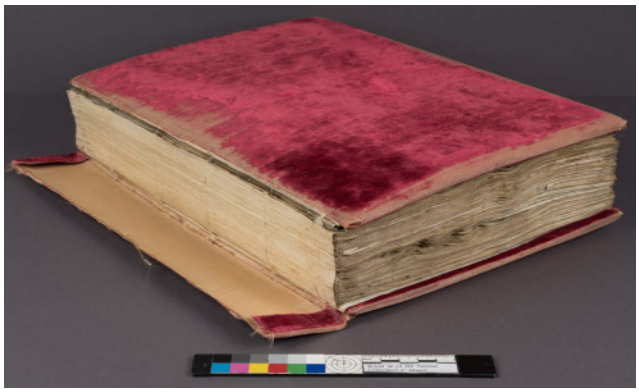

Fig. 9. German Gospel Book (W.14), an 11th-century illuminated manuscript. Before treatment. Image courtesy of the Walters Art Museum, Baltimore.

opportunity to see if gels could be useful in reducing spine adhesive. Microchemical tests indicated that this adhesive was also a mixture of animal protein and starch.

It was thought that determining the pH at which the adhesive was most soluble would quickly facilitate the removal of the spine adhesive. Solubility tests were done with three buffer solutions (pH 4, 7, and 10) on small samples of the adhesive that had been removed from the spine. A few drops of each solution were placed on the samples in a ceramic well dish. Their rates of dissolution were observed under a microscope. All of the samples swelled and became very soft within 30 seconds.

Given the success of the ethanol gels from the pastedowns of W.75, the same recipe was tried first (see the preceding Gel B information). This gel typically has a pH of about 6. The gel was left on the spine adhesive for about 5 minutes and then removed (fig. 10). This amount of time was enough for moisture to begin seeping through cracks or gaps in the adhesive layer, and the parchment underneath had begun to wet out. Only the top layer of adhesive became softened. This layer could be scraped off with a flat wooden spatula, but a layer of hard adhesive was left underneath. It took two or three passes with the gel to fully remove all of the adhesive residue, with the undesirable result of disturbed parchment fibers from the excessive mechanical action. A second gel was tried: 1% HAGG in deionized water (.4 g/L of calcium acetate), pH 6.5. This gel was also unsuccessful in sufficiently softening the adhesive after sitting on the adhesive for 5 minutes.

At this point, consideration returned to the buffer solutions. Perhaps it was not the pH but the conductivity of the solutions that caused the adhesive samples to solubilize so quickly. The buffer solutions of pH 4, 7, and 10 have conductivities of 4.9 mS/cm^2, 7.7 mS/cm^2, and 9.8 mS/cm^2, respectively. Although very different, they are all much higher than the conductivities of both gels (ethanol HAGG, .21 mS/cm^2; water HAGG, .99 mS/cm^2). To boost the conductivity of the water gel, .05 g of sodium chloride was added, bringing the conductivity up to 2 mS/cm^2. Most of the spine adhesive was softened and removed in one pass (fig. 11). Mechanical action was still necessary to remove the adhesive, because even though it was not terribly thick, it was still too much material for the gel to absorb via capillary action.

Removing adhesive with this method left behind adhesive that seeped between the quires, which could not be reached by the liquid expressed from the gel. This adhesive was addressed after the book block was disbound and the quires were separated. Rather than picking it off dry, the same gel was used to soften the adhesive locally while the outer bifolia were unfolded.

SURFACE CLEANING

Investigations into the use of HAGG for surface cleaning on parchment have only just begun. Gels cannot work as quickly as the parchment requires; one does not simply let the gel soak out the parchment for an hour or two as one could with paper. HAGG can be left on for a few minutes, depending on

Fig. 10. The ability of HAGG to conform to the uneven book spine was instrumental to the success of the gel.

Fig. 11. The adhesive could be removed with a wooden spatula after becoming sufficiently softened.

Gel	Ingredients	pH	Conductivity
Gel 1	.5 g HAGG in 50 mL of deionized water	4.8	0.78 mS/cm^2
Gel 2	.5 g HAGG in 50 mL of deionized water (.4 g/L of calcium acetate)	5.5	0.92 mS/cm^2
Gel 3	.5 g HAGG in 25 mL of ethanol + 25 mL of deionized water (.4 g/L of calcium acetate)	5.8	.32 mS/cm^2
Gel 4	.5 g HAGG in 50 mL of deionized water (.4 g/L of calcium acetate) + .05 g of NaCl	5.7	2.9 mS/cm^2
Gel 5	.5 g HAGG in 40 mL of deionized water (.4 g/L of calcium acetate) + 10 mL of pH 7.5 citric acid monohydrate	7.0	9.3 mS/cm^2
Gel 6	.5 g HAGG in 50 mL of saturated calcium hydroxide	7.0	.61 mS/cm^2

Table 1. Experimental Gels

the thickness and condition of the parchment. This is enough time for capillary action to begin, but, as with adhesive removal, it cannot be relied on for cleaning. Gel application must be followed by mechanical action via swab. However, that action generally disturbs the parchment fibers and causes the parchment surface to appear rough.

The six different HAGG gels shown in table 1 were applied to a portion of a 16th-century parchment book cover (fig. 12). The gels were left on for 5 minutes before being removed and the areas swabbed. The results vary widely, showing that gels can effectively deliver cleaning solutions to parchment and that not all cleaning solutions are equal. The area cleaned with Gel 1 (.5g HAGG in 50 mL of deionized water, no divalent ion added) seems to have had the best results.

TIDE LINE REDUCTION

A small scrap of modern goatskin parchment was given an artificial tide line using su-su, also known as "paper extract" or "paper dirt". The same six gels used for surface cleaning were left on for about 5 minutes (fig. 13). In this instance, gel application was not followed by swab action, as the effectiveness of capillary action alone was of interest. In some areas, the gels do seem to have softened the edge of the tide line, but by no means was the stain removed. The most improvement was seen in the area cleaned by gel 3 (.5 g HAGG in 25 mL of ethanol + 25 mL of deionized water [.4 g/L of calcium acetate]).

Fig. 12. Six gels were used in the experimental cleaning of a 16th-century parchment book cover. The numbers by the cleaned areas in the image correspond to the number of the gels in table 1. Image courtesy of the Walters Art Museum, Baltimore.

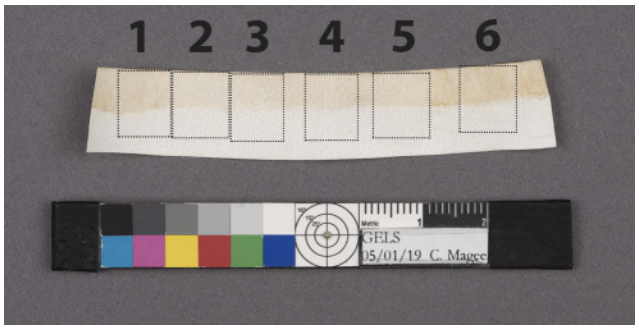

Fig. 13. The efficacy of the six experimental gels (see table 1) were tested in the reduction of an artificially created tide line on a piece of modern goatskin parchment. Image courtesy of the Walters Art Museum.

ARTIFICIAL "AGING"

Polysaccharides are, in theory, chemically innocuous to parchment. However, exposure to the water, solvent, and salts may cause long-term damage to the protein fibers of the membrane. The six HAGG gels used in the cleaning and tide line experiments were applied to six squares of recently made goatskin parchment (fig. 14) and squares of Whatman filter paper. Control samples of parchment and Whatman

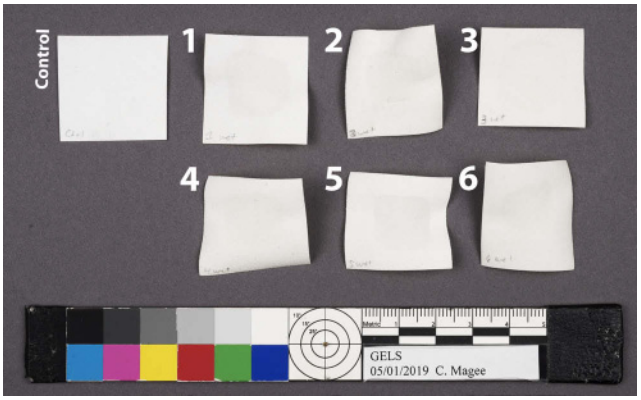

Fig. 14. Squares of modern goatskin parchment were exposed to the six experimental gels and artificially aged in an oven. The control sample was not exposed to a gel. Image courtesy of the Walters Art Museum.

paper that were not exposed to gels were also included in the test. Pieces of each gel (about 1 cm^2) were placed on the parchment and paper squares until the substrates wet through, about 5 minutes. Then the samples were allowed to air dry.

Parchment and paper samples treated by the same gel were placed in a small glass jar containing a glass test tube with a dampened cotton ball at the bottom (seven jars total). The mouths of the jars were covered with pieces of aluminum foil, over which plastic lids were screwed on. The jars were placed in an oven at 60°C for 21 days.

Although it is plainly visible where the gels were applied, the samples do not look much worse than before they were placed in the oven. Much of the darkening and distortion were present after the parchment was allowed to air dry. If anything, this experiment demonstrates the need for limited exposure to moisture and controlled drying for parchment rather than being an argument against using gels.

CONCLUSION

Gels made of HAGG can be successfully used on parchment components in codices for the purposes of softening and reducing adhesives made from animal protein. The gels can deliver cleaning solutions to parchment surfaces, but the removal of surface grime must be done mechanically and may be disfiguring to the surface of the parchment. The gels are also limited in their effectiveness in reducing tide lines. It is possible that a different combination of pH and conductivity modulation in addition to chelators or surfactants may make a difference in the effectiveness of the gels for these purposes.

ACKNOWLEDGMENTS

The author would like to thank Abigail Quandt, Elisabetta Polidori, Dr. Glenn Gates, Madison Whitesell, and the always supportive conservation department at the Walters Art Museum. Special thanks to Michelle Sullivan for inspiring this research and for continued guidance. Deep gratitude goes the Society of Winterthur Fellows for their support through a Research and Continuing Education Grant. This article is dedicated to Grumpy Cat, who passed away the week that the original paper was presented.

NOTES

1. The concentration of calcium acetate in deionized water at .4 g/L has been seen in several sources (Iannuccelli and Sotgiu 2010; Hughes and Sullivan 2016), but how this concentration was determined is unknown.
2. The pH and conductivity were measured with Horiba LAQUAtwin meters. Each meter was calibrated with standard solutions before measurements were taken. Slight variations were observed in both the pH and conductivity when measuring different areas within a gel.

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SOURCES OF MATERIALS

KELCOGEL LT100 Gellan Gum (High Acyl)
CP Kelco US, Inc.
3100 Cumberland Blvd., Ste. 600
Atlanta, GA 30339
800-535-2687
https://www.cpkelco.com/products/gellan-gum/

Calcium Acetate Hydrate (CAS: 114460-21-8)
Acros Organics, via Fisher Scientific
300 Industry Dr.
Pittsburgh, PA 15275
724-517-1500
https://www.fishersci.com/shop/products/calcium-acetate-hydrate-99-extra-pure-acros-organics-3/AC211052500/

Buffer Solutions (pH 4, 7, and 10)
Aldon Corp.
221 Rochester St.
Avon, NY 14414
585-226-6177
https://www.aldon-chem.com/

Sodium Chloride
J. T. Baker Chemical Co.
Phillipsburg, NJ 08865

Horiba LAQUAtwin Compact pH Meter B-71X; Horiba LAQUAtwin Conductivity Meter
HORIBA Instruments Inc.
Irvine South Office
34 Bunsen Dr.
Irvine, CA 92618
949-453-0500
https://www.horiba.com/laquatwin/en/lineup/index.html#ph/
https://www.horiba.com/laquatwin/en/lineup/index.html#cond/

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An Analysis of Training and Institutional Context on Book Conservation Practices in Research Libraries in 2007 and 2017

INTRODUCTION

In 2007, a survey was conducted among conservation practitioners, resulting in a published assessment of book conservation practices in research libraries in the US (Baker and Dube 2010). This research identified a "standard toolbox" of treatments for both general and special collections in the first decade of the 21st century, establishing a baseline for future comparison and providing a quantitative synopsis of how book conservation was practiced in research libraries at that time. A second publication correlated institutional context and training of conservation professionals with specific treatment practices (Dube and Baker 2010). This second work concluded that practitioners working in hybrid facilities—in which both general and special collections were treated— tended to use a hybrid treatment approach, straddling more traditionally general versus special collections treatment practices.

In 2017, the survey was repeated to determine if and how treatment practices had changed in a decade. For continuity, the new survey was almost identical to the 2007 version. The longitudinal research project has the following research goals: (1) to document standard treatments in research library book conservation, (2) to identify similarities and differences between special and general collections practices, (3) to determine whether demographic characteristics of conservation practitioners are associated with particular treatment practices, and (4) to determine how treatment practices have changed in a decade.

The first findings from the 2017 data were published in *Library Resources and Technical Services* (Baker 2019), focusing on how the standard toolboxes of treatments for general and special collections have changed in the period from 2007 to 2017. The survey findings suggest that frequently employed treatments for general collections changed relatively little, indicating that a standard toolbox of treatments exists for general collections treatment in US research libraries. However, in the special collections context, the survey data indicated that practices continued to evolve, with 10 treatments added to the "highly standard practice" list (indicating that 75% or more of respondents considered a treatment standard practice). These 10 treatments joined 8 treatments that were identified in 2007. As such, the data suggest that special collections practices are not as codified among practitioners.

In this publication, the 2017 survey data will be assessed to determine if and how demographic characteristics—size of library, type of conservation facility, type of conservation practitioner, and practitioner training—correlate with changes in treatment practices in the past decade.

DEVELOPMENTS IN LIBRARY CONSERVATION PRACTICES IN RESEARCH LIBRARIES, 2007 TO 2017

Several factors may have significantly influenced the resources and focus of conservation practitioners and laboratories since the first survey was conducted in 2007. First, the growth of digitization initiatives in research libraries has placed new demands on conservation over the past decade, significantly affecting the treatment approaches employed by conservation professionals and influencing staffing needs. Treatments required to support digitization typically focus on minimal stabilization prior to scanning. As noted by panelists in the 2008 Library Collections Conservation Discussion Group session, there has been a "shift from . . . treatments for handling and use in a reading room towards treatments concerned with the requirements of imaging systems" (Reidell and McCann 2008, 116).

In addition, as research libraries increasingly acquire similar general collections resources in the form of large digital collection subscriptions, special collections have become a more important means for libraries to differentiate themselves. Many research institutions have broadened their definition of "special collections" beyond rare books and manuscripts to include archival collections, international or area studies, and other topical or specialized collections that

Independent Submission

distinguish one library from another, often under the rubric of "distinctive collections." An increased institutional focus on distinctive collections may affect types of conservation practitioners hired to care for those materials and the treatments employed.

In the past decade, many conservation units have added staff trained in treatment of special collections materials, whereas staff additions to care for general collections have been relatively rare. Miller and Horan, in a review of position announcements for preservation professionals from 2004 to 2015, noted that "special collections conservation [is] more likely to remain present in job advertisements" versus a "de-emphasis on many aspects of treatment and care of circulating collections" (2017, 195–196). Miller and Horan found a marked reduction in positions advertising for circulating book repair treatment (from 41% to 11%), indicating that there have been fewer advertised positions focusing on the treatments more likely to be performed by technicians than by those performed by professionals with graduate degrees (2017, 190).

Another potential variable is the formal education of research library book conservators. In 2009, the University of Texas at Austin (UT Austin) conservation training program closed to incoming students. At the time, it was the only graduate-level training program specifically dedicated to training library and archives conservators in North America. As a result, the Andrew W. Mellon Foundation funded the development of book conservation training at the three American art conservation programs: Buffalo State, the State University of New York; Winterthur/University of Delaware; and New York University. The first students from these programs specializing in books graduated in 2013 (Patricia H. and Richard E. Garman Art Conservation Department 2019). It is possible that book conservation training practices have evolved as more training centers have developed.

SURVEY METHOD

To ensure consistency and to determine whether changes to the survey instrument were warranted, both the 2007 survey data and literature from the past decade were reviewed. Treatments that were deemed extremely low use in 2007 were not included in the 2017 survey if there were no new publications or references to them between 2007 and 2017. To maintain continuity for comparison with the 2007 data, these changes were only made after careful scrutiny. Nevertheless, three treatments that met the criteria were removed: (1) leather-covered box, (2) paperback stiffening, and (3) in-house use of Wei T'o deacidification spray.

In addition, a decade's worth of literature was examined to identify any new book treatment techniques for both general and special collections introduced in published form, through workshops, or via social media. Although most of the techniques identified in this search were more relevant to book arts than to conservation, a few new conservation techniques associated with minor paper treatment and textblock repair were well publicized: the use of remoistenable and solvent-set tissues in mending paper items, and toning Japanese paper for mends or fills. Since 2007, remoistenable and solvent-set mending tissues have been the topic of many publications and a series of hands-on workshops hosted by the AIC and the Guild of Book Workers. The toning of Japanese paper was perceived as a common practice in many laboratories that was inadvertently omitted from the 2007 survey.

To compare practices over time, the survey structure developed 10 years ago was reused, facilitated by Qualtrics software. The 2007 survey was evaluated and updated to ensure a more robust and representative response in the 2017 version. In 2007, the survey was distributed via a common weblink, and respondents were asked to answer once per treatment facility. In 2017, thanks to improvements in survey technology, individuals were invited to take the survey via personalized links, resulting in multiple responses per institution to more accurately capture treatment practices across the field. Furthermore, considering that large institutions often employ conservation professionals with diverse training experiences, greater participation could invite wider perspectives. To facilitate comparison to the 2007 data, in which almost all respondents were from institutions that were members of either the Association of Research Libraries or the Independent Research Libraries Association in the US, the 2017 survey was limited to respondents whose libraries were part of those organizations. Therefore, "type of library" was not a demographic factor considered in the 2017 analysis.

The survey instrument consisted of four sections: (1) audience definition and participation disclaimer, (2) demographic questionnaire, (3) treatment questionnaire(s), and (4) a request for voluntary follow-up. To ensure the survey's relevance to both general and special collections practitioners and to permit a comparison of practices, the questionnaires pertaining to general and to special collections treatment practices were identical, containing 54 treatments in seven categories that could be applied to bound materials in either a general or special collections setting: (1) protective enclosures, (2) binding reinforcements, (3) minor paper treatments and textblock repairs, (4) board reattachment methods, (5) rebinding styles, (6) binding repair techniques, and (7) advanced paper treatments performed on bound materials. Where treatment names were not sufficiently self-explanatory, definitions were supplied with the treatment. Respondents were asked to indicate how frequently each treatment was performed by selecting from a set of options: (1) standard practice, frequent; (2) standard practice, occasional; (3) anomalous use only; (4) never; and (5) not sure.

The appendix presents a list of treatments included in the survey. For the complete survey and treatment definitions, refer to Baker (2019).

The survey design enabled respondents to provide treatment information—as appropriate to their responsibilities—for only general collections treatment, only special collections treatment, or both. Individuals with treatment responsibility for one type of collection—general collections *or* special collections—were asked to complete one page of identical treatment questions, whereas respondents with treatment responsibility for both general collections and special collections received two pages of questions, one for each type. An analysis of the potential errors associated with the survey is provided in the previous report on the 2017 data (Baker 2019, 89–90).

Respondents		Treatment Cases		
Type	No.	Special Collections	General Collections	Total
Hybrid practitioners	57	57	57	114
Special collections only	51	51	—	51
General collections only	14	—	14	14
Total	**122**	**108**	**71**	**179**

Fig. 1. Respondents' demographic characteristics and number of treatment cases, 2017

DEMOGRAPHIC CHARACTERISTICS OF SURVEY RESPONDENTS

Of the 212 invited respondents, 122 individuals from US research libraries fully completed the survey, resulting in a 58% response rate—a large increase from 2007's estimated response rate of 29%. The survey sample was relatively diverse with respect to collected demographic characteristics: respondents were almost evenly matched between those holding positions with hybrid treatment responsibilities involving both special and general collections (57 respondents [47%]) and those working only with special collections (51 respondents [42%]). Only 11% of respondents worked solely with general collections. The 122 respondents provided a total of 179 "treatment cases" because the 57 hybrid respondents were asked to complete two treatment questionnaires, one for each type of collection, whereas the remaining 65 respondents completed one questionnaire each (fig. 1).

Size of Library

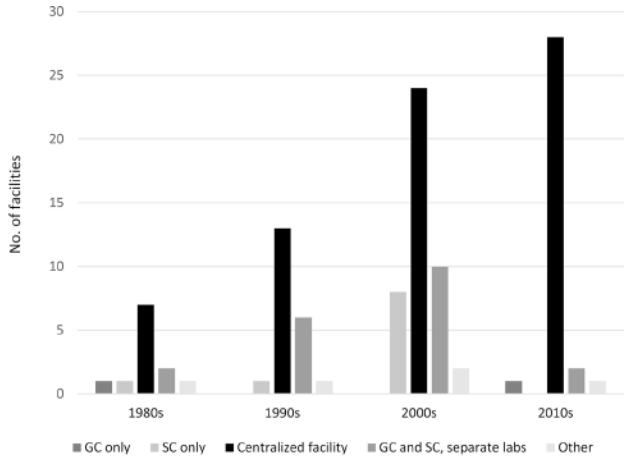
In 2007, respondents were distributed relatively evenly among large libraries with more than five million volumes, mid-size libraries with two to five million volumes, and smaller libraries with fewer than two million volumes. In contrast, in 2017, many more of the respondents worked for large research libraries than was the case in 2007: 57% of respondents worked in institutions with more than five million volumes compared with 29% in 2007. This may be a function of allowing multiple responses from the same institution and may not adequately reflect shifts in hiring practices (fig. 2).

Some relationships were identified between the size of the library and the type of practitioner (i.e., hybrid, special collections only, or general collections only). In the special collections context, nearly two-thirds (64%) of the special collections–only practitioners were from libraries with more than

		2007		2017	
Question	Response	No.	%	No.	%
Size of institution	Fewer than 2 million volumes	24	33	17	14
	2–3 million volumes	28	38[a]	10	8
	3–5 million volumes			26	21
	More than 5 million volumes	21	29	69	57
Type of conservation/repair facility	Special collections only	2	3	11	9
	General collections only	7	10	2	2
	Centralized/hybrid facility	48	66	77	63
	Separate facilities	15	21	27	22
	Other	1	1	5	4
Year facility built or last renovated	2010s	N/A	N/A	32	30
	2000s	32	44	44	40
	1990s	16	22	21	19
	1980s	10	14	12	11
	Pre-1980s	10	14	N/A	N/A
	Other	5	7	N/A	N/A

[a]The 2007 survey had only three categories for institution size, with the middle category encompassing "2–5 million volumes."

Fig. 2. Respondents' institutions, 2007 versus 2017



GC, general collections; SC, special collections.

Fig. 3. Facility type versus decade built or renovated

five million volumes, whereas none were from libraries with fewer than two million volumes. Conversely, in the general collections context, the opposite trend was observed: nearly half (47%) of general collections–only practitioners were from smaller libraries with fewer than two million volumes. As for the hybrid practitioners, nearly half (46%) were associated with mid-size libraries with two to five million volumes.

Type of Conservation Facility

The 2007 data indicated a trend, when comparing respondents' facility types and their most recent renovation dates, of a preponderance of centralized, or hybrid, facilities, in which both general and special collections were treated. The 2017 data presented a strong continuation of that trend, as two-thirds of respondents worked in a library with a centralized, or hybrid, conservation facility (see fig. 2). Thirty percent of respondents worked in a facility that was built or renovated since 2010, with an additional 40% in a facility built or renovated in the 2000s (fig. 3).

Respondents' Training

With respect to the respondents' training, 51% of individuals had a graduate degree in library or information science, 45% had a graduate degree in conservation, 32% had served a conservation apprenticeship, and 18% had attended a bookbinding program with a conservation component (fig. 4). Multiple responses were allowed for this question.

A comparison of the respondents' formal training with the types of collections served (i.e., special collections and/or general collections) revealed some trends. Professionals working only with general collections and "hybrids" working with both general and special collections were more likely to have had training in library science than other types of training.

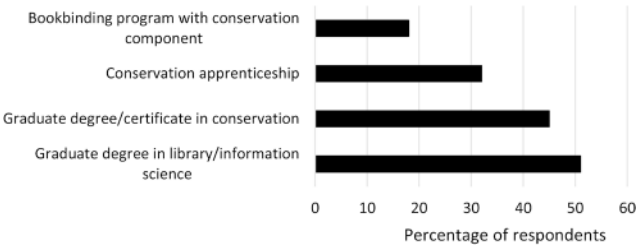
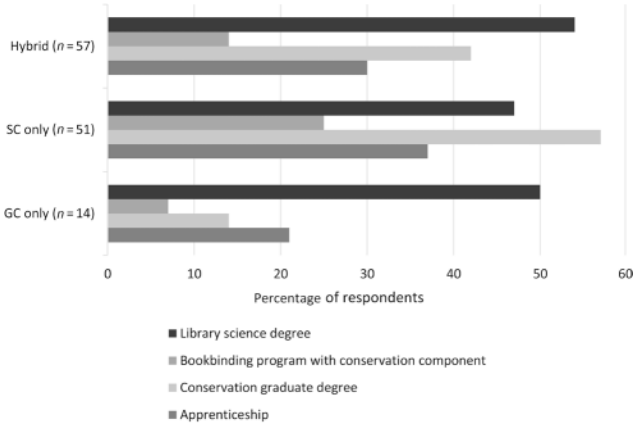


Fig. 4. Percentage of respondents with various types of formal conservation training (n = 122). Multiple responses were allowed.

In fact, for all three categories of conservation professionals, including individuals working only with special collections, the percentage of individuals with library or information science degrees was around 50% (fig. 5).

With regard to individuals working *only* with special collections in 2017, 57% had a graduate degree in conservation and 47% had a graduate degree in library science. More than one-third (37%) had served a formal conservation apprenticeship and one-fourth (25%) had attended a bookbinding program with a conservation track or component. The respondents working *only* with general collections, however, had relatively little formal training in conservation proper. The most typical way of gaining conservation training was by apprenticeship (21%).

Hybrid practitioners closely mirrored the training of special collections practitioners; in all cases but the possession of a library science degree, the percentage of respondents in each category is slightly lower than that of special collections–only individuals. Forty-two percent of hybrid respondents had earned a conservation graduate degree, and nearly one-third (30%) served an apprenticeship. Overall, the training patterns of practitioners working only on special collections was quite similar to those of hybrid practitioners. In contrast, the training of general collections practitioners was quite different, and rates of formal training were significantly lower (see fig. 5).



GC, general collections; SC, special collections.

Fig. 5. Type of practitioner versus formal training types, 2017

SURVEY RESULTS

The collected data pertaining to treatment practices were compiled and graphed, comparing general collections and special collections practices. Each treatment was classified—once for general collections and again for special collections—as either standard practice, moderate use, or low use. A treatment was designated "standard practice" when it was reported as "standard practice, frequent" or "standard practice, occasional" by 50% or more of the respondents. Treatments reported as standard practice by 25% to 49% of conservation units were designated "moderate use," whereas the remaining treatments—those considered standard practice by fewer than 25% of units—were designated "low use." Figure 6 shows the overall 2017 data for both general and special collections.

The data were examined for trends in treatment practices across all collected elements of demographic information. For each treatment, the percentage of respondents from various demographic groups who reported the treatment as standard practice was calculated for both special and general collections, and the figures for various demographic groups were compared. In addition, the data in each section were compared with the conclusions from the 2007 data. The following section details the similarities and differences in practices associated with four demographic variables:

- Size of library
- Type of conservation facility (whether special collections, general collections, or both)
- Type of practitioner (whether special collections, general collections, or both)
- Practitioner training

Size of Library

When comparing treatment practices between larger and small libraries, the separating line of three million volumes was selected. Overall, the data indicate that size is a greater factor in determining treatment practice in the special collections context than in the general collections context.

Size of Library: Special Collections

In the special collections context, the data indicate a potentially lessening relationship since 2007 between the size of a respondent's institution and its reported treatment practices. All but 3 of the 54 treatments studied were found to be more common to larger libraries (with three or more million volumes), the exceptions being encapsulation and joint tacketing. (One treatment, Japanese paper mending, was employed at an equal rate.) With respect to the percentage of respondents reporting techniques as standard practice, the average differential ($\triangle$) between larger libraries and smaller libraries for all 55 treatments was 14 percentage points. This number is smaller than in 2007, when it was 18 percentage points, indicating that perhaps size of library is less of a factor in treatment practice than it was a decade earlier.

Nine (17%) of the 54 treatments studied displayed a significant differential ($\triangle \geq 25$ percentage points) with respect to the percentage of respondents reporting them as standard practice, all of which were more common to larger libraries. Three of these treatments were repeated from 2007: heat-set-tissue mending, dyeing cloth with acrylics, and tape/adhesive/stain removal using solvents—all of which were more common in larger libraries. In 2007, there were 16 treatments that displayed large differentials in rates of employment compared with 9 treatments in 2017, again indicating that in 2017, size of library may be less of a factor in influencing treatment practices than it was in 2007 (fig. 7).

Size of Library: General Collections

The relationship between treatment practices and the size of the library collection is not as strong in the general collections context as was observed in the special collections context. In 2017, 57% of treatments were more common to smaller libraries (fewer than three million volumes) than larger libraries (more than three million volumes), so practices were fairly evenly divided, indicating that perhaps size of library is not a particularly strong indicator of treatment practice in the general collections context. With respect to the percentage of respondents reporting techniques as standard practice, the average differential between larger libraries and smaller libraries for all 54 treatments was 14 percentage points. This number is a little larger than it was in 2007, when the average differential was 10 percentage points. Identically to 2007, just 5 (9%) of the treatments displayed a significant differential ($\triangle \geq 25$ percentage points) with respect to the percentage of respondents reporting them as standard practice, 4 of which were more common to larger libraries. (The exception was cloth-covered box constructed in-house.) Only one of these five treatments—stapled pamphlet binding—was a repeat from 2007 (fig. 8).

Although the treatments with large differentials were more common to larger libraries, in fact smaller libraries employed treatments in five of the treatment categories at higher rates (31 treatments overall): binding reinforcements, board reattachments, rebinding, binding repairs, and advanced paper treatments. Larger libraries more frequently employed treatments in the categories of protective enclosures and minor paper repairs. These findings may indicate that general collections materials may be paid more individual attention in smaller libraries, whereas in larger libraries the treatments employed on general collections are not very invasive or time consuming.

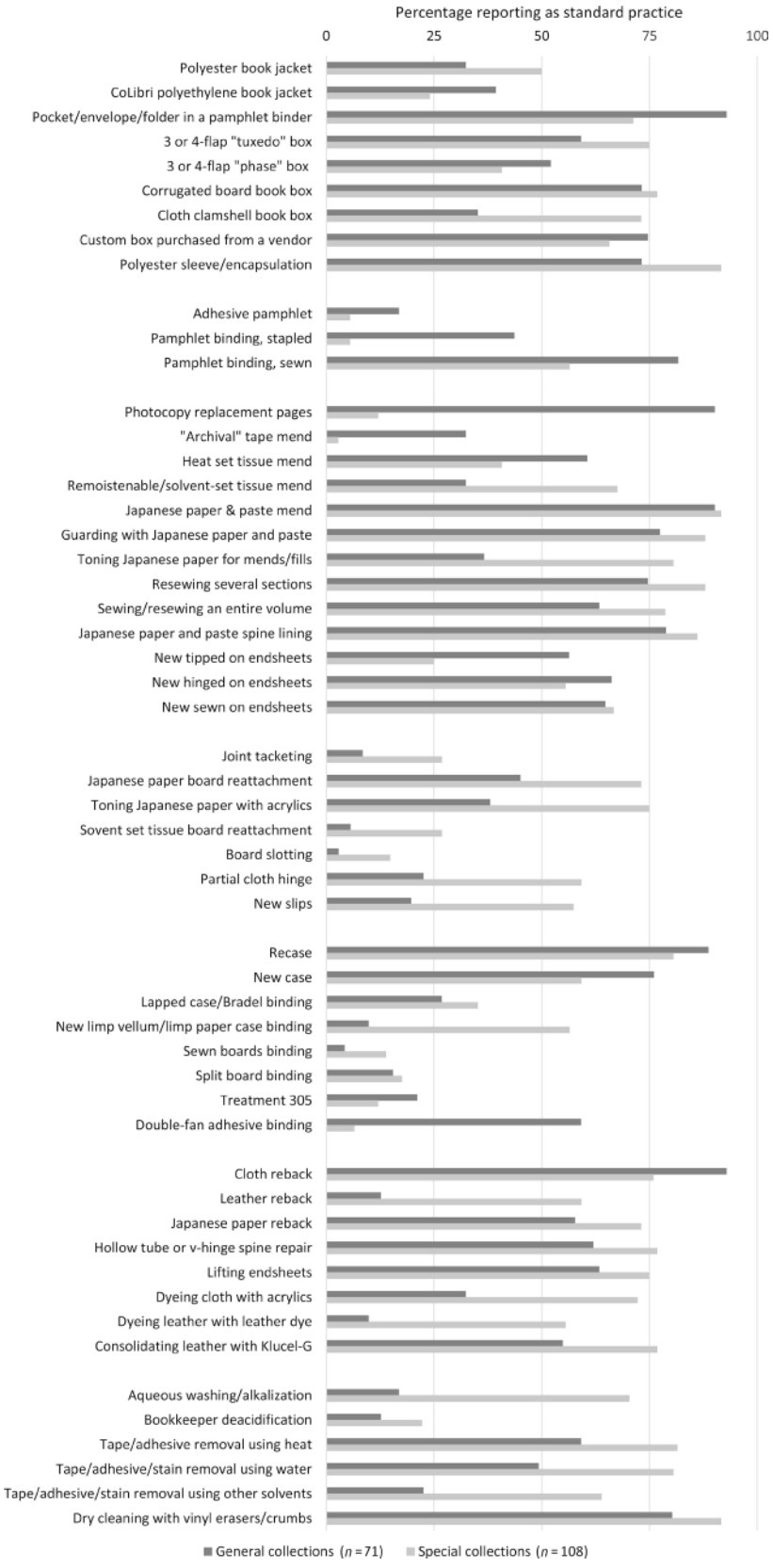


Fig. 6. Treatment practices employed for general and special collections, 2017

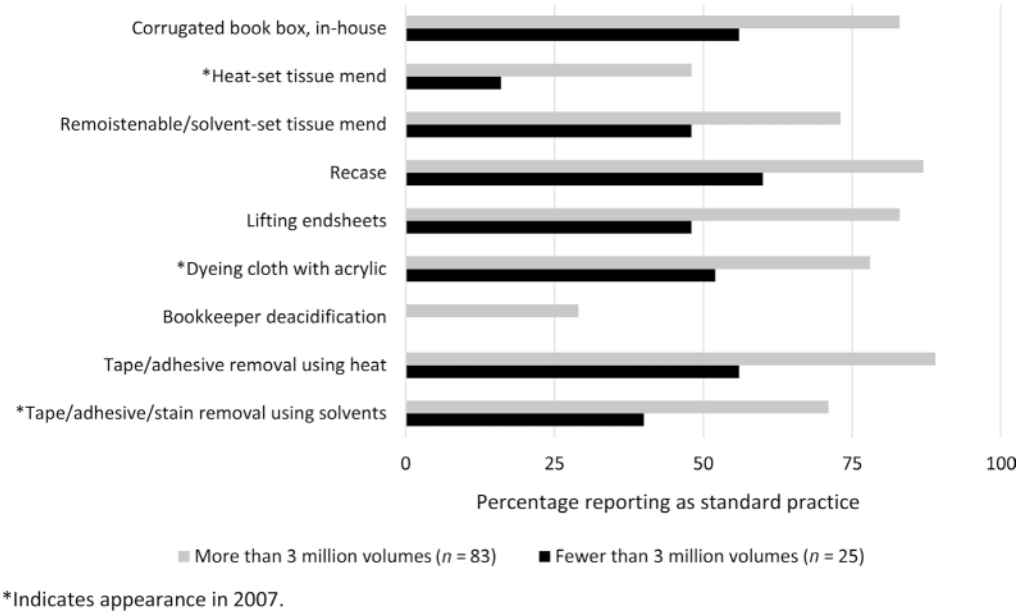


Fig. 7. Special collections treatments with significant variance in practice (≥25 percentage points) by size of library, 2017

Overall, the treatment practices in general collections show that although the gap between larger and smaller libraries has widened slightly, this trend is not well defined and little change has been observed in this category in the past decade. However, the number of respondents for general collections has declined, making conclusions about the data less confident. When pairing this fact with the data, size of library is not a particularly strong influencer on general collections treatment practices.

Type of Conservation Facility

The treatment practices of respondents from centralized, or hybrid, facilities were compared with those from facilities dedicated solely or separately to special or general collections. Significant overlap between this characteristic (type of facility) and the category below (type of practitioner) was identified: of the 57 hybrid practitioners responding to the survey, most (95%) worked in a centralized/hybrid facility. Similarly, of the 77 respondents

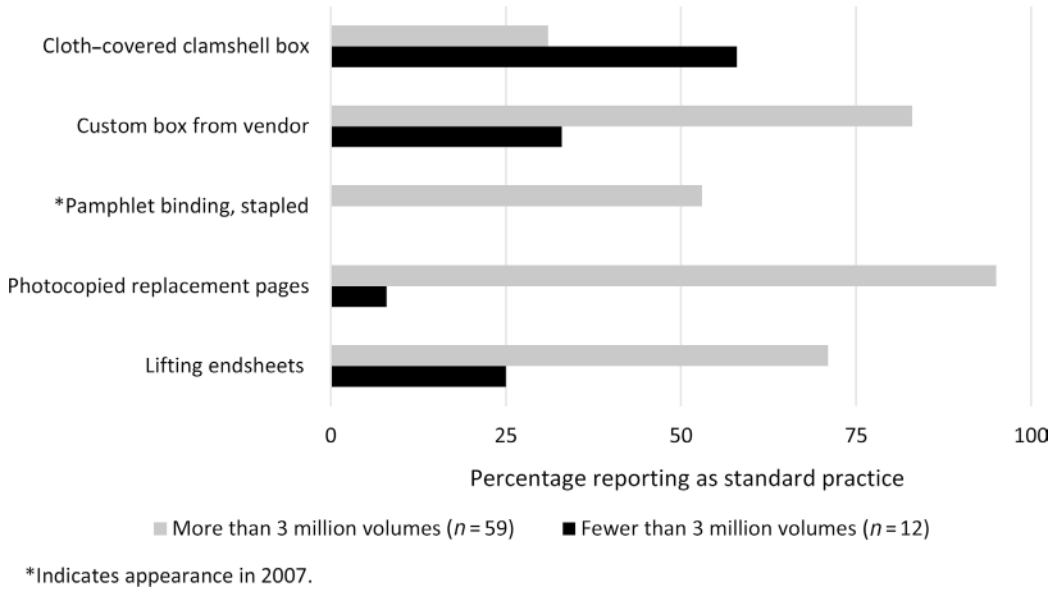


Fig. 8. General collections treatments with significant variance in practice (≥25 percentage points) by size of library, 2017

from a hybrid facility, most (74%) reported hybrid responsibilities.

Type of Conservation Facility: Special Collections

The data indicate that practitioners in hybrid facilities were more likely to consider treatments standard practice than were their counterparts in facilities dedicated only to treatment of special collections: 45 of the 54 special collections treatments (83%) were more common to hybrid facilities than to special collections–only facilities. All treatment categories were more common to hybrid facilities, except for board reattachments, which were more popular with facilities focusing only on special collections. In 2007, in contrast, 73% of treatments were more common to facilities in which only special collections were treated, so preferences are reversed. The average differential for all 54 treatments was 10 percentage points (vs. the almost identical 11 points in 2007), with just 4 treatments displaying a differential of at least 25 percentage points, all of which fell into the category of protective enclosures and were more common to hybrid facilities (fig. 9). None was a repeat from 2007. Furthermore, when the category of protective enclosures is removed from consideration, the average differential between special collections and hybrid facilities is just 7 points, indicating that overall, special collections and hybrid laboratories are performing similar treatments at a similar rate. The data suggest that the practices of special collections–only and hybrid laboratories have become more similar in a decade.

Type of Conservation Facility: General Collections

Type of facility had a moderately strong impact on treatment practices in the general collections context, but somewhat less so than in 2007. Thirty-four of the 54 treatments (63%) were more common to hybrid facilities than to general collections–only facilities, and the average differential for all 55 treatments was 13 percentage points versus 17 points in 2007. Treatments in five categories were more commonly employed in hybrid facilities: protective enclosures, minor paper treatments, board reattachments, binding repairs, and advanced paper treatments. Binding reinforcements were more common in facilities serving only general collections, and treatments in the "rebinding styles" category were fairly evenly divided between the two types of facilities.

Seven of the 55 treatments displayed a significant differential ($\triangle \geq 25$ percentage points) in the general collections context, whereas there were 14 treatments with large differentials in 2007. Four of these treatments (cloth-covered clamshell box constructed in-house, "archival" tape mend, Japanese paper reback, and consolidating leather with Klucel-G) were more common in hybrid facilities, whereas 3 treatments with large differentials ([re]sewing entire volume, new sewn-on endsheets, and partial cloth hinge board reattachments) were more common in general collections–only facilities (fig. 10). Overall, treatment practices were more common at higher rates in hybrid facilities, but the differences in treatments—in terms of average differential in use and those with great discrepancies in treatment practice rates—are on the wane. This may indicate that type of facility is not as strong a predictor of practice as it was in 2007.

Type of Practitioner

In 2007, the data indicated that there were significant differences between the treatment practices of hybrid practitioners and their counterparts working solely with either special or general collections. When working with special collections,

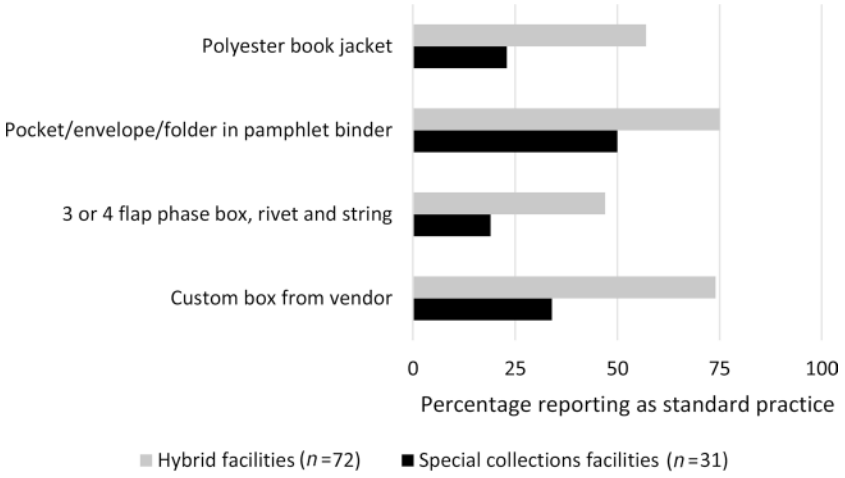


Fig. 9. Special collections treatments with significant variance in practice (≥25 percentage points) by type of facility, 2017

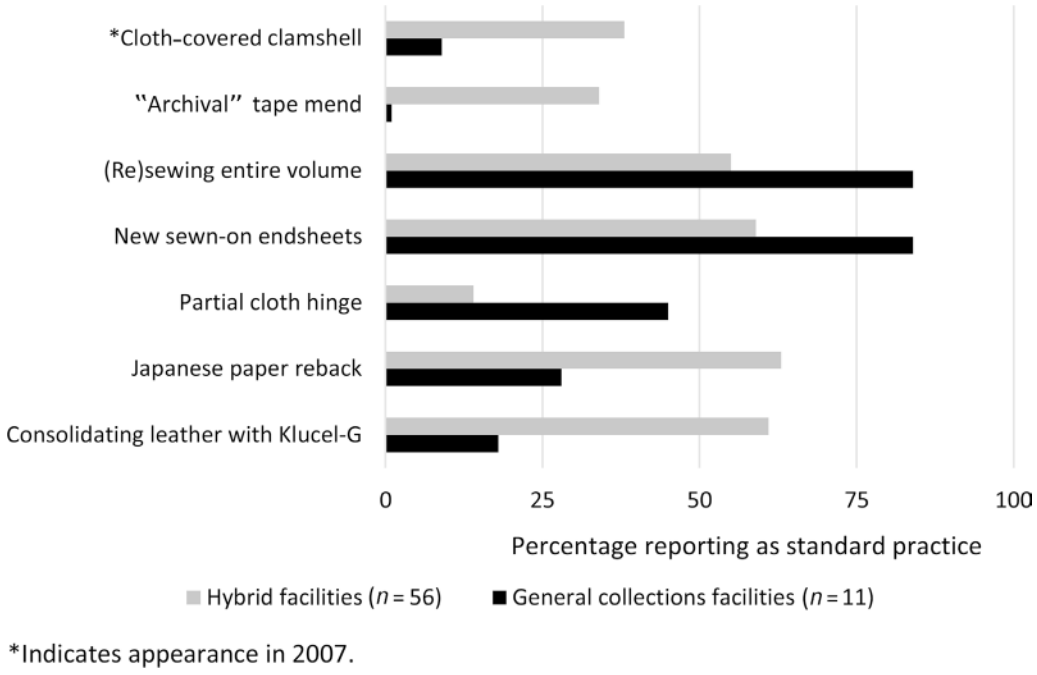


Fig. 10. General collections treatments with significant variance in practice (≥25 percentage points) by type of facility, 2017

hybrid practitioners tended to report fewer treatments, particularly more complex ones, as standard practice than did their special collections–only counterparts. Conversely, in the general collections context, hybrid practitioners tended to consider more treatments, including more complex ones, standard practice than their counterparts working solely with general collections. The 2017 findings confirm this trend, although the distinctions may be slightly less strong than in 2007.

Type of Practitioner: Special Collections

In the special collections context, practitioners working only with special collections were more likely to consider treatments, especially complex ones, standard practice than their hybrid counterparts. Thirty-eight of the 54 treatments (70%) were more common to special collections–only practitioners than to hybrid practitioners. In 2007, in contrast, the percentage of treatments favored by special collections practitioners was 89%, so the gap may be closing. Categories of treatments more common to special collections–only practitioners include minor paper treatments and textblock repairs, board reattachments, rebinding styles, binding repairs, and advanced paper treatments on bound volumes. The remaining two categories—protective enclosures and binding reinforcements—were favored by hybrid practitioners, but just barely.

The average differential for all 54 treatments was 12 percentage points compared with 16 points in 2007. Only 2 treatments displayed a differential of at least 25 percentage points, both of which were more common to special collections–only practitioners (fig. 11). In 2007, in contrast, there were 9 treatments with large differentials, all more common to special collections practitioners, none of which was repeated in 2017. The data indicate, therefore, that in the special collections context, whether or not a practitioner also works with general collections (in a hybrid position) is still a strong but lessening indicator of treatment practice than in 2007. The treatment practices of individuals working only on special collections and hybrid practitioners are more similar, although higher-end treatments are still favored at higher rates by special collections–only practitioners.

Type of Practitioner: General Collections

In the general collections context, practices were quite similar between hybrid practitioners and general collections–only practitioners, with 23 treatments (43%) more likely to be standard practice for hybrid practitioners and 30 treatments (55%) for general collections–only practitioners. (One treatment—cloth reback—was employed at equal rates for hybrid and general collections practitioners.) Classes of treatments more common to general collections practitioners were binding reinforcements, minor paper treatments, and rebinding; hybrid practitioners overall reported higher usage of binding repairs and advanced paper treatments performed on bound volumes. Use of protective

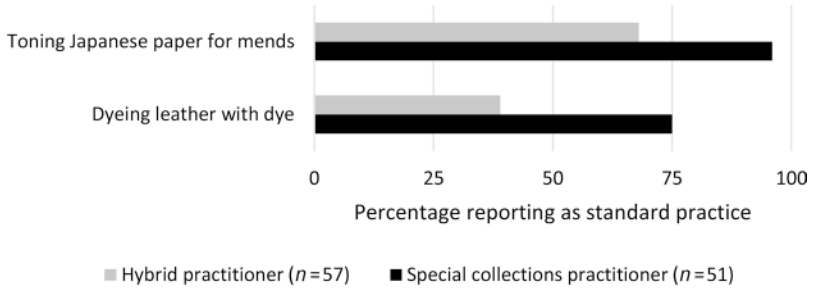


Fig. 11. Special collections treatments with significant variance in practice (≥25 percentage points) by type of practitioner, 2017

enclosures was highly popular for both types of practitioners; conversely, treatment usage rates were low overall for board reattachments in the general collections context. The average differential for all 54 treatments was 11 percentage points compared with 13 percentage points in 2007. Only 4 of the 54 treatments displayed a significant differential, all of which were more common to general collections–only practitioners than to hybrid practitioners (fig. 12). These findings are a switch from the 2007 data, in which all of the treatments with a large differential were more common to hybrid conservators. None of the treatments with big differentials is repeated among the 8 treatments that appeared in 2007.

In 2007, general collections data was considered a "moderately strong indicator of treatment practice, particularly with respect to more complex treatments" (Dube and Baker 2010, 150). It is still true that more complex treatments tend to be favored by hybrid practitioners, whereas the simpler treatments are more highly used by practitioners specializing in general collections.

Practitioner Training

The respondents identified where they were formally trained in conservation. The provided choices included (1) Columbia University, which later moved to UT Austin, a library and archives-focused program; (2) Cooperstown, which later became the art conservation program at Buffalo State, the State University of New York; (3) Winterthur Museum/University of Delaware art conservation program; (4) New York University/Institute for Fine Arts Art conservation program; (5) Camberwell College of Arts in Britain, which had a books and library materials conservation track; (6) West Dean College in Britain, with a book conservation track; (7) the conservation/restoration program at Sorbonne University in Paris; and (8) an "other" category for survey respondents to write in another formal training program.

Practitioner Training: General Collections

As noted in figure 13, the majority (58%) of respondents with conservation degrees attended the Columbia University/UT Austin program in the US. Most of the respondents with formal training from the British (UK) and American conservation programs reported that they worked in hybrid or special collections–only laboratories. When aggregating the responses from the three American art conservation programs (Buffalo, Winterthur/Delaware, and New York University), there were

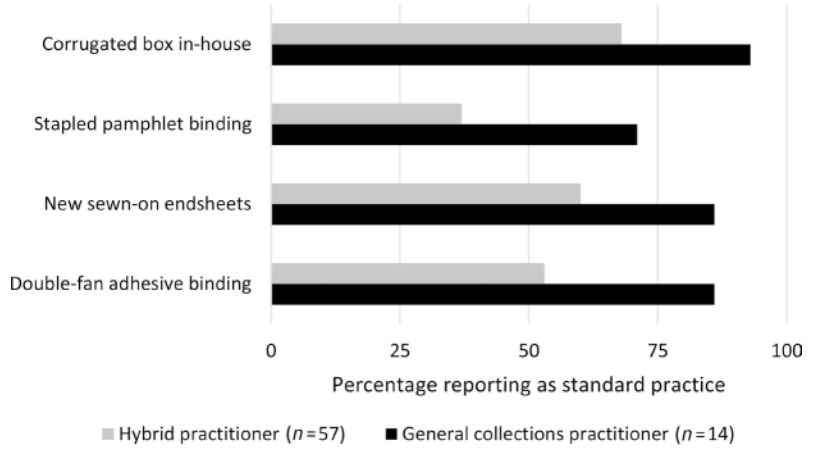


Fig. 12. General collections treatments with significant variance in practice (≥25 percentage points) by type of practitioner, 2017

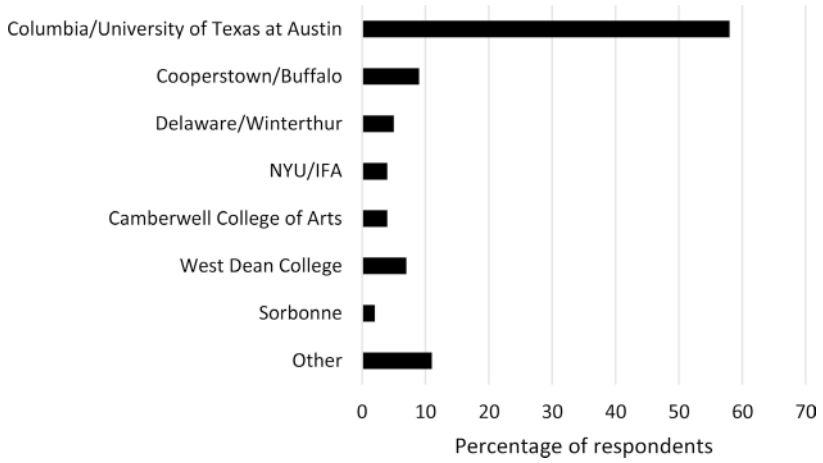


Fig. 13. Respondents' conservation training programs, 2017 (n = 122)

only three respondents who worked on general collections, joined by just four respondents among those who trained in the UK (Camberwell or West Dean). Because the sample sizes were so small, correlations could not be reached between training programs and general collections treatment practices.

Practitioner Training: Special Collections

In the special collections context, however, there was sufficient data to compare the responses from those who attended the Columbia/UT Austin library conservation training programs with the three US art conservation programs combined. This approach was justified because some training modules for book conservation students at those three programs have been taught jointly. In addition, data for the two UK conservation training programs were combined.

The data indicated that the practices among American-trained conservators are quite similar, whether the respondent trained at the Columbia/UT Austin program or an art conservation program. This may not be surprising, as some of the book conservation instructors at the US art conservation programs trained or taught at Columbia/UT Austin and undoubtedly took practices and techniques with them. Only five treatments showed a variance in standard practice of 25 or more percentage points (all more common to UT Austin graduates): heat-set tissue mending, new hinged-on endsheets, new sewn-on endsheets, lifting endsheets to save original pastedowns, and aqueous washing/deacidification (fig. 14). Of those, the latter three were performed by more

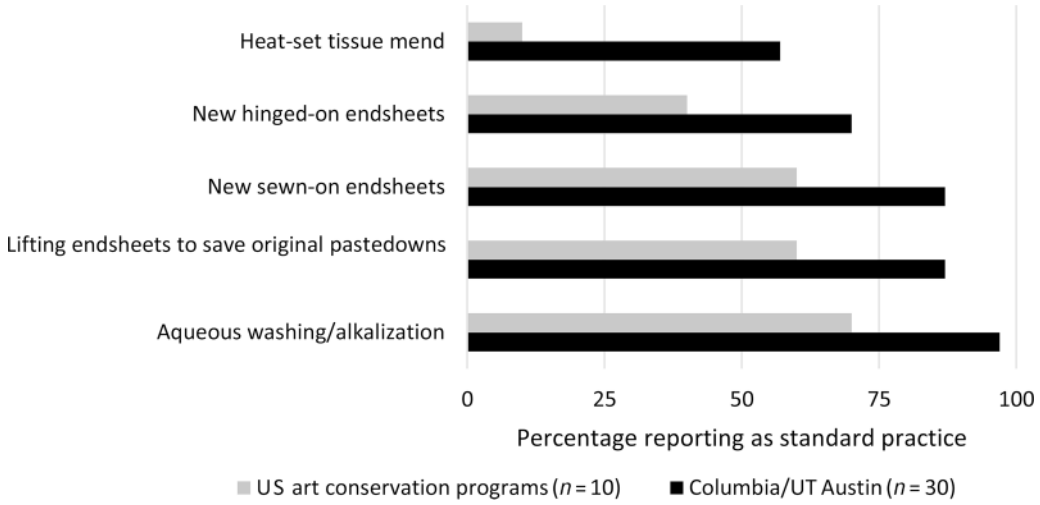


Fig. 14. Special collections treatments with significant variance in practice (≥25 percentage points) by respondents' conservation training, US art conservation versus Columbia/UT Austin programs, 2017

than 50% for both categories of practitioners. Heat-set tissue mending was the treatment with the greatest variance at a differential of 47 percentage points. Overall, the practices of US-trained practitioners were quite similar.

When comparing the Columbia/UT Austin graduates with those who graduated from UK conservation training programs, 16 treatments showed a variance of 25 or more percentage points, as displayed in figure 15. The data indicate that there are the fewest similarities between special collections treatment practices for the Columbia/UT Austin graduates and the practices of graduates from UK conservation training programs. In addition, the differentials in practice for those 16 treatments were consistently large, with the smallest being 20 percentage points (cloth-covered clamshell box). The "new case" treatment had a differential of 47 percentage points, in favor of Columbia/UT Austin graduates. Ten treatments were more common to graduates of UK training programs, including joint tacketing, board slotting, split board bindings, and double-fan adhesive binding. Overall, the practices of Columbia/UT Austin graduates and the UK-trained practitioners working in American research libraries were not highly similar (see fig. 15).

Eleven treatments had a variance of 25 or more percentage points when comparing the US art conservation programs and UK conservation programs. These treatments also all displayed large differentials of 30 points or higher, but this may partially be a function of relatively small sample sizes. All but four of the treatments were more common to the UK-trained conservators; exceptions were tuxedo box, Japanese paper board reattachment, new case, and consolidating leather with Klucel-G, all more common to US art conservation–trained practitioners (fig. 16).

Overall, the practices of individuals trained at the Columbia/UT Austin programs versus the three art

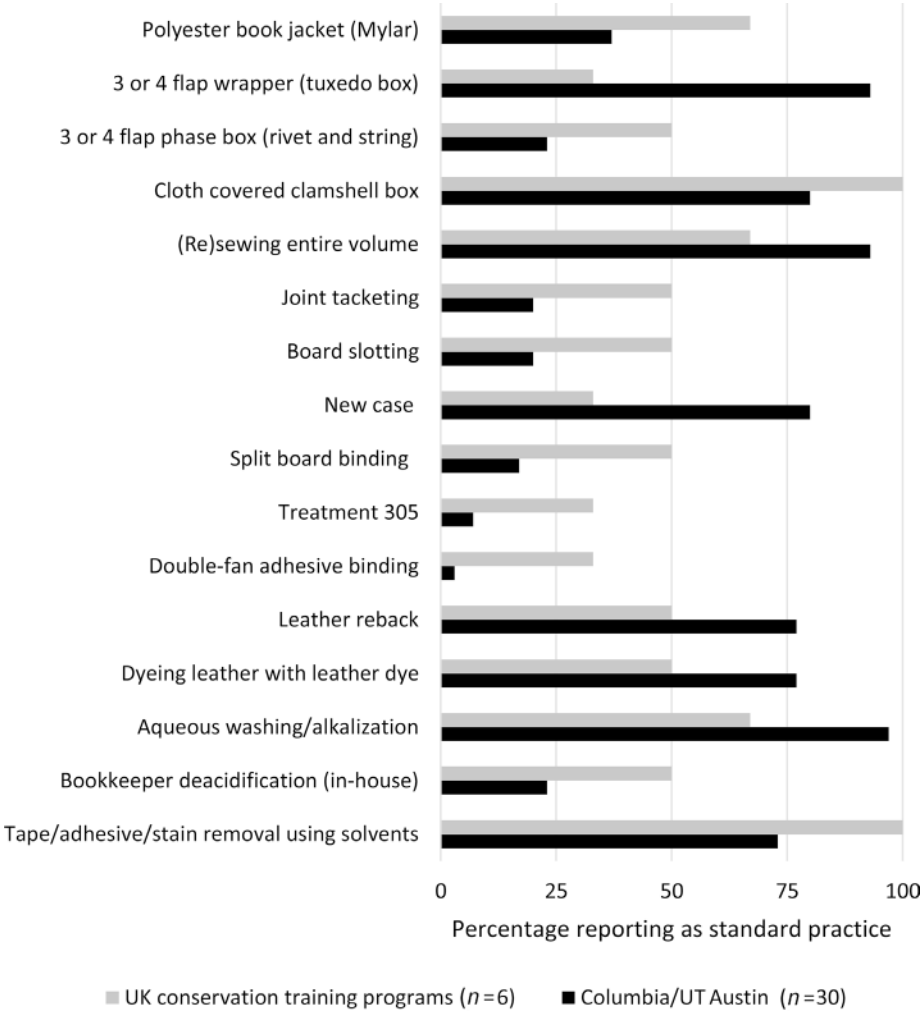


Fig. 15. Special collections treatments with significant variance in practice (≥25 percentage points) by respondents' conservation training, UK conservation versus Columbia/UT Austin programs, 2017

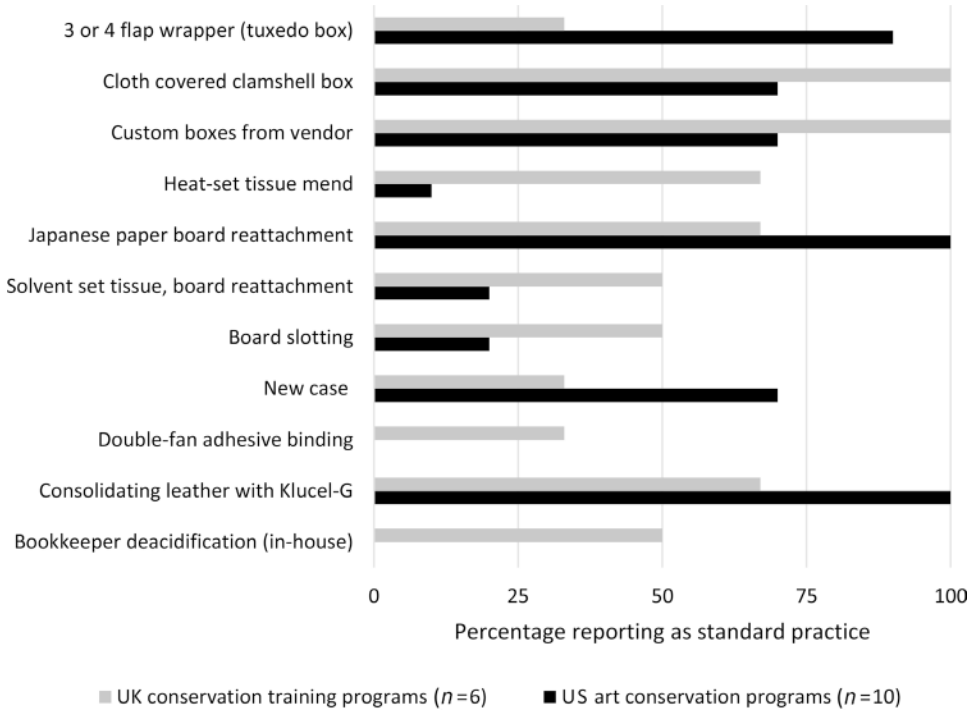


Fig. 16. Special collections treatments with significant variance in practice (≥25 percentage points) by respondents' conservation training, UK conservation versus US art conservation programs, 2017

conservation programs were the most similar, but admittedly there were also more datasets for those two types of practitioners, with higher confidence levels. More data from other training programs would lead to more conclusive results, but currently the practices of all practitioners trained in the US program are fairly similar. Still, at this point in time, most practitioners working in US research libraries with formal training were trained at the Columbia/UT Austin library and archives conservation programs. If this survey were repeated in another decade, as the numbers of art conservation–trained book conservators rise relative to the static or declining numbers of Columbia/UT Austin graduates, it will be interesting to see if the treatment data remain similar.

In 2007, the survey did not ask questions about specific training programs but rather just "informal" versus "formal" approaches, so it is not possible to compare the 2017 and 2007 data for this demographic variable. The analysis of the 2007 data noted that 93% of the treatments were more commonly reported as standard practice by formally trained practitioners than by respondents without formal treatment, with the conclusion that "in the special collections context, training is a strong indicator of treatment practice" (Dube and Baker 2010, 148). The 2017 data add to that analysis, indicating that where in the US one received formal training may not result in wildly different practices, but receiving training overseas may result in greater distinction in practice.

CONCLUSION

The results of this study indicate that the demographic characteristics of book conservation practitioners and their institutions—size of library, type of conservation facility and practitioner, and practitioner training—may be, to varying degrees, indicators of treatment practices. In analyzing the 2007 data, Dube and Baker concluded that the "practices of hybrid practitioners and hybrid facilities occupy a middle ground between those dedicated solely to special collections and those dedicated solely to general collections" (2010, 152). In 2017, this statement remained true, although hybrid practitioners have become more similar to those working only with special collections.

In comparing the results of the 2007 findings with the latest data, there were many more respondents in 2017 working with special collections materials than responded to the 2007 survey. This change could be a result of shifts in hiring practices, as Miller and Horan discovered, or it could be a function of allowing multiple responses per institution in 2017. There continue to be many individuals who are hybrids, working with both general and special collections materials. However, individuals working only with general collections have decreased significantly relative to the total respondent population, which is confirmed by hiring practices.

In addition, the trend of building or renovating a central laboratory space for both general and special collections treatment continued to rise, indicating that the work of conservation and repair departments is still valued by library administrators. In the special collections context, larger laboratories have greater standard toolboxes of treatments, whereas in the general collections context, size of library is less of a factor in treatment practices. Smaller libraries employed more time-intensive treatments at a higher rate, but overall size of library was not a major factor for general collections.

Centralized laboratories in which both special and general collections are treated reported more standard practices in the special collections context than special collections–only facilities, but overall, the practices of these two types of facilities became more similar in the past decade. Likewise, in the general collections context, 63% of treatments were more common to hybrid facilities, but the differentials in practice were small, so this variable is not a strong predictor for general collections treatment practice.

As noted earlier, the data continue to indicate that hybrid practitioners employ standard practices at a rate lower than special collections practitioners but higher than general collections ones. Hybrids continue to be at the center, as in 2007, straddling the practices of individuals dedicated solely to general or special collections. They are performing more advanced or complex treatments on general collections materials but fewer on special collections materials than individuals working only on those materials.

The 2017 data indicated that a graduate degree in conservation is more common for individuals working on special collections; hybrid practitioners are mirroring special collections–only individuals more in treatment practice than in 2007. The most common graduate degree overall, however, is in library or information science, not conservation. The data also indicate that where in the US a conservator trained is not a strong predictor of practice in the special collections context. However, there are significant differences between US-trained individuals and those who trained in the UK or elsewhere abroad. More data for overseas-trained practitioners working in US research libraries would strengthen the conclusions on how treatment practice is affected by training.

ACKNOWLEDGMENTS

The author would like to thank and recognize Liz Dube for fruitful collaboration on the analysis, research, and publication of the 2007 data, and her assistance in preparing and disseminating the 2017 survey that resulted in this analysis.

APPENDIX: LIST OF TREATMENTS INCLUDED IN THE SURVEY

Protective Enclosures

(1) Polyester book jacket; (2) CoLibri polyethylene book jacket; (3) pocket, envelope, or 3- or 4-flap folder in a pamphlet binder; (4) 3- or 4-flap card stock book wrapper ("tuxedo" or variant style); (5) 3- or 4-flap "phase" box (rivet and string closure); (6) corrugated book box; (7) cloth-covered clamshell book box; (8) custom-sized book box purchased from a vendor; (9) polyester sleeves and/or encapsulation

Binding Reinforcements

(1) Pamphlet binding, adhesive attachment; (2) pamphlet binding, stapled; (3) pamphlet binding, sewn

Minor Paper Treatments And Textblock Repairs

(1) Creating/inserting photocopied replacement pages; (2) mending with "archival" tape; (3) mending with heat-set tissue; (4) mending with remoistenable/solvent-set tissue; (5) mending with Japanese paper and paste; (6) guarding sections with Japanese paper and paste; (7) toning Japanese paper for mends and/or fills; (8) resewing several sections; (9) (re) sewing an entire volume; (10) barrier spine lining of Japanese paper and paste; (11) new endsheets, tipped-on; (12) new endsheets, hinged onto the spine with Japanese paper; (13) new endsheets, sewn-on

Board Reattachment Methods

(1) Joint tacketing, (2) Japanese paper board reattachment, (3) toning Japanese paper with acrylics for board reattachment, (4) solvent-set tissue board reattachment, (5) board slotting, (6) partial cloth hinge, (7) new slips

Rebinding Styles

(1) Recase, (2) new case, (3) lapped case/Bradel binding, (4) new limp vellum and/or limp paper case, (5) sewn boards, (6) split boards, (7) Treatment 305, (8) double-fan adhesive

Binding Repair Techniques

(1) Cloth reback, (2) leather reback, (3) Japanese paper reback, (4) reattaching detached spine with hollow tube or v-hinge, (5) lifting endsheets to save original pastedowns, (6) dyeing cloth with acrylics for binding repairs, (7) dyeing leather with leather dye, (8) consolidating leather with Klucel-G

Advanced Paper Treatments Performed On Bound Volumes
(1) Aqueous washing/alkalization, (2) Bookkeeper deacidification spray in-house, (3) tape/adhesive removal using heat, (4) tape/adhesive/stain removal using water, (5) tape/adhesive/stain removal using other solvents, (6) dry-cleaning with vinyl erasers and/or vinyl eraser crumbs

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