The Book and Paper Group Annual

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San Francisco Rock Posters and the Art of Photo-Offset Lithography

ABSTRACT

Offset lithography was the dominant method of commercial printing of the twentieth century. This workhorse of printing, with its complicated equipment and production sequence, left very little room for artistic experimentation. It was during the nineteen sixties, in the small photo-offset lithographic shops of San Francisco, that commercial need and artistic vision came together in the creation of psychedelic rock posters.

These posters were created to promote music and dance venues featuring many of the greatest rock bands of the sixties. Working under tight deadlines, the artists broke every rule of conventional design, producing works that reflected the visual chaos and revolutionary spirit of the scene. Using sheet-fed offset presses, the small offset lithographic shops affordably produced runs of single-color and multicolored posters in a short period of time. However, unlike larger commercial shops, they were able to provide an environment that was conducive to artistic input.

This paper examines the process of photo-offset lithography within the context of the making of the early San Francisco rock posters (1966–1968). The materials and major steps of the production sequence for flat multicolor prints are discussed and illustrated with images of original artifacts.

INTRODUCTION

During the mid to late nineteen sixties, thousands of young people converged on the neighborhood of Haight-Ashbury in San Francisco to take part in a scene of cultural and political rebellion, the apex of which was the “Summer of Love” in 1967. Along with this emerging counter-culture was a growing music scene. Psychedelic dance concerts were held on a weekly basis at dancehalls including the Matrix, Winterland, and the famed Avalon Ballroom and Fillmore Auditorium. They featured some of the most iconic bands of the time including Jefferson Airplane, The Grateful Dead, The Doors, and Big Brother and the Holding Company. These dance concerts were absolute visual and auditory experiences, with elaborate light shows and colorful bubbling overhead projections.

Fig. 1. Stanley Mouse and Alton Kelley, FD-26, poster for the Grateful Dead and Oxford Circle, 1966. 50.8 x 35.5 cm. Fine Arts Museums of San Francisco, Achenbach Foundation for Graphic Arts, 1974.13.100. Image of skeleton and roses taken from *Rubaiyat of Omar Khayyam* with illustrations by Edmund J. Sullivan
A series of posters and postcards were commissioned by the promoters of the venues to advertise the concerts. They were distributed at the dancehalls, poster stores, head shops, campuses, and various public places. The posters, designed by artists including Wes Wilson, Alton Kelley, Stanley Mouse, Victor Moscoso, and Rick Griffin, reflected the colors and visual chaos of the dance concerts, and the experimentation of the sixties counter-culture. The artists broke every rule of conventional design, creating works using distorted forms, unreadable lettering, unusual color combinations, and various collage elements (fig. 1). They drew inspiration from the mind-altering experience of psychotropic drugs, pop culture references, and art historical sources, in particular Art Nouveau.

Though a few of the posters were screen prints, the majority were made using the process of photo-offset lithography. They were printed at a number of small offset lithography shops in San Francisco including Rapid Repro, Cal Litho, Tea Lautrec, Bindweed, West Coast Litho, Contact Printing, Progressive Litho, and Double-H.

OFFSET LITHOGRAPHY

Offset lithography is a planographic process, meaning that the image area and non-image areas are on the same plane of the printing plate. It is based on the same fundamental principles of traditional lithography—oil and water do not mix. The offset lithographic printing plates are chemically prepared so that the non-image areas are receptive only to water, and the image areas are receptive only to ink.

The predominant mechanisms of an offset lithographic press are a series of rollers (fig. 2). There are three main types of rollers: the plate cylinder is a roller on which a flexible printing plate is attached; the blanket cylinder or offset cylinder is a roller that is covered with a rubber blanket; and the impression cylinder is a roller that carries the paper sheet. There is also a series of smaller rollers that make up the dampening system and inking system.

With the offset lithographic process the printing plate is first wet up by the dampening system. The dampening rollers apply a thin film of water to the water-receptive non-image areas. When the ink is next applied, it is repelled by the film of water in the non-image areas, and attaches to the ink-receptive image areas of the plate.

The process is called “offset” lithography because the printing plate is never in direct contact with the sheet of paper; rather the inked image on the printing plate offsets onto the intermediate blanket cylinder. The inked image on the blanket cylinder is then transferred to the sheet of paper pulled through on the impression cylinder. The advantages of offset lithography are its high speed and the fact that the image is printed in the same orientation as that on the printing plate.

MULTICOLOR PRINTING

Multicolor prints were composed of two or more colors. This included black as a color. In the offset lithographic process there were two main methods of producing a multicolor print: process color and flat multicolor printing.

With process color, a continuous tone multicolor image was photographed through a series of color filters to create halftone printing plates for each primary color and black. When the plates were printed, the dots combined to reproduce the original full color image (fig. 3). This process was used for some of the later Fillmore posters.
positives. Next, the stripper assembled all the pieces of film necessary to make a printing plate. This was done by cutting and piecing the film together into what was known as a flat. Finally the platemaker exposed the prepared film on a sensitized printing plate, which was later developed.

The following five sections gives a closer look at each of these pre-press steps within the context of the rock posters.

**Rough Layout**

Sometimes the artists would start with a sketch or rough layout working out issues of proportion, positioning, and color (fig. 5). Often notes were added to specify such things as color or placement. Working from this rough sketch, the artist began to prepare all of the finished design elements for the mechanical.

**The Paste-Up**

The paste-up (or mechanical) was the technical name for the series of images that comprised the finished artwork, ready to be photographed. There were many different ways of making a paste-up. However, all paste-ups for flat multi-color
printing had a way of clearly indicating or separating the design elements according to each color that was to be printed. The three methods primarily used to make the rock posters were acetate overlays, key-line mechanicals, and bluelines.

With acetate overlays, the artist executed the most complicated art, corresponding to a single color, on a smooth white illustration board. Then he placed designs representing other colors on their own acetate overlays (fig. 6). The colors in which the art was eventually to be printed were indicated with color swatches or handwritten notes made by the artists. Registration marks were indicated on each separation for proper alignment.

Most of the design elements were made using black ink. Often artists used masking films such as screen tints and Rubylith®. Both of these were adhesive backed acetate films that could be cut into shapes and attached to the mechanical. The screen tints came in a variety of black patterns that gave the illusion of shading or patterns (fig. 7). Rubylith was a transparent red film that photographed the same as black design elements. The orthochromatic graphic arts film used to shoot the mechanicals did not distinguish between red and black.

With a key-line mechanical, black and white art was prepared on an illustration board. The color separations were indicated in colored pencil on a single overlap of tracing paper (fig. 8). This method required much more work from the camera operator and stripper. The illustration board mechanical had to be photographed several times, producing many positives and negatives, which were later cut apart and reassembled by the stripper for each color plate.

Blueline was a technical term for a photographic print on a surface of plastic, glass, metal or paper, typically yielding a blue image. In offset lithography, the blueline process could be used for proofing and alignment of the negatives. With the rock posters, the blueline method was often used to create paste-ups. With this method, the original drawing was
photographed to make a negative. The resulting negative was then contact-printed on illustration boards or papers sensitized with diazo salt compounds to produce several blueline images. Then, working from these identical blueline images, the artist used black ink to demarcate the design elements corresponding to different colors (fig. 9). The beauty of the blueline is that when the paste-up is photographed, the blue is not recorded by the orthochromatic graphic arts film. Thus, the negatives produced showed only the design elements inked by the artist.

**Camera Work**

The finished mechanical and all its overlays were photographed individually on a copy stand. The mechanical was held in place at one end by a copyboard, and the film was inserted at the other end in a film holder. The film used to shoot the artwork was made especially for graphic arts production work. As the film was high-contrast, all continuous tone artwork, such as photographs and washes, were shot separately using halftone screens. The camera operator produced as many negatives and positives as needed by the stripper for the next stage of production (fig. 10).

**Stripping**

The film was assembled in preparation for making printing plates. Working on a light table, the stripper carefully cut apart the film positives and negatives, and placed the elements together to achieve the desired composition. The pieces of film were often attached to an opaque masking paper in which windows were cut out to reveal the parts to be exposed on the printing plate. This assemblage on the masking paper was called a flat (fig. 11). Any flaws in the negatives, such as pinholes and scratches, were corrected with an opaquing solution. Stripping was a very complicated process, and it could take many film assemblages and flats just to make one plate.

**Platemaking**

The plates used by the offset lithographic shops Tea Lautrec and Cal Litho consisted of an aluminum base presensitized with a light sensitive material, typically a diazo compound (fig. 12). To make the plates, the negatives or flats were assembled into a flat, and the positives were placed on the negative to form a composite (fig. 13). The composite was then exposed to ultraviolet light through a sensitized film frame, which hardens the diazo compound on the negative. The exposed film was developed, leaving the negative exposed to light in those areas that correspond to the desired printed image. The resulting plate was then washed and dried, and the final plate was ready for printing.
Lithographic inks used for sheet-fed presses generally consisted of colorants in oil and resin based vehicles with various modifiers including driers, plasticizers, waxes, chelating agents, surfactants, antioxidants, and defoamers. The inks were tacky with a paste-like consistency. During printing the force of the rollers increased the fluidity of the inks and dispersibility of the pigments, creating a film 0.8–1.1 micrometers thick on the surface of the paper (Herbst and Hunger 2004). As the film was very thin and generally transparent, it was important that the pigments had a strong color strength and fine particle size.

At the Museum of Fine Arts, Boston, samples of printing inks from seven rock posters were analyzed using Raman spectroscopy. The majority of the colorants identified were synthetic organic pigments. Frequently occurring colorants were diarylide yellows, beta-oxynaphthoic acid calcium and barium reds, and copper phthalocyanine blues.

### Papers

The papers on which the posters were printed are variously described as index, bristol, vellum, or tag. In general, the rock posters were printed on a sturdy, fairly thick paper stock, which appears to be composed of primarily chemical wood pulp. Most of the posters made between 1966 and 1968 were printed on uncoated papers. Surfaces ranged from an even and slightly porous vellum finish, to a dense, smooth machine finish (APPA, 202). Coated papers were used with greater frequency from 1969 onwards. Many, but not all, of the papers were made using optical brighteners.

The earlier posters were printed one at a time. Subsequent posters were usually printed on larger sheets of paper either two posters at a time, or one poster with several postcards or tickets on the same sheet of paper. The posters, postcards, and tickets were then cut to size after printing. Most of the posters made for the Avalon Ballroom measured approximately 20 x 14 inches. Fillmore Auditorium posters typically had slightly larger measurements. Variations in papers and dimensions were no doubt due to affordability and availability of the paper, and the size of the press.

### Printing

The majority of the rock posters were printed using small one-color sheet-fed offset lithographic presses. As the name “sheet-fed” suggests, individual sheets of paper, usually in large stacks, were pulled rapidly through the press one at a time. As the presses used to print the rock posters were only one color, it was necessary to run the sheets through the press several times to achieve multiple color prints.

A printer had to have a good understanding of the complexities of the press to keep it running smoothly. Some of the many tasks of the pressman included adjusting the paper...
feeder and delivery system, attaching the plates and the blanket, and positioning the rollers. Maintenance of the inking and dampening systems required special attention in order to avoid a variety of issues such as emulsification of the ink and water, and off-set of the ink onto the non-printed areas.

The offset lithographic company Tea Lautrec printed many of the posters for the Fillmore Auditorium concert venues. Owned and operated by Levon Mosgofian, Tea Lautrec was staffed with two printers, Joseph Buchwald and Monroe Schwartz. Joseph Buchwald still lives in San Francisco, and was able to provide valuable insight into what it was like printing the rock posters.

At Tea Lautrec a one-color thirty-six inch Miehle sheet-feed press was used to print the rock posters. The shop typically did one or more rock poster jobs a week, and about 500 to 5000 posters per job. According to Buchwald, to run one thousand sheets through the press took approximately fifteen minutes, and required about one pound of ink or more. At Tea Lautrec, all colors for the rock posters were printed in one day. Each print run was given approximately forty-five minutes to one hour drying time before the next printing. This period is what Buchwald refers to as the “make ready” time, in which the press was cleaned, a new plate attached, and new ink added. By this time, the prints would be dry enough to run through a second time, though the inks were not completely dry for a good twelve hours after printing.

ARTISTS AND PRINTING

What made Tea Lautrec and the other small offset lithographic companies so unique was the willingness of the printers to work one-on-one with the artists, often at the press, helping them to achieve their visions including unconventional color combinations. The rock poster artists were all involved in the printing process to varying degrees. Some were more demanding, and some more hands-off. Likewise the printers showed varying degrees of flexibility. Deadlines were tight for both the printers and the artists. Often it was a push-and-pull negotiation. But everyone, it seemed, knew that they were on to something unique and meaningful. As the rock poster artist Bob Fried reflected in his interview in The Art of Rock, “I saw it as a throwback to Lautrec’s time, what with the artists and printers working together, the people in the audience and the bands on stage serving as weekly inspiration, the costumed people in the street, and colors, colors, colors everywhere.” (Grushkin 1999)

The rock poster artist Wes Wilson is often attributed with developing the psychedelic style with his fluid lettering and bold color choices. A self-trained artist, Wilson started his career working at Contact Printing with Bob Carr. This firsthand experience with offset lithography equipped him with the skills to understand the limitations and the potential of the press when working with various printers on his subsequent rock posters for both the Avalon Ballroom and the Fillmore Auditorium. A number of his designs for the Fillmore Auditorium were printed at West Coast Litho, including posters that exhibited blended rainbow backgrounds. These rainbow backgrounds were achieved using what is known as the “split fountain” or “rainbow fountain” technique. By placing several colors next to each other in the ink fountain, a blended effect could be achieved when the sheet of paper was run through the press. Wilson described the experience of printing these posters as a collaborative effort with the printer Ivor Powell. Working together, they made adjustments to the press to create variations in effects from thin bands of color to smooth, wide, gradations (fig. 13).

The rock poster artist Stanley Mouse started drawing at an early age. He studied at the Detroit Society for Arts and Craft, but developed his true style creating monster and hotrod art for car shows and mail orders. After moving to San Francisco, he worked independently as well as jointly with the artist Alton Kelley designing many of the rock posters for the Avalon Ballroom and Fillmore Auditorium. Mouse thoughtfully pointed out that using a one-color lithographic press was very similar to the process of silk screening. Printing one color at a time allowed for greater control and experimentation, which could not be achieved by the confines of process color or multicolor presses. Indeed the versatility afforded by the one-color press was reflected in the artistic range of Mouse and Kelley’s posters, from subtle and elegant hues to wildly colorful combinations. They also experimented with metallic inks and the split fountain technique just described (fig. 14).

At the offset lithographic shop Tea Lautrec, Levon Mosgofian and his printers were known for working closely with the artists and helping them to translate their vision into print, particularly with regard to color selection. Getting just the right ink mixtures and color combinations was a crucial component in the dynamics of a rock poster. As the printer Joseph Buchwald recalls, the artists were usually present for the initial printing. Rough color choices were typically made from ink manufacturers’ color books. Unless the artists picked a straight color that was already available in a can, the inks had to be mixed by eye on the spot. As Mr. Buchwald explained, it would not be worth buying a five-pound can of ink for every color they were going to print. With the artist present, the ink mixture would be tapped on a piece of paper to give a better idea of how the inks would appear when they were printed. With the artist’s approval the printing would begin. Artist Stanley Mouse acknowledges that getting the right color combinations was often a matter of guesswork and pushing the printers to their limits. Likewise, Buchwald noted that the artists were sometimes striving for the impossible, and that there was only so much color that could be laid down before it started “messing up or off-setting”.

The rock poster artist best known for exploiting color combinations was Victor Moscoso. Moscoso came to San
Christmas lights and noticed that the image appeared to be moving. Moscoso is also quick to point out that it was an accident only once, and with similar posters that followed the effect was quite intentional.

It is easy to assume that the rock posters were made using daylight fluorescent colorants, typically known by the commercial name Day-Glo. However, Wes Wilson and Victor Moscoso both adamantly stated that they did not use Day-Glo inks. Nor did they even use small amounts to brighten standard printing inks. Stanley Mouse stated that he did not use Day-Glo either, with the exception of one poster and one handbill. All of the artists emphasized that the popping color so typically associated with their rock posters was due to color juxtapositions of standard printing inks.

During the course of this research, hundreds of Fillmore, Avalon, and Neon Rose rock posters and postcards in the collections at the Museum of Fine Arts, Boston and the Fine Arts Museums of San Francisco were examined under both normal illumination and long wavelength ultraviolet radiation. Of these hundreds of posters only two exhibited the
typical luminous color and bright fluorescence associated with daylight fluorescent colorants. These were the two prints noted by Stanley Mouse.

While further confirmation via a reflectance spectrophotometer needs to be done, it makes sense that the artists did not use inks containing daylight fluorescent colorants in the creation of the rock posters. Day-Glo offset lithographic inks (as opposed to screen printing inks) were very thin and not easy to work with. They often required two runs through the press, which was both time consuming and economically unfeasible.

CONCLUSION

No one can doubt the impact of the San Francisco rock posters on our cultural and historical psyche. They represent an energetic and rebellious period of creativity and collaboration comparable to that of the French Art Nouveau posters. Whereas these historical predecessors are only available to us through the texts and the art that remains, the rock posters hover on the edge of our contemporary world. The complicated photomechanical techniques and sophisticated color manipulations used to make the rock posters are the antecedents of contemporary graphics editing programs, such as Adobe Photoshop and Illustrator, used in offset lithography today. The artists and the printers of the rock posters pushed the capabilities of offset lithography, and in the process defined a cultural period.

ACKNOWLEDGEMENTS


NOTES

1. The Family Dog, a collective lead by Chet Helms, organized venues for the Avalon Ballroom. The numbered series of Family Dog Posters dating between 1966 and 1968 were designated by the Family Dog with the prefix FD printed in the bottom margin. Other venues under the umbrella of the Family Dog include Denver, Colorado (designated with FDD), and the Great Highway in San Francisco. There were approximately one hundred-and-fifty San Francisco posters produced by the Family Dog with the addition of thirteen Denver posters.

Bill Graham opened the Fillmore Auditorium in 1966. In 1968 the Fillmore was moved to a new location in San Francisco and renamed Fillmore West. There were many other venues with events produced by Bill Graham. Some of these include Fillmore East in New York City, the Winterland Theatre in San Francisco, the Oakland Coliseum, and the San Francisco International Sports Arena. Numbered Bill Graham posters dating between 1966 and 1973 were designated by Graham with the prefix BG printed in the bottom margin. There are approximately three hundred posters in this series.

The Neon Rose series of posters was published independently by Victor Moscoso. The posters were primarily produced for The Matrix club. Numbered posters from Neon Rose were designated by Victor Moscoso with the prefix NR in the bottom margin. There are approximately twenty-seven posters in this series.

2. Other names for process color in which full color images were reproduced include full-color process and four-color process. The flat multicolor process is also referred to as spot color.

3. As many of the offset lithography shops that made the rock posters were very small, the pre-press steps such as photography and stripping were sometimes outsourced to trade shops.

4. Original printing artifacts including dockets, paste-ups, negatives, flats, and printing plates were provided by Phil Cushway at Art Rock, San Francisco, California.

5. Paste-up or mechanical is the technical term used in offset lithography manuals. The rock poster artists interviewed preferred the term artwork.

6. Rubylith is a brand name for transparent red masking films manufactured by the Ulano Corporation. Commercial names for screen inks include Letratone, Zip-A-Tone, and Chart-Pak.

7. Raman Spectroscopy was conducted with the Bruker Optics Senterra dispersive microscope using a 785 nm laser and a 50x objective for an analytical spot size of 2 microns.


8. Several of the original printing dockets from Tea Lautrec list paper type ordered. These include a 22.5 x 28.5 inch basis 125 Springhill tag purchased in 1967; a 22.5 x 28.5 inch 125 basis ivory Springhill velum Bristol purchased in 1968; and 22.5 x 28.5 inch 184M Foldecut purchased in 1968.

9. The inches associated with an offset lithographic press refers to the largest paper dimension that can be run through the press.

10. Numbers for print runs are based on printing dockets from Tea Lautrec.

11. Daylight fluorescent products available during this period include Day-Glo manufactured by Day-Glo Color Corporation, and Rad-Glo manufactured by Radiant Color N.V.

With the success of the San Francisco rock posters came a proliferation of posters imitating this new style. Within this growing market there were many posters, mostly screen prints, which were made using inks with daylight fluorescent colorants.
REFERENCES


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Mold Outbreak at the Documentation and Information Center

ABSTRACT

The House of Representatives, Brazil boasts a huge and significant collection that comprises manuscripts, photographs, films, objects, paintings, furniture and oversized panels from Athos Bulcão, Oscar Niemeyer and Di Cavalcanti, which are integrated to the architecture of the building.

In 2006, a mould outbreak was detected at the Historic Documentation Collection, which affected around 300,000 manuscript documents dated from 1823 along with other collections of the library. Besides the immediate actions, this major disaster trigged many changes on the conservation strategies of the Institution, which were mainly based on the treatment of individual items rather than cared for the collective. In addition, more competition than cooperation among the areas was always causing severe constraints on the development of the conservation projects.

Nowadays, with the support of managers and directors, conservators are focusing on ways of preventing the deterioration of the objects by improving environmental conditions, cleaning, handling and storage areas. The creation of teamwork with other key departments allowed the implementation preventive conservation strategies and projects throughout the Institution. Besides, together with the conservation team we have a group of mental disabled people who were specially trained for the job and are help with the preservation activities.

HOUSE OF REPRESENTATIVES, BRAZIL

The House of Representatives is located at the Palace of the National Congress, Brasilia, the capital of Brazil. The palace, designed by the well-know architect Oscar Niemeyer, was created in 1960 and became a UNESCO heritage site in 1987.

The Institution boasts a significant and historic collection related to the to the legislative history of Brazil, which comprises around: 250,000 of library books, 1,000,000,000 of manuscript documents, 4,000 rare books, 700 art objects, including furniture and paintings, 800,000 items of videos, films and photographs and important oversized panels, from Athos Bulcão, Oscar Niemeyer and Di Cavalcanti, which are integrated to the architecture of the building.

DOCUMENTATION AND INFORMATION CENTER

The Documentation and Information Center, founded in 1971, is located in an annex of the House of Representatives. The mission of the Centre is to manage information for institutional purposes, to preserve the House of Representatives institutional memory and cultural assets, and to disseminate them to society.

The Conservation Section is an important area of the Center and it is responsible for the conservation activities, which contribute to the preservation of the Institutional collections. Since its creation in 1983 until 2007 most of the work was concentrated on the treatment of individual items rather than focusing on the long-term well being of the collections.

All strategies involved in the preventive conservation were an obscure field for the conservators and although they were aware of the problems that inappropriate environmental conditions, storage areas and cleaning could cause to the collections, addressing these matters effectively was very difficult because of the reasons described below:

- Lack of support from the Institution; It is important to point out that the raise of preservation awareness, especially in developing countries has been occurring only in the last ten years.
- Preservation was seen as a tertiary consideration at the Institution; Any political crises have always had a huge impact on the preservation resources.
- Managers tended to be very conservative concerning the necessary changes; It was believed that attending immediate conservation needs was far more significant and urgent.
• The shortage of staff. This problem, as it will be explained later, was solved only in 2008,
• Conservators did not have a well-designed picture of the Institution’s collections and their problems; Most of the preservation projects ended up not being planned nor developed satisfactorily.

THE DISASTER

Unfortunately in 2006, a major mold outbreak was discovered at the Historic Documentation Section, which houses approximately 1,000,000,000 of manuscripts documents dated from 1823. Documents are stored inside boxes and separated among envelopes, folders and sleeves. This special way of storing gives them an address and this is the only way of finding a piece of information.

Around 300,000 manuscript documents from this important collection were heavily affected and the main causes of this major disaster are listed here:

• Malfunctioning of the central air-conditioning unit; This problem had been occurring for more than 15 years without any effective solution. During this period humidity level could reach 80–85%.
• Necessity of moving staff to the storage area; This fact completely changed the environmental conditions of the place. Before that, the humidity level was high and the environmental conditions although not appropriate, seemed to be constant most of the time.
• Lack of preventive conservation measures and insufficient house keeping; The shortage of staff did not allow the conservators to work efficiently in all storage areas.
• Lack of communication between the areas; When the mould outbreak was discovered the metal boxes had been recently moved from shelves to sliding cabinets with a wooden base covered by a thin layer of PVC.
• Inappropriate cleaning procedure, made by the maintenance staff of the building, increased the humidity level inside the area.

PLAN OF ACTION—HISTORICAL DOCUMENTATION COLLECTION

The situation was chaotic, but even more disturbing was the potential health implications for the staff. As a consequence, the following immediate actions were taken:

• Controlling the access to the storage area to ensure people’s health and avoid the widespread of the infestation;
• Purchasing dehumidifiers and placing them inside the affected area; This dropped the humidity from 80% to 60%. Special cabinets, with a 20-liter plastic container, were built for the dehumidifiers. This avoided the automatic shutdown of the equipment and the raising of humidity, especially during the closing hours.
• Constant monitoring of the environmental conditions of all storage areas trying to keep them within the appropriate parameters; Since the Centre has a system of central air-conditioning, the risk of mould widespread was even higher.
• Analyzing the mold samples; These analyses showed that the mold samples were not toxic and most of them were inactivated.
• Analyzing the air quality of all offices and collection areas; These analyses showed that the air quality was within the acceptable parameters, which gave more confidence to the staff members to continue work at the Centre.
• Use of protective gear; It was made mandatory the use of protective gear by all staff that needs to enter the affected area or work with the infested material. Safety equipment including a respirator with HEPA filters, vinyl gloves and Tyvek overalls.

The mold outbreak disaster brought about some pressing problems at the Institution such as, the risk of losing unique documents related to the legislative memory of Brazil and the demand from the staff members who urged for prompt actions. The solutions of these issues triggered the Institutional support for the conservation department projects. And for the first time in 15 years, it was possible to start building teamwork with other key departments of the house, changing competition between the areas into collaborative work.

TREATMENT—HISTORICAL COLLECTION

The first challenge was to find a place for undertaking the treatment. Since the Center has a central system of air conditioning, cleaning could not be done inside the building. The best option was to install a tent in a well-ventilated area outside the building. It was decided to start the work from the oldest boxes that showed, by sampling, to have a higher number of infected documents. The procedure followed the steps below:

• The boxes were transported from the affected area to the tent inside plastic bags;
• Documents were assessed for mold and checked whether it was active or not; If mold was active the document was left to dry before its removal. And then, another box with no active mold was taken for treatment.
• Moldy documents were cleaned;
  – A set of brushes, frequently disinfected to avoid transfer mold spore from one page to another, was used for this purpose. Most of the time, the use of a HEPA vacuum cleaner, even with low pressure, was not possible
because of the level of iron gall ink corrosion and acidity on the paper.

- Cleaning was also accomplished by using a soft brush to lift the mold off the paper into the vacuum cleaner nozzle, depending on the fragility of the support.

- The work was carried out by two separate pairs of people and another person was responsible for keeping the tables clean using a HEPA vacuum cleaner and disinfecting the boxes.

- After the document was cleaned by the first person of the pair, the second member placed thedocument inside the new storage material. This was made by an archivist, who was responsible for maintaining the original order of all documents inside each box.

- Each moldy document, after being cleaned, was placed inside an individual envelop with the date of its treatment on the top. This procedure would help during the future monitoring of the material.

- An overall condition report was made for all documents located in each box; This report showed the total number of moldy documents, their location and their priorities for future conservation treatment. Only documents, which presented a high level of degradation, were sent to the laboratory for conservation treatment.

- Cleaned material was placed in an environmentally stable area being monitored every three months.

Nowadays, all the procedures mentioned above are part of the Institution’s routine. Until now, 300 boxes, which have been mostly affected, have already been treated. The interventions made in the central air-conditioning unit have changed the environmental conditions, with humidity levels ranging now from 50–55% and temperature between 20–22°C.

ANOTHER DISASTER—LEGISLATIVE COLLECTION

Later in 2007, another mold outbreak was detected. At this time, around 5,000 volumes of the Legislative Collection were affected. A thick growth of grayish mold appeared on the spine of the books and close examination showed that most of the volumes head, fore edges and tails were also affected. Sampling of inside pages showed them to be unaffected.

The main causes for this new mold outbreak were:

- The difficulty to control the environmental conditions of the place due to leaking problems on the basement area;
- The poor housekeeping of the collection; Due to the shortage of staff the vacuuming of books as well as the dusting of shelves had been deferred.
- Overcrowded storage area; For years the place was being used as a deposit of diverse library materials. Most of them were waiting to be evaluated for future donation or discard.

PLAN OF ACTION—LEGISLATIVE COLLECTION

The treatment of this collection was divided in two stages. The first one comprised the following actions:

- Isolation of the affected area
- Analyzes of the mold samples and air quality
- Discard of the volumes, which did not follow the Institution’s acquisition policy
- Boxing of the volumes
- Renovation of the area

The second stage started months later with the arrival of the new staff members and it comprised:

- Stabilization of the environmental conditions
- Beginning of cleaning treatment
- Storage of the volumes in an environmentally stable area
- Daily monitoring of the environmental conditions

THE NEW STAFF MEMBERS

In 2008, five new conservators and eight conservation technicians joined the conservation team. With their arrival, it was possible to boost important projects related to the mold outbreak recovery, implement some preventive conservation strategies throughout the Institution and initiate the Institutional storage survey, which would give an understanding of the collections and their problems.

Three months later, following the House of Representative Accessibility Program, which has the objective of planning and executing integrated actions to ensure the accessibility of people with disabilities to all products, services and areas of the House, it was possible to hire a new group of people. At this time, eight professionals with mental disability and one trained monitor—who was responsible for supervising the work—joined the conservation team. Their activities comprised the removal of dust from documents and books and the assembling of storage materials.

This unique experience showed that people with mental disability when well trained become highly skilled and proactive. During the last year, they were responsible for the cleaning of around 6,000 volumes, being 4,000 from the rare book collection. The group has been showing an outstanding standard of work and the House of Representatives strongly believes and hopes that this experience will inspire other institutions.

CONCLUSION

The conservation practices of the House of Representatives went trough considerable changes in the last four years. The Institution has adopted a broad preservation strategy of
preventative conservation—an approach that focuses on the long-term well being of the collections, rather than work on the treatments of individual items. The development of the collection survey has been enabling the Conservation Section to better prepare its projects and allocate resources. As for the preservation policy, besides defining the Institutional preservation responsibilities and guiding the staff members, it enhances credibility to preservation activities developed at the Institution.

However, what proved to be the greatest achievement was the creation of teamwork. This raised the awareness of the importance of commitment and collaboration among the areas, demonstrating that working in teams is vital for the development of effective preventive conservation strategies. It has become clear that by working as a group much more can be accomplished.

REFERENCES

Cassar, M. *Interdisciplinary in Preventive Conservation*. www.ucl.ac.uk/sustainableheritage/value_conservation (accessed on 5/04/10)


Put, N and Slade, S. *Teamwork for Preventive Conservation*. www.icrom.org/pdf/ICCROM (accessed on 8/03/10)


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Which ink? Which paper? Where is it?

FADAM, the Argentine Museums Friends Associations Federation, has held a Paper Conservation Laboratory, since 1994. The Laboratory, created to provide a solution for the progressive deterioration of paper based collections, was the first of its type in Argentina. FADAM caters for all kinds of works of art on paper and documents from museums, archives and collections all over Argentina.

WHICH INK?

The first step to treat a document or work of art is the accurate identification of substrate and inks before deciding what to do or even what not to do. Iron-gall inks are present in manuscripts and drawings; and in some cases in a crucial element: a signature on a Diploma, the artist’s signature on a watercolour or gouache. The need to solve these cases and the complex nature of inks led us to the decision to study iron-gall ink composition (Daniels, 2001), its process of deterioration and the current treatments proposed by conservators and researchers.

The basis for this investigation was the information available from other colleagues and scientists who have been working on ink corrosion phenomena, and the information received during the course “The History and Treatment of Works in Iron Gall Ink”, October 2008, at the Institute of Brazilian Studies, University of Sao Paulo, in Sao Paulo, Brazil organized thanks to financial support provided by the Getty Foundation. Conservators from 11 countries from South America and the Caribbean attended this training given by Dr. Han Neevel, conservation scientist and Birgit Reissland, conservator from the ICN in Amsterdam and with lectures and assistance by Valeria Orlandini, conservator from the Library of Congress, USA.

Solutions proposed such as the calcium phytate treatment seems to provide a chemical stability to documents containing iron gall inks (Neevel, 2001).

But which ink are we speaking about? In the Sao Paulo course, B. Reissland and H. Neevel mentioned the existence of hundreds of recipes due to translation misunderstandings, multiple ingredients combinations, diverse provenance of ingredients, and varying ingredients quality. Which ingredients and formulae were used to manufacture iron gall ink in our country?

WHICH PAPER?

Substrates have a crucial importance in Argentina’s heritage, as most historical manuscripts, printed documents and works of art were created in the nineteenth or twentieth centuries, when industrial paper production started and wood pulp appeared as a new source of raw material (Van der Reyden, D, 1995). We speak of “Modern papers” (Gear et al. 2007) when referring to machine made papers manufactured since 1850 to our days.

A folder holding manuscripts from the nineteenth century was analysed as a case study. These documents were written by Dr. Juan Antonio Argerich, a remarkable professional in Argentine Medicine History. He had a crucial participation during the Yellow Fever Epidemy (Typhus amaril). This Epidemy caused thousands of deaths in Buenos Aires in 1870.

The examination of this object included paper identification (watermark: Original Turkey Mill, Kent, microscopical fiber analysis: raw material identified as mechanical wood pulp), classification of ink condition, using the Condition rating system proposed by Birgit Reissland, visual examination, photographic documentation using different light sources and application of non-bleeding test for iron (II) ions, developed by Netherlands Institute for Cultural Heritage. According to Reissland’s condition rating, these papers presented a fair condition, so it was decided no treatment was necessary; just appropriate storage made from archival quality materials (Reissland 2001).
WHERE IS IT?

Should we put into practice treatment options when most paper collections in Argentina lack of appropriate environmental conditions? There is still a lot to be done to raise awareness on the need of better environmental conditions for collections exposed to violent RH and temperature fluctuations, dust and environmental pollution and/or inadequate storage. Given the fact that documents holding Iron Gall inks should be stored at 50% Relative Humidity + 5% and 18° C + 2, is such an ideal environment possible?

CASE STUDY: MANAGING AVAILABLE RESOURCES

A project called FADAM in MEGA, Plan de Recuperación Documental del Museo de la Emigración Gallega en la Argentina (Documents Recovery Plan in the Museum of the Galicia Emigrants in Argentina) became an opportunity to disseminate information on preventive conservation solutions for documents containing Iron Gall inks. The project, organized as a hands-on training experience for Conservation students from UMSA (Universidad del Museo Social Argentino), involved condition assessment for a group of 5000 historical documents: printed registration forms completed with ink. Procedures: substrates identification, inks identification, condition assessment, surface cleaning, design of enclosures for each document and storage boxes.

There was a special interest to complete this research showing a variety of possibilities for appropriate document storage, adapting inexpensive alternatives to substitute costly conservation materials. The idea was to design a working protocol, including processes and tested materials so that the museum can continue with similar documents, following the settled guidelines.

Fig. 1. Detail from Argerich manuscript, where solid particles can be observed on the ink surface. Magnification 40x

Fig. 2. Detail of Argerich manuscript—transmitted light showing watermark

Fig. 3. Document from MEGA—transmitted light used to observe paper morphology, watermark and ink penetration
MODERN PAPERS: LOOKING FOR ALTERNATIVES

The wide variety of modern papers, their inherent heterogeneous nature and our need to confirm quality and technical data provided by suppliers, led us to design a methodology for paper diagnosis (Gear et al. 2007). The main objective was to test papers which might be eligible for storage and treatment, by means of accessible tests that could be done in our Laboratory. To achieve this, we received specific training on fiber identification and paper analysis by Engineer Olga Casal, an expert on paper identification and paper quality testing.

Twenty-five samples of paper, cardboard and boards offered by local suppliers for conservation treatment and mounting were analyzed systematically through the following tests:

- Microscopic analysis: Qualitative fiber identification (TAPPI 401 om-82)
- Grammage (weight per square meter)
- pH Measurement (Cold water extract) TAPPI 509 om-88
- pH Measurement (Hot water extract). TAPPI 435 om-85
+ Surface pH measurement TAPPI 529 om-88
+ Lignin content
- Starch content

(-) Destructive analysis
(+ ) Non destructive analysis, but requires the application of a water drop on the paper

A paper used for conservation should contain chemically bleached paste and no unbleached mechanical paste, and a neutral or alkaline pH depending on its use (Novaresi, M. 2007, ISO 9706, 1994; ISO 11108, 1996).

Table 1 shows results obtained from three papers, amongst the 25 mentioned:

1. Japanese paper (Japan)
2. Medical Grade paper (Argentina)
3. Blotting paper (Argentina)
Conclusions: Paper 1 proved to be adequate for conservation treatments. Paper 2 proved to be adequate for document interleaving. Paper 3 (blotting paper) had low quality due to high lignin content; we replaced it with 100% cotton blotting paper.

Thanks to this project, we could identify papers available in our region, which were not created for conservation purposes but meet conservation standards.

To complete the materials selection for the FADAM in MEGA Project, we chose Medical Grade paper (paper 2) for document interleaving, and a 90 grams pale yellow paper, previously tested, to design folders for each document. Storage was completed with polypropylene boxes, size and design adapted to the documents dimensions. Museum authorities took the compromise to monitor environmental conditions within the building to optimize storage quality.

CONCLUSIONS

- Our approach towards documents containing Iron Gall inks takes into account paper, inks and environment. Stabilization treatment will be useless for a document if the environment in which it is stored in the future is not adequate and stable (Reissland, 2001).
- Using treatments developed abroad without proper identification of the items treated (paper composition and quality, inks composition), may give place to undesirable results (Kraan, M et al, 2007).
- We need to learn about local ink manufacturers and suppliers in Argentina. The creation of reference ink samples would be useful together with non destructive methods such as Fibre-Optics Reflectance Spectrophotometry (FORS), an interesting tool that provides spectral reflectance curves and help identify elementary composition of inks (Neevel, H et al, 2008).

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REFERENCES


Neevel, J. G., 2001 (Im)possibilities of the phytate treatment, Postprints of the Iron Gall Ink Meeting, The University of Northumbria at Newcastle.


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Wet Treatments of Works of Art on Paper with Rigid Gellan Gels

“What cannot he express in monochrome, that is with black lines! Light, shade, splendour, the sublime, depths…”
Erasmus of Rotterdam, on the work of Albrecht Dürer

ABSTRACT

Since 2003, the ICPAL Laboratory for the Conservation of Library Materials in Rome has been developing a conservation method to carry out cleaning interventions on works of art on paper using rigid aqueous Gellan gels, a microbial exopolysaccharide that allows a constant and controlled release of water onto the paper. The adoption of this method, which has been modified by research carried out during cleaning interventions on moveable paintings, is a result of the need to find a technique that—in comparison to traditional ones—minimizes the effects of aqueous swelling, guaranteeing the maintenance of the codicological aspects of the artefact and which takes into account that, in this type of work, paper not only plays the role of support for graphical media but is an integral part of the image itself. The mechanism of exchange that is established between the paper and the gel during treatment allows the effective removal not only of surface deposits but also of a part of the substances that are present within the paper that are responsible for its acid degradation. The effectiveness of this technique in terms of cleaning (which is attested by the variations in pH measured on treated works) can be equated to the effectiveness of the traditional system of washing with water. The technique of rigid aqueous gel has also recently been used on other types of more structural interventions, such as the removal of auxiliary supports, the removal of adhesives using enzymes and the preservation problems that are inherent to modern graphic works, generally characterised by an intrinsic fragility and chemical instability. This paper illustrates the results achieved on original works whose degree of opacity, average pH value and degree of whiteness were measured before and after treatment.


THE CLEANING INTERVENTION

Surface cleaning of a work of art on paper is the intervention aimed at removing inorganic and organic substances which, over time, have deposited and been partly encompassed within the paper’s surface. Given its completely irreversible nature, the operation must be carried out by using the difference in solubility between the substances present in the original materials and what has to be removed as a reference, and by carefully assessing the changes that can been seen on the work during the operation. While in other categories of artistic artefacts—such as movable paintings and frescoes—cleaning can be carried out selectively in line with the nature and stratification of the materials that they are made of, an intervention on a work of art on paper is much more structural as it involves the artefact in its entirety. The principal preservation issues that this type of work has for cleaning are ascribable to the high hygroscopicity of paper which, as well as being one of the most important characteristics of this material, is also responsible for the change in many of its properties. For example, the interactions that are established between the surface of the works and the airborne particulate matter (PM) that is deposited on them over time, can be caused by various factors such as the nature and dimensions of the particulate matter, the physical forces (Coulomb’s law, ionic and weak secondary reactions such as hydrogen bonds and Van der Waals force) which develop to keep the PM on the surface and by several characteristics of the paper support. The most influential of these are the chemical structure of the paper support, the varying surface roughness and—above all—the degree of hygroscopicity. For example, in the presence of relatively high humidity (generally ≥ 65%), water can condense between the airborne particulate matter and the surfaces of the artefact, acting like an adhesive between them. Generally speaking, the more permeable the material is to humidity, the more hygroscopical the surface is and the more easily water can condense on it in a way that holds the PM deposited there. Likewise, the more hydrophobic the paper, the less water will be able to act as an adhesive after
its condensation (Wolbers 2005, 13–20). Paper’s propensity to absorb humidity is also at the heart of a further factor of degradation given that—over time—a consistent part of the deposits that are initially present only on the outer layer of the work, tend to penetrate into the paper support, transmitted by the molecules of water that the material absorbs in its continuous attempt to reach hygrometric stability with its atmospheric surroundings. The effects of this phenomenon, in most cases, consist of processes of chemical degradation associated with structural and chromatic alterations that profoundly modify the aesthetic aspect of the images (figs. 1–2). In addition to guaranteeing the maximum level of aesthetic legibility of the work, the cleaning intervention must in these cases also ensure the chemical stability of the paper support. Water, if used as a solvent, represents the ideal method to satisfy these preservation needs. As well as performing its intrinsic dissolving power for hydrophilic organic and inorganic materials, water—by acting as a highly dielectric medium—is also able to partially or completely eliminate the aforementioned adhesive forces that fix the insoluble substances in the surface. However, the high level of porosity and hygroscopicity that characterise paper, together with the state of preservation and the morphological characteristics of the original material, can pose a risk factor in the use of water (or other solvents) in its free state.

TRADITIONAL SURFACE CLEANING TECHNIQUES

A traditional surface cleaning technique involves treating the surface of the paper support with a hydroalcoholic solution applied with swabs. Although it is reduced by the presence of alcohol, the heightened surface tension that characterises water gives the solution a limited washing power and very high subsurface penetration, which do not allow us to check how many

Figs. 1–2. José de Ribera, Poeta, etching, sec. XVII. Simulation on the work of the effects caused by the penetration of the airborne particulate matter (PM) within the paper support
of the dissolved substances remain on the surface and how many—on the other hand—penetrate within the paper support. The scant opportunity to control the solvent and the high hydrophilicity of the paper can provoke excessive swelling of the cellulose fibres and thus cause tensions, deformations and tide lines that are difficult to remove. An alternative to this technique is based on the principle of the gelification of the water with adhesive substances such as ethers of cellulose, which are able to modify the surface properties of water in a way that gives the solvent an increase in its washing power whilst considerably limiting the aforementioned problems. At low concentrations in water (1–2%) and applied with a brush, these substances act as a mild surfactant that is able to generate a foam that facilitates the removal of the unwanted material (fig. 3). Particulate matter of varying origin, which has more tenaciously penetrated the fibrous surface interlacing, is trapped in the foam generated by the methylcellulose and is then removed with hydrophilic cotton swabs. The operation unavoidably results in a high level of interaction with the paper support which undergoes excessive physical-mechanical stress, caused above all by the inevitable swellings produced by the localised transfer of humidity, with the emergence of tensions between the treated areas and the surrounding dry areas. Furthermore, the use of the brush causes an inevitable mechanical stress that can not always be adequately controlled due to the development of the foam, which obstructs the operator’s clear view of the support. With works in a state of preservation that is already precarious, this technique can also cause further damage such as the raising and ripping of fibres which can cause paper delamination with a substantial decrease in its original thickness and coefficient of absorbency (fig. 4). A further disadvantage is posed by the difficulty that is found, at the end of the treatment, in removing the residues of a gel based on cellulose ethers. After the evaporation of the solvent, these substances actually form an elastic and adhesive film that sticks to the outer surface of the single fibres. Thus it is necessary to systemically conduct washing, with the purpose of removing tide lines that have developed in the bordering areas between the treated and untreated areas and in order to remove the residues of the gelling agent. Traditional washing with a hydroalcoholic solution (80% water and 20% ethyl alcohol) applied with a swab does not always prove effective given that the dilution of the “adhesive-gelifying agent” can promote its further migration into the fibrous interstices of the paper. In addition to the generic contraindications in terms of preservation that we have listed so far, this method is particularly dangerous when it is used for the cleaning of graphic works of art as it permanently alters the original morphology of the support. As well as causing a lowering in the original porosity of the support, the irreversible input of adhesive substances used improperly as gelling agents is also responsible for the loss of opacity of the paper because it lowers the optical discontinuity. For example, the refractive index of CMC (carboxymethyl cellulose) when dry in fact results as very similar to that of the cellulose: when the ether spreads into the inter-fibre spaces it gives it greater homogeneity because it seals the empty zones previously occupied by air, creating ‘continuity’ between one fibre and another (fig. 5). This phenomenon makes the paper more compact and uniform from an optical point of view, making it more transparent to light, to the detriment of the legibility of the image.
THE AESTHETIC ROLE OF PAPER IN THE CONTEXT OF GRAPHICAL WORKS

The irreversible changes that paper undergoes using the aforementioned interventions jeopardise two of the fundamental functions that this material has for graphical works: the role of support of the work—including its historical value represented by a series of codicological elements contained within it—and its role as the material that is essential, together with graphical media, for bringing images to life. As can be seen in the precepts of ancient painting manuals, artists’ choice of materials to be used in their works was made in relation to the graphic result that they wanted to achieve. The choice of paper destined to support their graphical work, for example, did not occur by chance but on the basis of very precise technical characteristics such as the degree of whiteness, brightness, compactness and uniformity of the surface—all particularly accentuated on the felt side of the sheets compared to the wire side, which is instead characterised by a high surface macro-roughness (fig. 6). Generally speaking, very thick paper was used for drawings with inks or pigments in solution, and thus the paper was very opaque and was characterised by a consistent surface sizing. The more homogenous side (the felt side) was used, as it allowed a better distribution of the colours applied with the pen or with the brush. If, on the other hand, the artist chose to use solid colouring substances for his composition, the drawing was done on the wire side of the paper as the roughness present on this side facilitated the adhesion of the pigments to the paper support (Armenini 1988 [1586], 60) (fig. 7). With the advent of printing between the 15th and 16th centuries, original engraving—both xylographic and chalcographic—took hold in the search for the autonomous expressive qualities of every individual technique, as engraving had now been released from its traditional duties of text interpretation and the reproduction of pictorial works. The spread of this new artistic means of expression caused further technical diversifications in the field of the process of papermaking. As concerns engraving, artists—for example—needed paper that had the best ability to exalt the intrinsic singularities of the chosen techniques and the chromatic performance of their compositions. In one of the first “technical manuals” on the art of printing (Zonca 1607, 77–78), thin paper is recommended for etchings, whilst for burin engravings—characterised by very deep cuts—very thick supports were recommended. For example, Albrecht Dürer used paper with different characteristics for his works. According to studies carried out by Joseph Meder (Meder 1971), the German artist used paper with the watermark of the Bull’s Head or the High Crown for his works commissioned by the most prestigious of patricians (fig. 8), whilst in etchings by Rembrandt, paper with the Giulare (jester) watermark is recurring (Ash-Fletcher 1998) and present in many variations. The first essential characteristic was the brightness and degree of whiteness that only paper made from raw materials of excellent quality and rich in loading substances had. Thus the paper had to be obtained from a sufficiently refined pulp that made it more uniform and compact, and which was therefore better able to reflect the light in order to exalt the luminosity of the lighter tones achieved exclusively by exploiting the whiteness of the support. A good level of refining of the raw material was also essential in order for the paper to have a degree of plasticity that was sufficient to
receive the printing marks: the permanent structural modification caused by the pressing of the matrices on the paper which gives the final image an unmistakable material aspect. The paper was thus dampened before proceeding with the printing in order to increase its ductility and also to promote the absorption of the ink. This guaranteed the distinctness and the legibility of the individual graphic signs which, transferred onto the support, took on typical and clearly identifiable conformations, according to the technique adopted by the artist (Griselini 1770, 22). In the case of chalcographical engravings, thin surface rises were obtained in line with the grooves of the metallic matrix in which the paper penetrated; the surface layers of the paper therefore absorbed a more or less significant quantity of the ink that was deposited on it, creating the so-called ‘chalcographic relief’, identifiable on the recto of the work and, in the case of more significant stretches, even visible on the verso. In the case of xylographic

works, the paper underwent heavy pressure of the ‘full’ zones of the wooden matrices, thus giving it a structural deformation in the opposite direction to that of chalcographic works and visible both on the recto and on the verso (fig. 9). The level of refining however had to not be so forced as to totally uniform the dimensions of the fibres dispersed in water. This phenomenon would have increased the transparency of the support, compromising another important optical characteristic required by the artists: the ability to sufficiently contrast the graphical media on the recto, preventing the unwanted phenomenon of visibility on the verso. An excessively refined pulp would also have caused an increase in the points of optical contact between the cellulose fibres, which would result in a material that was structurally more compact and homogeneous but at the same time more transparent to light. Similarly to what already occurred for drawings, paper used for original engraving also fully took part in defining the chiaroscuro of the image in terms of light or maximum luminosity (de Denaro 1994, 104–112). In order to demonstrate this, we can refer to a small but symptomatic variant introduced by artists in works produced after the 16th century, relating to the placing of the artist’s signature on the work. On drawings, this is no longer present on the surface of the paper involved by the image but is placed in very marginal areas of the sheets (just as happened on paintings) or removed. In engravings, monograms or dates, which were abbreviated according to the circumstances, appeared within the engraved image in rocks or hanging from trees like ex-voti. In line with what was stated by Erwin Panofsky about Albrecht Dürer’s work, there is thus the conjecture that “the artist urged the spectator to interpret the paper not only as the material sheet on which the characters could be printed as if they were printed on the pages of a book, but as an imaginary plane of projection through which the pictorial space and its contents are seen” (Panofsky 1979, 111). During the 16th century, the stylistic evolution of engraving techniques, increasingly prone to emulating the effects of contemporary painting, radically transformed the traditional link between the image and the paper support, giving the latter

Fig. 8. (A) Albrecht Dürer, The Holy Family with two angels in a vaulted hall (1503–1504), burin engraving; (B) High crown watermark, Meder 20

Fig. 9. (A) Salvator Rosa, Soldato, etching (sec. XVII), close-up of the chalcographic cut with a microscope (15x); Jacopo de’ Barbari, Venetie M.D., woodcut printed on six sheets (1500). Close-up of the printing ink marks on the recto (B) and on the verso of the woodcut (C)
the further function of ‘colour’. With the *camaïeu* and xylographical *chiaroscuro*, together with the varied range of grey tones induced by the *peintre-graveur* in their chalcographic engravings, the graphical developments covered almost all of the surface of the supports with the intention of using paper exclusively as a colour, using its white colour for the definition of highlighting (Ficacci 2006, 45–49) which, in drawings, was however produced with the positioning of pigmented layers on top of each other (figs. 10–11). Before carrying out surface cleaning, it is therefore necessary to carefully assess the level of interaction that traditional techniques currently used can cause on this type of work, even when they are carried out professionally. The uncontrolled introduction of sources of humidity or additional substances that is seen in current methods can in fact alter the original characteristics we have mentioned, relating both to the surface aspect and to the structural conformation of the paper. These are aspects that, for the aforementioned reasons, represent an undeniable priority. Although it is not possible to prevent the material from coming into contact with sources of humidity (above all when it undergoes a conservation intervention), it is nevertheless necessary to optimise the use of water, minimising its impact on the paper. Thus experimentation was begun on techniques that are alternatives to the ones described in this paper so far, aimed at the use of rigid aqueous gels, which have been successfully tested in other conservation sectors (Anzani et alii 2007).

**RIGID AQUEOUS GELS**

Rigid aqueous gels or hydrogels, widely used and tested in the cleaning of paintings following the work of Richard Wolbers, are formed of long polymeric chains dispersed in water. Given the hydrophilic nature and the particular type of interaction with water, these are commonly defined as hydrocolloids or substances that—in certain conditions—take on specific structures capable of holding and trapping the molecules of free water that they are put into. In other words, they are able to gelify, forming networks that hold water, reducing its spread and stabilising its presence. Generally speaking, the sol-gel transition of rigid gels follows the *coil to helix* model when hot solutions are cooled at room temperature. Hydrogels can be formed from various natural composites, such as Agar agar (Campani et alii 2007) and Gellan, a linear, anionic heteropolysaccharide produced by a microorganism (*Sphingomonas elodea*). Its structure is based on a tetrasaccharide repeating unit composed of \((1\-3)-\beta-D-glucose\), \((1\-4)-\beta-D\text{-glucuronic acid}\), \((1\-4)-\beta-D-glucose\), and \((1\-4)\-\alpha-L\text{-rhamnose}\) as the backbone. Gellan gel in native form is esterified with L-glycerate and with acetate at C-2 and C-6 (approx. 50%) positions of the \((1\-3)\)-linked D-glucose, respectively. Gellan gel forms different types of gels depending on acyl contents (Bajaj et alii 2007, 341–345) (fig. 12). The gelation process is generally considered to involve two
the application of this technique is the necessity to be able to modulate the level of water transferred to the paper and to be able to monitor both the work and the process of extraction of the substances to be removed, the subsequent tests were carried out with rigid Gellan gels. Between 2003 and 2008, cleaning interventions were carried out with Phytagel Gellan prepared at different concentrations (Iannuccelli-Sotgiu 2004, 2006, 2007, 2008). The deacylated type forms hard and brittle gels in the presence of cations (especially Ca$^{2+}$) that are able to promote and stabilise the ordered “crystalline-like” structure of the gel at the end of the transition process. The compactness of the molecular structure, obtainable by hydrating low acyl Gellan gel in aqueous solutions containing Ca$^{2+}$ ions thus produces a gel with a molecular weight equal to 2-3x10$^5$ Daltons. The rheological properties highlight a structure that has a very high degree of visco-elasticity, and is filmogenic, homogenous, transparent, and very stable both at high temperatures and at pH variations (Sworn 2009, 204–227 and Shah-Jani 2009, 48–58). The gelling agent, tested in terms of effectiveness and biocompatibility (Pszczola 1993, 94–96), has a very widespread use in different production areas such as the food industry, as well as the biomedical and pharmaceutical industries and in the field of biological and microbiological research. For the purpose of selecting the product that best responded to the requirements of a conservation intervention on paper, a series of tests were carried out on samples of ancient paper, comparing Agar agar and Gellan, prepared at different concentrations, and applied to the surface to carry out contact cleaning. As well as being more transparent than Agar agar (fig. 14), the rigid gel obtained from Gellan was more effective in terms of water retention, above all at low concentrations of 1–2% (fig. 15). Given that one of the fundamental requirements for
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The gum is so compact that, if the polymer is placed in water at room temperature, there is no homogenous colloidal dispersion. It is in fact necessary to heat the compound to boiling point to allow the complete hydration of its structure. While it is still liquid and runny, it is poured into a specially chosen basin and allowed to cool. The gelification of the dispersion happens rapidly once it cools to a temperature of between 40 and 30 °C (fig. 16). Gel made in this way can be kept in the fridge for 1–2 weeks if it is sealed with waterproof cling film used for food conservation.

**SURFACE CLEANING WITH RIGID GELLAN GELS**

As the mechanism of gelation, in addition to being directly influenced by temperature, is correlated to the presence of bivalent cations in water, it is necessary to gelify a saline solution based on calcium acetate, \( \text{Ca(CH}_3\text{COO)}_2 \) (0.4 g/l) which provides the \( \text{Ca}^{+2} \) ions needed to stabilise the structure taken on by the polymer in the gel phase. The quantity of Gellan powder, which is calculated according to the concentration that is desired, is then added to the saline solution. At low concentrations in water (1–4 %), Gellan gel forms a thermoversible gel in which temperature plays a fundamental role. The three-dimensional network that characterises Gellan gum is so compact that, if the polymer is placed in water at room temperature, there is no homogenous colloidal dispersion. It is in fact necessary to heat the compound to boiling point to allow the complete hydration of its structure. While it is still liquid and runny, it is poured into a specially chosen basin and allowed to cool. The gelification of the dispersion happens rapidly once it cools to a temperature of between 40 and 30 °C (fig. 16). Gel made in this way can be kept in the fridge for 1–2 weeks if it is sealed with waterproof cling film used for food conservation.

**RIGID GELLAN GEL PREPARATION METHOD**

15–24). Subsequently two other brands of Gellan available on the market were tested: Gelrite and Gélzan CM, in addition to Phytagel. The aim was to widen the range of Gellans that can be used. Out of these three, Gélzan CM was chosen as it offers greater transparency and better stability at equal concentrations, as well as the capacity of gelifying deacidifying aqueous solutions based on calcium propionate (Iannuccelli-Sotgiu 2010, 73–94). A valid alternative however is Kelcogel GC-LA, which is equally effective and is much more economical and produced by the same company (CP Kelco Inc. (http://www.cpkelco.com/products-gellan-gum.html)).
gel gradually releases water molecules onto the underlying paper, the most common degradation elements present on it are picked up by the Gellan film which, following application, visibly yellows (fig. 18). One of the possible causes of this chromatic alteration is due to the migration of products of the acid degradation of the paper and thus of water-soluble organic acids \((R-COOH)\) that are transferred into the gel from the paper support, the final pH value of which is always higher after contact with the film. The pH values of Gellan prepared at different concentrations \((2, 3\) and \(4\)%\) were measured before and after application on paper supports that were heavily oxidised or acid. The average difference of the pH values of the gel were equal to one point, whilst the pH value of the paper was raised by around one and a half points. The physical phenomenon that takes place during treatment in fact consists of a process of exchange between the paper and the gel. In the initial phase, the water tends to spread spontaneously in the paper, solubilising acid degradation by-products of cellulose. Subsequently, the concentrated solution of these products, present in the inter-fibre spaces of the paper support spreads according to the gradient of concentration from the paper to the gel (Lienardy-van Damme 1990, 23–30). Thus the treatment is not only limited to the removal of PM, but most likely it is able to carry out a cleaning action that is similar to actual washing with water. Measurements conducted by the ICPAL Physics Laboratory on works that have undergone a simple cleaning treatment with the gel have highlighted that the intervention caused no significant variations to the original opacity of the supports that were treated, whilst there was a moderate improvement in the level of brightness and a reduction in the yellowing measured according to the colour coordinate system of CIELab (fig. 19). The method described...
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allows the gel to mould itself to the three-dimensional relief of graphic print marks and to the surface texture of the paper (figs. 20–21). Neither of these suffer alterations following contact with the gel, on which we can observe the impression of the codicological elements and printing marks. And finally, after cleaning has taken place, the removal of a compact, non-adhesive film does not cause substantial presence of residues of gel on the support as is the case with cellulose ethers. Once it has been used, the gel can be disposed of as biodegradable organic waste. Gellan gel, which is in fact stable when it is in dry powder form, is on the other hand easily biodegradable in its gelified form, due to its high content of water and due to the fact that it is essentially impossible to work in sterile conditions when working on handmade artefacts in normal working conditions.

SELECTING THE ‘IDEAL’ CONCENTRATION

The water uptake of the support is inversely proportional to the concentration of the gel: the greater the quantity of powdered Gellan gel used—and thus the more tightly reticular structure of the gel—the smaller the quantity of water transferred into the paper in the same time interval. From results shown in the graph (fig. 22), it can be seen that the percentage of increase in weight ($P_2 - P_1 / P_1 \times 100$) of samples treated increases substantially with the decrease of the concentration of the biopolymer. Even after an extended contact period of 18 hours, the quantity of water transferred into the samples nevertheless results as less than what is absorbed by a sample immersed in water for ten minutes. In any case, the ‘ideal’ concentration of Gellan gel depends on the degree of wettability of any single paper to be treated. The degree of surface porosity of the paper and its level of wettability in fact depend on the type of fibre that make up the pulp, on the

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Fig. 19. CIELab color variations measured with tri-stimulus Minolta CR200 chromo-meter on a burin engraving on paper by Giacomo Lauro, Basilica S. Petri in Vaticano (1626)

Fig. 20. (A) Giacomo Lauro, Basilica S. Petri in Vaticano (1626), burin engraving on paper. Close-up of chalcographic engraving; (B) Close-up of the gel at 2% which—following contact with the work—shows the mirror image of the chalcographic engraving

Fig. 21. A same piece of paper from 1635 before (left) and after treatment (right) with Gellan gel at 2% applied for 30 minutes. Images taken with Dinolite video microscope (65x)

Fig. 22. Comparison of percentages of increase in weight in samples of Whatman paper (no.001090) after contact with Gellan gel at different concentrations (w/gel x%) and after immersion in free water for 10 minutes and for 18 hours. Readings taken with Wunder BH-150 scales (Max 150 g; d: 0.005 g) at 26°C and RH equal to 55%
extent and type of sizing present, as well as the level of refining of the cellulose fibres and the state of preservation of the materials present. Thus it is useful to carry out a simple test of the degree of wettability before choosing the best concentration of Gellan to be used and, if necessary, a humidification treatment in an ultrasonic humidifier chamber can be carried out if the paper is particularly hydrophobic.

THE CLEANING TREATMENT ON DRAWINGS

Conversely to the application method developed for printed works, the cleaning treatment for drawings is carried out by placing the gel on the verso of the work after verifying the stability of graphical media to water (fig. 23). As a further safety precaution, it is necessary to place a piece of Japanese paper between the gel and the work as an interleaving tissue. The latter does not interfere in the exchange process that takes place during the treatment, thanks to its excellent permeability, but, at the end of the treatment, it will assist the removal of the item from the gel surface. The technique also prevents the temporary fixing of any fragments with adhesives that could cause a substantial change to the support’s absorbency of water. Generally speaking, when using an interleaving tissue, a low concentrated gel (about 1%) will work more effectively to overcome the presence of an additional support. In any case, the gel concentration has to be selected according to paper wettability, which can vary even in a similar paper. In an attempt to counteract the unavoidable stresses caused by different hygroscopic behaviour during the wetting procedure on a series of drawings that showed problems of this sort, we used two gels at different concentrations to ensure the uniformity in the imbibition phase, preventing the appearance of risky physical-mechanical tensions between areas showing different hydrophilic levels (fig. 24). The contact times depend on the characteristics of the works and the quantities of residues to be removed, taking into account that, if necessary, applications using clean gel can be carried out until no more yellowing of the film can be seen.

THE REMOVAL OF AUXILIARY SUPPORTS WITH RIGID GELLAN GELS

During conservation treatments of graphic works, it is not uncommon to come across auxiliary supports applied with amylaceous or protein adhesives. In these cases, their presence brings about chromatic alternations associated with structural modifications that—with the varying of thermo-hygrometric parameters of the conservation area—become the cause of deformations, tensions, as well as surface darkening of works to such a point that their use is compromised. Whenever the conservation intervention should require the removal of these and the subsequent removal of the adhesives, rigid gels offer an effective technique for the humidification of the paper support. Traditionally, the intervention is conducted via localised humidification with steam, produced by an ultrasonic generator, or with packs of gelified water. Both removal techniques inevitably result in a high level of interaction with the work that is subjected to a substantial physical-mechanical stress, as all the materials present in it—original paper support, adhesive, strengthening material or integral lining—tend to swell in their interaction with the water solvent and subsequently shrink in a different way. The variations in size that are found in successive cycles of swelling-shrinkage bring about structural deformations that are irreversible. The extent of these deformations depend on the degree of interconnection of the abovementioned constituent materials, on the force applied during the operation of the separation of the various paper layers and on the pressure used during the mechanical removal of the adhesive, as well
as on the inhomogeneous quantities of water transferred onto the areas that are individually treated. The aim of the use of rigid aqueous gels for the removal of additional material, is to keep the level of the humidification of the entire surface of the work uniform and constant throughout, avoiding the risk of over- or under-dosage of water and the aforementioned consequences. Conversely to the function it has during the intervention of surface cleaning, the rigid gel in this case is used exclusively as a reservoir for the constant and controlled release of molecules of water for the purpose of making all the materials present in the work sufficiently hydrated throughout the intervention. As a rule, the removal of additional supports is carried out immediately after the surface cleaning intervention is completed, repeating the application of Gellan film prepared at a concentration that is suitable for the nature and quantity of materials that are to be removed. The coefficient of the diffusion of the water solvent within the work will in fact be substantially influenced by the percentage of water present in the gel, on the degree of porosity and wettability of the paper, on the presence of additional elements (original sizing) and on the quantity and state of preservation of the adhesive present. In order to minimise mechanical tractions that—even if they are mild—could be caused on the original surface, the Gellan film is in this case also applied to the recto of the work—placing a sheet of Japanese paper between the paper and the gel which will then serve to lift up the work once the operation is completed (fig. 25). The intervention is however conducted on the verso, once the ‘sandwich’ has been turned over using two sheets of Plexiglas and after having carried out a test aimed at assessing the extent of the force required to separate the two or more paper supports to be separated. Subsequently, the mechanical removal of the adhesive is carried out: the constant and uniform inflow of water molecules from the gel under the work and the subsequent decrease in the viscosity of the adhesive, allow the operation to be carried out quickly without tide lines or mechanical tractions, thus preventing irreversible distortions and any losses of cellulose fibres from the original support. However, although this technique allows a raised hydration of the adhesive layer, the permanence in the layer of internal friction—which is somewhat high—prevents its complete removal.

**ENZYMATIC GELLAN GELS**

The operation of removing support material and the subsequent removal of the adhesive can be assisted by the application of enzymes (hydrolases) that—as is well known—act as catalysts for hydrolysis reaction of specific substrates. The enzymatic gels prepared over recent years and the gelled enzymatic solutions with gelling agents of different types have several limits. Ready-to-use enzymatic packs (Schwarz et alii 2003, 98–108) only act on amylaceous adhesives, and other different types of gelling agents, like cellulose ethers, polyacrylic acid neutralised with sodium hydroxide and natural polysaccharide gums require a subsequent phase of mechanical removal from the paper surface. The need to remove residues of gelling agents can be eliminated by using a rigid gel used as a carrier for enzymatic solutions (Campani et alii cit, 16). The preparation of the enzymatic Gellan gel is carried out only once gelification has taken place as the preliminary phase of the hydration of the polymer takes place around 90–100°C, a temperature that would denature the protein molecules of the enzymes. The milligrams or the grams of enzyme (Cremonesi 1999, pp. 46–48), calculated in line with the total quantity of saline buffer solution (0.4g/l calcium acetate and Trizma base or other buffers) which is transformed into gel, are hydrated in a few millilitres of the same solution. In this way, we obtain a concentrated enzymatic solution in a homogenous medium (water) which is then deposited with a micropipette and distributed uniformly over the surface of the gel using a synthetic brush. As a rough guide, for a Gellan film at 3% made starting with 800g of pH 7 aqueous buffer solution and the surface of which is 20 x 30 cm, 5–6 ml of concentrated enzymatic solution are sufficient.

The intervention can be carried out only when the solution has been completely absorbed by the rigid gel. Initially distributed only on the surface, the enzyme molecules tend to spread throughout the microporous structure that characterises Gellan film via capillary action in the space of just a few minutes (fig. 26). The gel is placed directly in contact with the adhesive layer to be removed for a period of time that varies according to the thickness of the deposit, its nature and its

![Fig. 25. Positioning of Japanese paper and of the gel on the recto of a print (A); removal of the auxiliary support and of any previous conservation interventions, working on the verso and using the gel as a humidifying support (B); mechanical removal of the adhesive (C).](image-url)
Iannuccelli and Songiu  *Wet Treatments of Works of Art on Paper with Rigid Gellan Gels*  

...t-tert butyl aminoborane as a reducing agent. The latter can be used only if the graphical media that are present do not contain copper compounds. Again in this case, the wide range of stability of the pH of Gellan allows the use of deacidifying aqueous solutions and reduction-oxidation agents in gel phase, which can be used separately, at the same time or in subsequent interventions. The reduction-oxidation gel is prepared starting with the calcium acetate solution (0.4g/l) to which the necessary Gellan powder is added, using however the forethought of inserting the tert butyl aminoborane (7g/l) immediately after the dispersion has ended the heating cycle in a microwave, an operation that requires the use of personal protective equipment and which is always conducted under a fume hood (fig. 27). The tert butyl aminoborane dissolves immediately and so it is possible to pour the compound into a basin—as is common practice—and wait for the sol-gel transition to take place once it has cooled. Even in

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Fig. 26. Distribution of the enzymatic solution and absorption by the gel (A-B-C); application of the gel (D) and the result of cleaning on the reverse of a large-scale work (E)

The aim of the studies on Gellan gel use conducted between 2003–2004 by ICPAL was to develop an alternative technique that could remove substances that cause degradation on works of art on paper without causing morphological changes to the support. The gradual and controlled release of water molecules from the gel to the paper, its capacity to absorb hydrosoluble substances of degradation, the ease of application and removal, and its visco-elasticity make it particularly suitable for use in this field, ensuring the maintenance of the overall function—both structural and aesthetic—of this type of artefact. In experiments carried out in recent years, the versatility of this material in other phases of conservation has emerged, including the removal of auxiliary supports, its use as a carrier for enzymatic solutions and for deacidification and reduction-oxidation solutions. The results achieved in terms of the variations of optical properties, as well as in terms of the pH and alkaline reserve, are extremely encouraging. Future developments of the research are being directed at identifying the substances that the gel is able to remove from paper supports using Size-Exclusion Chromatography (SEC) and the verification of the effects that it can produce on different types of paper through mechanical testing. These studies are currently in progress on treated paper samples, as well as on untreated samples, as part of the research project ‘Gel rigidi polisaccaridici per il trattamento di pulitura di materiale cartaceo’ (http://www.icpal.beniculturali.it/progetti_ricerca.html). Partners involved in the project include the ICPAL Physics Laboratory and the ICPAL Laboratory for the conservation of library materials (Istituto
centrale per il restauro e la conservazione del patrimonio archivistico e librario), the OPD (Opificio delle pietre dure—Florence), Cesmar7 (Padua) and the University of Parma.

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REFERENCES


Griselini, F. 1770. Dizionario delle Arti e dè Mestieri, 8°.


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Decision Making and Treatment of the Ephrata Cloister ABC Book

ABSTRACT

The decision to apply new treatment methods and technologies is often a difficult one for conservators. The history of restoration, and later conservation, is littered with technologies adopted and later discarded as unsafe. In paper conservation, fungicides, oxidative bleaches, and alkalinization treatments have been modified or called in to question, particularly with the growth of conservation science and its vast contributions to our knowledge of how materials chemically interact, age, and degrade. Today’s paper conservator, having experienced or witnessed the shortcomings of previous treatment protocols, has an understandable hesitance to adopt new technologies even when they are supported by promising scientific research. All treatment has side effects and despite recent advances in artificial aging, deleterious side effects that may appear in the future are difficult to portend.

This paper will discuss the decision-making process and treatment of a unique, and among cognoscenti, iconic work of early American frakturschriften know as the Christian ABC Book. This work is neither convincingly a book nor a primer for learning the ABC’s but a mysterious object that has intrigued scholars for decades. The designs are composed almost entirely of iron gall ink, bringing into debate the use of aqueous anti-oxidant treatments and the appropriateness of using them on a unique work of art. Ultimately, decisions guiding treatment protocols for this object included ample input of the owner while drawing on key trends in the treatment of iron gall ink—though ultimately leaving the application of an antioxidant to a future generation to consider.

CONSERVATION DECISIONS

The remarkable object that spawned so much conservation soul-searching and this paper is generally known as the Christian ABC Book (fig. 1). Its full title, written in an elaborate Gothic script called frakturschriften, is: “The Christian ABC is Suffering, Patience and Hope; whoever learned this has attained his Goal.” Some aspects of the ABC Book are known to us, but many are not. We know it was created in approximately 1750 at the Ephrata Cloister, a German pietistic religious community in Pennsylvania. By applying ink to paper with amazing skill, members unknown to us created this 80-page volume of seven alphabets and one page of Arabic and Roman numbers. The manuscript contains intricate drawings surrounding ornate examples of the alphabet. It is not a primer for calligraphy but the letters are thought to be icons, objects of contemplation with symbolic significance. Some believe that the pages may have been individually hung in the cells of the brothers and sisters, who lived separately in spare dormitories.

Conservation decisions are particularly difficult with unique objects and with objects of great value, such as the ABC Book. Experienced conservators have seen hemlines on chemical treatments shift over time—calcium or magnesium, bleaches reconsidered, fumigants come and gone. Add to this the idea that our profession, unlike medicine,
The major concepts of these codes, checklists, and models, may be grouped into general categories, shown schematically in figure 2. Research has shown that people can consider seven variables at once when making judgments, and so the commonalities have been organized into seven very broad categories (Meyer and Booker 1991 cited in Caple 2000). In this paper, these categories will be used to tell the story of the real-world conservation decision-making process of the ABC Book, treated at the Conservation Center for Art and Historic Artifacts (CCAHA).

Jonathan Ashley-Smith sums it up quite well, stating “it is difficult to find any useful advice on how to treat physical objects of great value or significance” (Ashley-Smith 2009, 12–13). And so we look to resources such as: Codes of ethics, AIC, UKIC, and ICOM-CC, among the more commonly cited by western conservators. These codes have all contributed substantially to our healthy self-examination as a profession and accountability for our work. In Britain, checklists, like those in medicine, have gained currency. One example is the very fine Victoria & Albert Museum Ethics Checklist developed initially in 1994 by Jonathan Ashley-Smith and since revised by the conservation staff (Ashley-Smith 2004). As in finance, risk management models for individual treatments and for collections have also entered the conversation (Michalski 1994; Sebera 1994; Ashley-Smith 1999; Caple 2000).

Too, various conservation decision models have been described in the literature, and they include:

- **Object centered** models—sometimes called “classical” or “truth-driven” (Muñoz Viñas 2005). These could include Chris Caple’s RIP Balance Triangle as well as conservation treatment trees (Caple 2000).
- **Functional** views stress that conservation should not only consider artistic and historic values but how an object or site function within a culture—as tourist attraction, social icon, personal icon, etc. (Muñoz Viñas 2005).
- **Values driven** models, such as that of the Getty Conservation Institute, are similar to the functional models, but stress additionally that we must consider the values that people place on an object—while also acknowledging that such values are mutable and relative. (de la Torre 2002; Muñoz Viñas 2005, Avrami 2009; Cane 2009).
- **Contemporary** model—as formulated by Salvador Muñoz Viñas—who uses terms such as negotiative, common sense, and adaptive to describe this approach to conservation and professional ethics (Muñoz Viñas 2005).

The major concepts of these codes, checklists, and models, may be grouped into general categories, shown schematically in figure 2. Research has shown that people can consider seven variables at once when making judgments, and so the commonalities have been organized into seven very broad categories (Meyer and Booker 1991 cited in Caple 2000). In this paper, these categories will be used to tell the story of the real-world conservation decision-making process of the ABC Book, treated at the Conservation Center for Art and Historic Artifacts (CCAHA).

The form in figure 2 shows a pre-Copernican universe, where we humans again are at the center and “you” signifies the conservator/decision maker. This model is not a checklist, since the process of decision-making is generally not linear. All of the variables presented here relate to one another, but are directed back to “you,” the decision maker and interpreter of the data from various sources. This form, or interpretive model, illustrates the constellation of critical factors that conservators must consider when making ethical and sustainable conservation decisions.

**YOU**

Have I defined my role as:
- Manager
- Treatment Leader
- Expert/Analyst

Who are “you,” what are your roles, and how do you support yourself in the decision-making process? “You” in this model are assumed to be the decision-maker, not necessarily the one who makes a final authoritative decision but one who negotiates the decision. “You” may also be the treating conservator or perhaps a project manager.
As conservators, most of us know when we need to strengthen skills, seek out new technologies, or acquire knowledge to undertake a treatment. But what steps do we take to mitigate our own biases and subjectivity? Research indicates that people make judgments based on their own experiences and thoughts and are innately predisposed to consider their own ideas very highly (Caple 2000). Subjectivity and bias may be important aspects of decision-making and judgment, considering that conservation is an activity that is sometimes based on the tastes of a particular person or attitudes prevalent at a particular time. These attitudes clearly can affect treatment decisions, particularly in qualitative areas such as extent of cleaning or alteration of format, etc. (Muñoza Viñas 2005). Another factor that can play a key role in judgment, considering that conservation is an activity that is risk tolerance. Depending on their education, experience, and biases, different people see the same activity as more or less risky (Ashley-Smith 1999). Some argue that the way that conservators work is heavily influenced by the internal politics and pressures of their work place (Caple 2000).

Have I developed feedback loops for:

- Stakeholders
- Peers
- Checking

Many authors have stressed the utility of biases as part of heritage assessment and have defended the role of subjectivism (Muñoza Viñas 2005). However, individual biases must be tempered in order to maintain alignment with institutional perspectives and ethical codes. One important source of countering bias and subjectivity, is feedback. Feedback loops can help test judgment. For many professions, says Caple, “reality provides a natural feedback loop” (Caple 2000, 7). However reality sometimes takes a long time to deliver the check. More immediate sources of feedback may come from colleagues. At CCAHA, feedback loops are structurally integrated in the workflow of projects. The feedback is called “checking” and is given in written form or verbally by a supervising conservator after each of the following has been completed: condition report, treatment, housing, and final treatment report. For the ABC Book, each treated leaf was checked, permitting feedback as the project proceeded, allowing conservators to adjust techniques and discuss possible refinements.

THE PAST

Have I considered:

- History of the object
- Creator intention
- History of proposed treatment

The past also influences our decisions, though it often raises more questions than it answers. Is there evidence of an object’s creation, use, and even conservation treatment that contributes to the meaning of the object? Objects are layers of meanings—having cult or historical, sentimental, ideological, or group identification meanings. These meanings may change over time and are culturally relative (Muñoza Viñas 2005).

The history of the creation and use of the ABC Book, mysterious to begin with, has been obfuscated with previous repair—for which there is no written documentation and only scant photographic record. Was this always a book? The object yields no physical evidence of a previous binding structure, although at least one early photograph indicates that it arrived bound at the State Library of Pennsylvania, where it remained between 1905 and 1917 (Mohn 2010). At some point in time, the edges of all sheets appear to have been trimmed. Some have speculated that the leaves were hung on the walls of the cloister, an idea partially supported by corner pinholes in some of the pages. Evidence of transfer staining and grime from thumbing, however, suggests that the leaves lived as a book for a period of time, but we cannot say for how long. It is important also to remember that the book is composed of several complete alphabets—and we do not know if they were all intended as one compilation.

No matter what their distant history, the leaves were adhered to stubs and re-bound during a conservation
campaign of the early 20th century, likely between 1905 and 1917 during its stay at the State Library. At this time, chamered inserts were made and silk linings were attached. The conservation work was quite possibly performed by Miss Mary F. McDowell and Miss Ethel Torrington, who worked for the State Library in 1905 (Mohn 2010). Though the previous conservation may have contributed to some loss of format and meaning, the repairs themselves are now part of the history of the object. Some say objects have meaning because we choose to preserve them (Muñoz Viñas 2005). Keeping the repairs in place was considered, however the silk was failing, had developed a cloudy appearance in places, and distortions were emanating from the adhered inserts—causing stress in areas of very brittle iron gall ink.

One crucial issue related to the past is the history of the conservation treatment under consideration. Jonathan Ashley Smith speaks to the importance of prediction and evaluation in considering possible treatment options (Ashley-Smith 1999). He suggests that the most obvious way is to look at naturally aged specimens, acknowledging that the utility of this may be limited due to limited pre-treatment records, small sample size, and that new treatments have not been in use long enough (Ashley-Smith 1999). For paper conservators, some treatments, such as alkalization, now have a substantial body of naturally aged examples. These samples have allowed paper conservators to examine and consider, among other things, the effects of alkalization on re-treatment (O'Loughlin and Witty 1999). Obviously, newer treatments, such as calcium-phytate, cannot yet offer such naturally aged samples for conservators to revisit.

It appeared, therefore, that the past would not lead CCAHA conservators forward to a solution for the ABC Book. Due to previous treatment, there was no evidence of an original format to serve as guide. Even if this evidence existed, there is an inherent fallacy in returning to a new, original format (Muñoz Viñas 2005). Alteration of the ABC Book must therefore look ahead, with the task of sustaining the object and evidence of its meaning. And this is where our peers can contribute data and information to the decision making process.

PEERS

* Have I consulted peers for:
  - Knowledge
  - Feedback
  - Peer review

Who are our peers? They can be scientists, workplace colleagues, and specialist consultants. An American Institute for Conservation survey once polled members for research needs—respondents said there was not a lack of information but poor spread of information (Ashley-Smith 1999). This speaks to the importance of publication and professional meetings for dissemination of conservation information. Meetings are, evidently, not just places to offer or soak up information but places to seek consensus as well. It has been reported that conservator Miriam Clavir, during a professional meeting in 1994, asked attendees to vote on treatment options that considered the views of native peoples about spiritual values of objects (Ashley-Smith 1999). The voting indicated a popular movement toward acceptance of the views of groups outside of the museum and a greater inclusivity in decision-making—a trend that has been growing in the field of ethnographic conservation since that time.

During the research and development phase of the ABC Book project, which took nearly two years, CCAHA staff reached out to colleagues nationally and internationally as the treatment team investigated conservation options. Colleagues at institutions such as the Library of Congress, National Archives Canada, Netherlands Institute for Cultural Heritage (ICN), and Folger Shakespeare Library were consulted and or visited between 2003 and 2005, a time before many North American trials on calcium phytate were published. The CCAHA was given an opportunity to see objects treated with calcium phytate, pulp-filled, then naturally aged, albeit for only a few years. These images, too, were shared with our clients in one of several pre-treatment meetings. In particular, visual study of the Trelavelyon manuscript at the Folger, with ornamental designs rendered in iron gall ink, served as a possible treatment template. Now a reformatted post binder, with small, removable booklets, the Trelavelyon approach was and still is a viable formatting option for ABC Book.

RECORD/DOCUMENTATION

* Have I established an appropriate treatment record in terms of:
  - Accessibility of records
  - Tools for monitoring
  - Sustainability

The extent and type of conservation record or documentation, is, like treatment itself, a matter of judgment, although ethical guidelines provide some minimum accepted standards for item-level and group treatments. Documentation practices, again like treatment, vary from institution to institution, object to object, and often depend on whether the record will be part of a larger ongoing survey or system (Caple 2000). With item-level treatments, many details are sometimes excessively recorded while others are overlooked, particularly the negotiative and decision-making process. It is often the case, especially with unique and valuable objects, that the decision process is far more involved than the ultimate treatment—or decision not to treat. Not only is content of documentation an area for decision making, but permanence and accessibility of that record must be considered as well. Recent discussions in the literature focus on the accessibility of documentation...
records to persons other than the traditional “keepers” of information, conservators and curators. Some in Britain have even suggested documentation wikis, with version-controlled encoding, allowing the documentation to be available to diverse users (Kemp 2009).

The emphasis on the record is one of the defining aspects of our profession, differentiating it from craft-driven emphasis on immediate cosmetic improvement to an emphasis on long term, ongoing care (Caple 2000). It is this idea of ongoing care, which brings us back to the notion of sustainability—the goal for the preservation of the ABC Book and for its documentation. Therefore it was important for CCAHA conservators to determine what information would be useful to future generations—to record that information in as standard and permanent a format as possible.

With future users in mind, the Conservation Center has developed an approach to documenting culturally significant and high value artifacts such as the ABC Book—an approach they call Baseline Documentation. It is designed to provide a thorough record of condition—serving foremost as a tool for monitoring condition in the future. In considering this documentation approach, it is important to note that the extent of documentation at a regional center such as the CCAHA is often driven by the resources of the owner. Therefore, at CCAHA, baseline documentation typically relies on tools and techniques that can be practiced in-house by staff conservators. These tools for monitoring baseline generally include:

- An extended prose report, including treatment history.
- In-house analysis such as polarized light microscopy and microchemical testing. Outsourced quantitative analysis, particularly of design media, is undertaken if the owner’s budget permits.
- L*a*b* color measurements of paper, media, and for iron gall inks, areas of haloing and penetration. These color measurements will provide more accurate data than photography and can detect changes before they are visible to the human eye. Hard copy records of data are retained and polyester templates used to take the readings are stored with the object.
- High-resolution photographs are captured with a digital camera using a RAW format. Baseline photographic documentation generally includes digitally captured transmitted and ultraviolet light images, the latter are particularly important for iron gall inks. High resolution before and after treatment photographs, in normal and raking light, are also taken. Uncompressed TIFF versions of the digital images are stored on network attached storage units. Hard copy versions are printed on Epson Premium matte inkjet paper, using pigmented inks, and are retained with CCAHA treatment records.

### Future

Are the results of my actions sustainable in terms of:

- Predicted outcomes
- Probability of re-treatment
- Impact of proposed treatment on re-treatment (solubility, pH, etc.)

Making treatment decisions based solely on the idea that artificial aging offers a glimpse into the future is fraught. There have been many thoughtful discussions over the last decade on the fallibility of artificial aging and Arrhenius principles upon which some predictions have been made (Daniels 2009; Bansa 2002; Porck 2000). Add to this the notion that paper itself is a complicated matrix of furnish, fabrication, and finish, making the job of interpretation of aging experiments that much more complicated (Dwan 1987). Some conservators say that that there are limits to how far time can be compressed while drawing meaningful conclusions (Ashley-Smith 1999). In response, conservators and scientists have offered the idea that the artificial aging of paper should be calibrated with standards of known composition and age (Ashley-Smith 1999; Bansa 2002). Others suggest that using real time observations of small changes—for example, very low concentrations of gaseous degradation products—would be more accurate (Edge 1996 cited in Ashley-Smith 1999). It would appear, therefore, that there is risk in accepting novel treatments based on Arrhenius principles and perhaps these risks should be acknowledged by conservators (Ashley Smith 1999; Muñoz Viñas 2005). The effect of treatment on stability is not only difficult to predict because of questionable artificial aging models, but also because stability itself is always in flux and subject to environmental conditions.

One of the ways conservators have historically sought to mitigate the risks of conservation treatment is by embracing the notion of reversibility (Viñas 2005). Ideas about reversibility have been evolving for decades (Applebaum 1987; Smith 1988; Oddy 1995). The topic has been much examined, particularly in Britain, where a number of thoughtful conferences and publications have been offered. As a result, the concept of retreatability has been gaining currency and vies with stability as a leading factor today in decision making. For objects of high value, retreatment is very likely. Retreatability was an important factor in the ABC Book project, because, CCAHA conservators were, after all, essentially undoing a treatment executed approximately one hundred years ago.

Sustainability, therefore, becomes a key yardstick by which we must assess the appropriateness of conservation treatments and preservation plans. By advocating sustainability in conservation decision making, conservators must consider the effect of treatment not only on future conservators but on other users as well (Muñoz Viñas 2009). If an object is a source of meaning, loss of meaning to future users
must be a factor in determining possible treatment—and this is a tall order. It is difficult enough to find agreement on meaning with present observers—but now we are also charged with safeguarding meaning for future interpreters and users (Muñoz Viñas 2009). And so, our jobs as conservators have become more complex in terms of critical thinking, but potentially much more rewarding.

**STAKEHOLDERS**

*Have I identified appropriate stakeholders in term of:*
- Owners/ Clients
- Consultants/ Specialists
- Public/ Users

“Conservation should not be imposed, but agreed upon.”
Salvador Muñoz Viñas, 2005

Who are stakeholders? One good definition is that stakeholders are the people for whom an object is meaningful and who are impacted most by changes in the object (Avrami 2002; Muñoz Viñas 2005). Our field has been criticized for the misuse of scientific objectivism to create what Salvador Muñoz Viñas calls “restricted arguability” (Muñoz Viñas 2005). This occurs when scientific and conservation language are used to limit discussion with non-technical experts, outsiders and stakeholders. An outcome of this is that our decisions cannot be questioned by others, even those who may be most affected by changes in an object (Muñoz Viñas 2005).

*What type of stakeholder input is appropriate:*
- Determination of value (rarity, historical significance, monetary)
- Interpretation — aesthetic object versus document
- Feedback regarding treatment

How should conservators weight stakeholder input in decision-making? Many of the authors cited in this paper, including Mr. Muñoz Viñas quoted above, suggest that conservators should not function merely as technical operators carrying out the wishes of the owner or curator. Yet, if conservation is performed for those people for whom the object is meaningful, it is their resources, preferences, interests, needs and priorities that should be paramount in decision making, regardless of their training (Muñoz Viñas 2005). However, it is not only the contemporary negotiative decision model that calls on conservators to acknowledge the priorities of stakeholders. The Getty’s values-driven model clearly supports the democratization of the heritage field, where the opinions of specialists are not imposed but are recognized as complex negotiations with diverse stakeholders. And the Conservation Center had complex negotiations with stakeholders during development of the ABC Book conservation plan. There wasn’t always agreement, for instance, about compensation methods and the extent of bathing. CCAHA conservators were insistent about treatment preferences in these areas because there were well established procedures at their laboratory and elsewhere.

Less well established, at least at the time, were aqueous treatment options. The ABC Book complicated matters because it is a unique object and because it straddles the realms of document and work of art. Therefore, CCAHA presented various aqueous treatment options to stakeholders (curators, consultants, site administrators), including calcium phytate—providing published and unpublished data gained from colleagues. The stakeholders felt that the calcium–phytate treatment, despite a growing trend of encouraging scientific data, was too new. It was not only new, it meant leaving a chemical deposit behind—one, which CCAHA conservators could not then, and perhaps not now—argue soundly for its effect on retreatment. And so, in keeping with the idea of not leaving a chemical deposit in the paper, neither scavenger nor alkaline reserve, CCAHA negotiated for an optimized washing treatment detailed below. Some of this decision making parallels those treatment decisions made for the conservation of the Last Will and Testament of George Washington, also rendered in iron gall ink, described and treated by Christine Smith (Smith 2003).

Decision makers are, therefore, negotiators who must find a happy-medium, a sweet spot, between preserving all possible meanings, future meanings, and outcomes. Perhaps it is useful to remember the words of Lowenthal: “nothing ever made has been left untouched. Nothing ever known remains immutable; yet these facts should not distress us but should emancipate us” (Lowenthal cited in Muñoz Viñas 2005). And in this freedom, the notion of sustainability of artifact and meaning may serve as a guide.

**THE OBJECT**

In the care of the Ephrata Cloister, the ABC Book had received periodic condition evaluations. Each time, the consulting conservators, either private or institutional, provided the client with their opinions on what needed to be done for the best care of the object at that given time. The recommendations were, mostly, not to perform any further treatment. Not that the object was in a perfect condition, but that the risk involved in potential treatment seemed to be too high. In 2004, the object was brought to CCAHA for another condition evaluation.

The object, as reported by the owners, had received extensive treatment in the early 20th century. By this time, it had already suffered a severe degree of ink corrosion resulting in significant losses of the paper support. The early 20th century treatment involved the following stabilization measures: filling the numerous small and large losses in the paper support with chamfered inserts attached from the verso using starch
based adhesive; inpainting the inserts with a water soluble medium; and lining the front and the back of the object with fine silk and starch based adhesive. The chamfered inserts were individually made with a high degree of craftsmanship, but the silking procedure was done rather haphazardly with excessive amounts of adhesive. In some cases, the sticky surface of the freshly silked object had attracted dust and random debris from the air or a contacting material, which made the finished product appear rather hazy. Each of the 80 leaves was uniformly treated in this manner, including several blank leaves, which did not receive inserts. The leaves were then re-bound as a book with a paper tab attached on the left edge of each leaf. As a result, each leaf remained sturdy but slightly rigid, encased in the layers of aged and discolored silk and adhesive. Other than these visual clues, there was no surviving record associated with the previous treatment. With the aid of improved examination tools, an in-depth condition assessment was performed at CCAHA. It seemed that the excessive moisture applied during the silking process had caused bleeding of latent water soluble components in the inks. Viewed under ultraviolet illumination, these latent components appeared as dark halos around the inked areas. The inks and some of the halos tested strongly positive for the presence of Fe (II) ions, using the non-bleeding bathophenanthroline indicator paper, confirming the reason for the severe corrosion and the potential for further degradation. Given the extent and the pattern of haloing, it was highly doubtful that the object had been washed during the previous treatment.

How has the previous treatment affected the condition of the object? If it had not been treated before, would the object be in a better or worse condition now? It seemed that the previous treatment was intended mainly to provide physical strength. It is conceivable, however, that the encasement in silk and a thick adhesive layer, though now considered disfiguring and of questionable stability, might have provided some chemical buffering by limiting to some degree the exposure to atmospheric oxygen and other pollutants. At the very least, the object was saved from extensive fragmentation owing to the mechanical and physical protection provided by the previous intervention.

The condition examination of the object at CCAHA brought up a range of questions for the conservation staff to ponder. When is the right timing to treat this or any object, now or later? Could we wait for another time? Is the object in dire enough condition to warrant intervention? If so, would the treatment decision-making be easier? How long would the object stay in this relatively stable condition without active intervention? If we are to treat the object this time, which treatment procedures can we apply with confidence, based on “real time” proven results? Would our treatment facilitate or interfere with future intervention? Could the next generation add a treatment “layer” on top of our treatment, without undoing our work or risking the object? Will our treatment buy enough time for the next generation? Would the changes in the appearance after treatment be acceptable? None of these questions could be easily answered, and some of them remain unanswered today. Once the decision was made by the owners and stakeholders to go ahead with a treatment, the many significant details and extent of the treatment procedure remained for the conservators to propose, test, and evaluate. All of these were to be discussed with and approved by the client.

The crucial discussion in developing the treatment procedure involved the choice between recent chelation and anti-oxidant approaches and more traditional aqueous washing methods. As mentioned earlier, the possible application of a calcium phyate treatment was declined by the client. The client’s doubts about the unknown long term side effects were understandable and partly shared by the conservators. The stakes were too high, considering the huge amount of ink deposited in each leaf. For some of the bold, heavily drawn letters, the iron gall ink occupied nearly 50% of the page. The conservators, therefore, determined to pursue an optimized washing treatment—while attempting to assure that this washing would be as safe and as thorough as possible. The CCAHA approach essentially quotes from the prevailing treatment protocols for iron gall ink without the application of the phytate and calcium bicarbonate (Huhsmann and Hähner 2008; Albro et al. 2008). Perhaps a newer and more effective anti-oxidant or chelation treatment will become available in the reasonably near future; or the calcium phyate treatment itself may be time proven to be the safest and the best way to treat this type of object. Until then, it is hoped that our current treatment will buy enough time to transition the ABC Book into re-treatment with minimal complications. Leaving the pH of the treated object in the neutral range was done intentionally in order to “leave the door open” for a future phytate or chelation treatment.

After presenting and discussing different prototypes with the client, the basic scheme of the treatment was agreed upon. The plan was to completely remove silk and old chamfered inserts; thoroughly remove silking adhesive remnants, which was to be achieved by alpha-amylase treatment; wash the object as thoroughly as possible to remove harmful Fe (II) ions; fill the losses with wet antique paper pulp, which provided the best results in terms of planarity and appearance without causing the localized stresses of adhered inserts; line the verso with thin mulberry paper and wheat starch paste; size the object with dilute gelatin; and inpaint the losses with ground pigment and dilute methylcellulose. Each step was refined and developed into a standardized protocol, which a team of conservators could precisely follow and reproduce over the course of one year. (See APPENDIX for detailed treatment sequence.)

The extensive washing brought out the brightness of the paper, which at first was unfamiliar and somewhat startling.
for the client. However, the recognizable benefit of treatment, including the revelation of fine details in the drawing that had been obscured by the previous treatment, small overlays attached by the artist to correct images, and tiny pin holes at the four corners of the image boundary, helped the client to overcome the unfamiliarity and appreciate the newly discovered details. These details have led to a better understanding of the techniques of the calligrapher and have helped to reinforce the appropriateness of the treatment decisions.

In addition to the treatment, measures to forestall the eventual degradation of the media and paper included consideration of the housing and storage of the treated leaves. Each leaf was housed in an alkaline, ragboard window mat (with zeolites), with a portfolio cover. Folded mulberry paper corners were used to secure the object in the mat, instead of using adhesive and hinges. For exhibition purposes, the cover and the window were attached in a way so that they could be completely folded back. The client felt it was important to be able to show each leaf in its entirety, with the thumb-stained margins all visible, in order to remind the viewer that the object once lived as a book page. Possible advantages of the new format and housing include increased visual and mechanical access to the leaves, once bound as a heavy book that was difficult to handle and exhibit safely. Individual leaves can now be exhibited without flexing the large swaths of iron gall design, which was not possible before treatment. Additionally, recent evidence suggests that bound stacks of paper, rather than individual leaves, age more quickly than single sheets (Shahani 1995). Again, conservators, owners, and stakeholders must balance possible “meaning loss” with longer term preservation. Final decisions on the ABC Book format were made by the owner. Today, the matted objects are housed in seven clamshell boxes.

CONCLUSION: R.I.P

Chris Caple’s elegant and ironically named RIP decision model encourages conservators to balance revelation, investigation and preservation (Caple 2000). CCAHA conservators hope that their conservation approach to the challenges of the ABC Book led to a balance of these RIP factors and to a sustainable preservation solution. With the possible exception of preventive conservation, all treatment alters and or modifies an object. While the ABC Book may have lost some if its “bookishness,” and possible meanings therein, all or some leaves may become a book again some time in the future, should evidence and stakeholder volition lead the way. It is somewhat ironic that the treatment, after one hundred years of advances in paper conservation, has come full circle in some respects. The essential ingredients of the treatment circa 1900 and today, water, starch paste, and gossamer thin linings (this time cellulose instead of silk) are much the same. Perhaps the major changes of the recent conservation efforts relate to the ways in which the ingredients were applied and the critical process that led to their use. Too, the very absence of prior treatment documentation, and of any record of the “negotiative” process one hundred years ago, is telling. It is hoped that the decision process of this century, as well as product, will be entered into the permanent record of the ABC Book and will facilitate its future care.

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APPENDIX: TREATMENT STEPS IN SEQUENCE.

1. Solubility test.
2. UV examination to record the latent bleeding caused by previous treatment (fig. 3).
3. Fe (II) test: All strongly positive.
4. 100% ethanol spray and air-dry.
5. Immersion washing in 50:50 (ethanol: water) → 25:75 (ethanol: water) → water 100%, approximately 30 minutes per each bath. The last 30 minute water bath is divided into several frequent baths in order to remove the residual ethanol from the paper prior to enzyme treatment (fig. 4).
6. Enzyme treatment: prepare 200ml alpha-amylase enzyme solution (200 ml of 100 units/ml activity solution = 0.01g amylase + 20ml 0.05M Trizma + 180ml calcium enriched deionized water) → place the object on top of a Plexiglas, which covers a tray of hot water. The Plexiglas gives away a slight curvature to contain the enzyme solution in full contact with the object. Cover the object with a piece of Mylar, bigger than the object, and keep it on the warm surface for 35–40 minutes total.
7. Cold water washing in shallow baths, repeated several times. Old patches and silks are removed in these cold rinsing baths. The gritty residues on the surface are gently squeezed out with the object sandwiched between Mylar on the front and polyester webbing material on the back.
8. Fe (II) test: All inks tested negative at this point.
9. Pulp fill the losses with pressure-cooked antique paper pulp from the verso, on the light table.
10. Line the verso of the object with Korean mulberry paper (#1101) and wheat starch paste.
11. Size with 0.25% warm gelatin by spraying on the recto—applied twice with an interval to give a chance for full penetration (fig. 5).
12. Dry the object between felts under glass plate. No weight on top. On the following day, place the object between blotters under Plexiglas and moderate weights.
13. UV exam to check if the treatment has caused any further latent bleeding of inks—a way of evaluating the success of aqueous treatment before and after treatment.
14. After several weeks of drying, the losses were inpainted with ground pigment and dilute methycellulose A4M.

REFERENCES


sources of materials

Korean paper #1101
FIDES International Co.
102-811 The # Island Park
17 Yeoido-dong
Yeongdeungpo-gu
Seoul, Korea 150-874
(82) 10–2369–5433
www.ifides.com

Gelatin, laboratory grade, 275 Bloom
Fisher Scientific
2000 Park Lane Drive
Pittsburgh, PA 15275
(800) 766–7000

Ground pigment
Sinopia Pigments & Materials
1340 Bryant Street @ Division
San Francisco, CA 94103
(415) 824–3180

α-Amylase from Bacillus sp., A 6380, Type II-A, lyophilized powder, 1,500–3,000 units/mg protein (biuret)
Sigma-Aldrich
3050 Spruce St.
St. Louis, MO 63103
(800) 521–8956

Trizma® Pre-Set Crystals, pH 7.6, T-4253
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A Dionysian Dilemma: The Conservation and Display of Oversized Pompeian Watercolors at the Kelsey Museum of Archaeology

ABSTRACT

Long-term display of works of art on paper is problematic, and installation of oversize works of art can be challenging. However, a joint project between the Kelsey Museum of Archaeology and the Intermuseum Conservation Association successfully achieved both. This paper describes the treatment of twenty one oversize watercolors, and their subsequent installation in a setting that can function as both display venue and long-term storage.

The watercolors, the largest of which measures nearly twenty feet long, presented challenges not only because of their extraordinary size, but also because of their hybrid nature; they were painted on paper backed with canvas. Because of their large size, many of the works were stored rolled, and were thus inaccessible to students and visitors. The treatment involved surface cleaning, humidification, flattening, and hinging of the watercolors to aluminum honeycomb panels. Although much of the treatment drew on techniques commonly used in paper conservation, it successfully combined methodology and materials from both paintings and paper conservation. Micro-fading tests of the watercolor pigments were used to design display lighting, and a simple cleat system was used to hang the panels.

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INTRODUCTION

The Kelsey Museum of Archaeology at the University of Michigan, Ann Arbor, houses a collection of over 100,000 objects from the civilizations of the ancient Mediterranean. The Museum’s collection was begun in 1893 by Professor Francis W. Kelsey, for whom the Museum is named. Although the majority of the objects come from University of Michigan excavations conducted in the first half of the 20th century, Professor Kelsey supplemented the collection with objects purchased during his travels in Italy, North Africa, and the Near East.

The twenty one watercolors that were the focus of this project were an artist’s illustration of the famous fresco cycle in Room 5 of the Villa of the Mysteries in Pompeii, Italy. The watercolors were commissioned by Kelsey and painted by Maria Barosso, a highly regarded Italian artist and archaeological illustrator. Painted at nearly life-size (5/6ths scale), the watercolors were intended to recreate the experience of visiting the room at the Villa. Kelsey, who was present at the Villa’s discovery in 1909, wished to document accurately the condition of the frescoes and the technical details of their creation. He hoped the paintings would be a research and teaching tool for the University (de Grummond 2000). Painted on-site in Pompeii between 1925 and 1927, the watercolors were the only large-scale pictorial record of the fresco cycle that was roughly contemporaneous with its discovery.

A temporary exhibit of the watercolors in the year 2000 focused attention on their condition. Due to their great size, the paintings had been rolled and stored in various locations, including the attic, in the Museum’s 1890s building. The paintings had to be unrolled to be viewed, and the combination of rolled storage, dirty and dusty conditions, a wildly fluctuating climate, and poor handling created a number of condition issues. The paintings, which were watercolor and gouache on heavy-weight paper lined with linen or cotton, had become creased, warped, and distorted, with numerous tears and small losses along the edges.

Sadly, despite Professor Kelsey’s desire for the watercolors to be available for research and study, the paintings’ large size precluded their display at the Kelsey Museum. The sole temporary exhibit in 2000 had to be hosted by another campus museum. When the Museum received a generous private donation to build new gallery and collections facilities, there was finally an opportunity to house and display the Barosso watercolors properly.
In 2007, Kelsey Museum conservators applied to the Institute of Museum and Library Services (IMLS) for a Conservation Project Support Grant to assist with funding for the treatment and mounting of the watercolors. The conservation department at the Kelsey Museum specializes in the conservation of archaeological objects, and the conservators knew that the watercolors would require assessment and treatment by both paintings and paper conservators. The oversize paintings would also require a large, open-plan lab to accommodate treatment. The Intermuseum Conservation Association (ICA) in Cleveland, Ohio met all these requirements. In addition to performing the treatment, ICA conservators also assisted with the successful grant application, writing an initial condition report as well as providing a treatment plan and cost estimate for the watercolors.

This paper will describe the condition of the watercolors at the inception of the project. It will also provide a detailed description of the treatment and mounting process, which successfully combined methodology and materials from paintings and paper conservation. The results of the micro-fade tests of the watercolor pigments will be discussed along with the design of the gallery/open-storage area created to house the watercolors, which included innovative lighting and design elements to protect light-sensitive pigments.

DESCRIPTION AND CONDITION BEFORE TREATMENT

The watercolors are faithful renderings of the frescoes in Room 5 at the Villa of the Mysteries in Pompeii, Italy. Eighteen of the twenty one watercolors were painted at 5/6ths scale; the three additional watercolors are 1:1 copies of the original frescoes. Maria Barosso and Francis Kelsey originally intended to produce all the watercolors at a 1:1 scale, but the local Soprintendenza official charged with the care of the Villa of the Mysteries would not allow a complete set of paintings at 1:1 scale (de Grummond 2000).

Each wall of the original fresco cycle was divided into three sections: a central figural panel with decorative borders above and beneath. Barosso divided her paintings in the same way, so that each wall was broken into three horizontal sections. The watercolor panels range in size from 25" high by 33 ½" wide, to 59 ¼" high by 237" wide.

Barosso carefully drew and painted her images to reflect accurately the condition of the wall paintings, including cracks and losses (de Grummond 2000). In this way, the watercolors function as a condition map of the frescoes as they appeared in the late 1920s as well as works of art in their own right. Because the original frescoes have deteriorated further since Barosso’s renderings were completed, the watercolors are considered key documents of the condition of the frescoes at the time of excavation.

Much of Barosso’s work was carried out on-site in the Villa, under working conditions she described in her regular letters to Kelsey as oppressive and lonely. The images were first sketched in pencil, and then painted using Winsor and Newton watercolors (de Grummond 2000). The support is heavy-weight wove paper variously lined with linen or cotton cloth, or thick wove paper. The artist’s name and notes are written on the lining cloth/paper in multiple places.

This primary paper support came from two sources: Superior II, and Canson and Mongolfier Paper (Baird 1986). To form the lengths of paper needed for the longest set, Barosso joined two shorter papers with strips of paper or fabric attached with thick hide glue. Outlines of figures or motifs in the design were used to hide the joins, meaning the lines along which the two pieces of paper met were not straight, but instead followed elements in the paintings. The edges of each watercolor were irregularly trimmed, and Barosso included additional borders on the top and bottom edge of each painted panel. These borders were unfinished and contain notes and light sketches in pencil and watercolor. Perhaps Barosso was planning to use them as guides for joining the sections, or perhaps they were meant to be cut. Because the artist’s intent is unknown, the edges remain as she left them and are exposed in the final installation.

Overall the watercolors were in fairly good condition. Because they have rarely been on display, the pigments are in excellent condition with no obvious fading, and the only damage is a slight darkening of small areas of white. The majority of the condition issues were related to storage and handling. The edges of many of the paintings were tattered, from both handling and the pins used by the artist along the edges of the paper at regular intervals to hold the support flat while she painted. There were numerous scratches, abraded areas, creases, and handling dents from where the paintings had been rolled and rerolled over the years for display and storage.

While the majority of the backings were stable, one fabric-lined watercolor panel had some rippling and detachment of the backing. The upper and lower panels of the full-sized set of paintings had had their fabric backings removed at some point, leaving grainy adhesive on the verso. There were several lengthy tears in these two panels as well, which had been mended with Japanese paper and wheat starch paste. The three segments of the longest set were created by joining two pieces of backed paper. These joins were rippled and significantly less flexible due to the stiffness of the adhesive and paper/fabric used as a bridge. The upper panel had been split at the join, leaving a small end piece separate from the rest of the watercolor.

For the exhibition in 2000, all the watercolors had been humidified, flattened, and mounted to Gatorboard support panels with Japanese paper T-hinges adhered with wheat starch paste. Following the exhibit, the six longest watercolors were removed from their mounts and re-rolled around six inch diameter, paper-wrapped, plastic tubes, leaving the hinges attached to the verso. The smaller watercolors had been stored upright on their mounts but were beginning to
curl away from the Gatorboard in the spaces between the hinges. In addition, because the edges of the watercolors were uneven, both the hinges and the dark brown color of the Gatorboard were visible in many areas. Seeing both the positive and negative aspects of the mounting system used for the 2000 exhibition gave the team a wealth of information for designing a new system that would be both stable over time and aesthetically pleasing in the galleries.

CONSERVATION TREATMENT

The basic course of treatment was to remove the smaller watercolors from their mounts, unroll the larger watercolors, and prepare everything for humidification and flattening. An extensive condition report was written for the watercolors in 1986 (Baird 1986), and it seemed that little had changed overall. Therefore, the team decided to create a binder of annotated photographs in lieu of a written condition report as a visual reference for tears, folds, abrasions, scratches, and pin holes (fig. 1). The idea was that the photographs could also be used for future gallery condition checks. Following the completion of condition notations, the Japanese paper hinges were removed from the verso with a light application of moisture. The verso was then gently vacuumed with a brush attachment while the recto was brushed with a soft brush. Each watercolor was humidified for a few hours in a chamber constructed of Gore-Tex or Tyvek covered with damp toweling and finally plastic sheeting. Following humidification, the watercolors were moved to a stack of dry blotters, and weighted under boards for two weeks.

Working with twenty one oversized watercolors turned what is normally a fairly straightforward treatment into an enormous task, both literally and figuratively. A great deal of time was spent simply planning how the watercolors would shift through the labs during the six months it took to flatten all the individual pieces. In addition, the irregular edges meant that inevitably some hinge paper would show outside the image area. To make the hinges less noticeable, a neutral tone, common along many of the edges, was chosen, and all the Japanese paper was dyed with acrylics to match.

In the first two cycles, the hinges were attached to fully humidified watercolors with wheat starch paste prior to flattening. However, because of the composite structure of the pieces, the wet hinging process caused excessive warping to both the watercolors and the hinge paper. Adjustments were made to the amount of moisture in the hinge paper during the attachment step to reduce the severity of the distortions. In one instance the hinges were placed in a humidification chamber, and in another they were sprayed out fully prior to pasting. Unfortunately, even after weeks under weight, the watercolors were still not flat enough to be mounted, and it quickly became apparent that a dry method would be a more viable hinging option.

Because the paper was backed with canvas, the watercolors had properties not only particular to works on paper, but also to paintings, leading to further investigation of techniques and adhesives used in paintings conservation. After considering options for an adhesive that would provide a strong, reversible attachment, BEVA 371 film was chosen. This flexible, heat activated, synthetic adhesive could be used both to attach the hinges to the watercolors and to mount the watercolors to the panels, in the style of a strip lining. Another advantage was that the film could be custom cut to follow the irregular edges of the watercolors. This technique allowed the watercolors to be fully flattened and the hinges attached dry using a tacking iron. Because the largest watercolors were to be mounted to their panels in the gallery at the Kelsey Museum, this method also served to alleviate the problem of reintroducing moisture to the watercolors in a less controllable setting.

Once the treatment protocol had been established for humidification and flattening, it became clear that the joined
pieces of the longest set would need to be separated. There was concern that the stiffness of the joins would prevent expansion during humidification and cause even further distortion. Therefore, the joins were split and the fabric/paper lining and adhesive removed from the verso with a poultice of methylcellulose. Following humidification and flattening, the joins were reconstructed from the verso using bridges of Japanese paper adhered with BEVA film cut to follow the irregular shapes of the joins. Gaps were filled from the recto as necessary with small pieces of the hinge paper pushed into the spaces and compacted with wheat starch paste (fig. 2). The fills, along with other obvious losses in the media, were toned with watercolor, both at the ICA and after the watercolors were mounted in the galleries at the Kelsey Museum.

**Mounting to Rigid Support Panels**

Once the watercolors had been flattened, they were carefully measured for the fabrication of custom aluminum honeycomb panels made by the Small Corp company in Greenfield, MA. Aluminum honeycomb panels were chosen over paper honeycomb panels (Tycore) because they could be manufactured in continuous pieces creating more solid panels in the sizes needed for these watercolors. Each panel had a frame of sealed poplar exposed on the verso. On the recto, the manufacturer lined the aluminum skin with 2-ply conservation mat board.

Due to the size of the watercolors, it was not surprising that the widths of the panels within each set were not uniform. In fact, the top section of the longest set was eight inches shorter than the central panel just below it. For the exhibition in 2000, the Gatorboard panels were cut exactly to the size of each individual watercolor. This created a stair step horizontal edge when each set was hung on the wall.

For the current installation, the decision was made that it would be less visually distracting to have all the mounting panels within a set be the same width, especially since all the hinge paper had been toned to the same neutral hue. The height of each panel was sized to the individual watercolors. In addition, as previously discussed, all of the edges were uneven and out of square. To ensure that the irregularities of the watercolors would not impact the ability to align them properly on the wall, a buffer of half an inch on all sides was built into the measurements sent to Small Corp. With this bit of wiggle room, painted elements such as cracks that continued from one panel to the next could be more closely aligned to improve visual cohesion. The exposed neutral hinge paper around the edges—in most cases about an inch—was almost unnoticeable when viewed on such a large scale (fig. 3).

As was noted in the treatment section, BEVA film was used to both attach the hinges to the watercolors as well as to the exposed poplar on the backs of the panels. After the watercolors had been measured, custom strips of BEVA film were cut to follow the irregular edges and tacked to the canvas or paper backings on the verso of the watercolors. Half-inch strips were used for the fifteen smaller watercolors, and three-quarter-inch strips were used for the six larger watercolors. The hinge paper was given a feathered edge and laid out along the edges of the watercolor over the BEVA film. The film was activated by applying light pressure with a tacking iron set at 76°C for fifteen seconds. To mount the watercolors to the panels, a strip of BEVA film was lightly adhered to the exposed poplar on the verso of the panels. The placement of the watercolors was determined from the front, and then the watercolors were laid face down with the aluminum panels on top. The panels were weighted and the hinge paper wrapped to the back and attached to the poplar strips with the tacking iron.

**Micro-fade Testing**

With the knowledge that the watercolors could be on display indefinitely, the team had to devise a way to measure if and when the pieces might need to be rested from exhibit. To this end, the IMLS grant was written to include non-destructive micro-fade testing of the pigments. In January 2009, Dr. Paul Whitmore, conservation scientist and director of the Art Conservation Research Center at Carnegie Mellon University in Pittsburgh, PA brought his equipment to the ICA in Cleveland and performed micro-fade testing of the pigments in the watercolors chosen for study.
One minute of micro-fade testing approximates one year of gallery conditions, or eight hours/day of exposure to light at 50 lux with ultra violet and infrared filtered out. The test results showed that most of the pigments in these watercolors were fairly stable. The greens, blues, yellows, and purples were slightly affected by light, roughly equivalent to blue wool three on the standard scale. The reds were somewhat more sensitive, with most of the reds roughly equivalent to blue wool two or three. Two of the reds tested in some of the smaller watercolors were very unstable, roughly equivalent to blue wool one or two. Tests on unpainted paper indicated that the paper was also slightly sensitive to light in the range of blue wool three (Whitmore 2009).

Even though the test is called a micro-fade test, Dr. Whitmore is measuring any change in the tonality of a pigment, based on color shift comparisons with the blue wool samples used to calibrate the machine at the beginning of each day. In some instances, as was the case with the reds in these watercolors, pigments may shift to a darker tone, contrary to what the term “fading” might suggest. It is well known that some reds darken with exposure to light, specifically pigments containing red lead and vermillion. According to Barosso’s letters, she used Winsor and Newton watercolors imported from England. Phil Jones, Group Research and Development Director for ColArt Fine Art and Graphics in London, the owner of Winsor and Newton, checked the archives and found that watercolors from the mid-1920s would have contained various grades of vermillion (Jones 2010), supporting the findings of the micro-fade tests. In contrast, the paper did not darken with exposure to light as many papers do, but rather became lighter during testing, indicating the possibility that the paper could bleach out with excessive exposure to light.

LIGHTING AND GALLERY DESIGN

Even before micro-fade testing was carried out, Kelsey Museum staff members were concerned about the long-term effects of light on the watercolors. Planning for the Barosso watercolor room began as long ago as 2003, when the Kelsey Museum received a generous donation from longtime patrons Ed and Mary Meador to construct a new gallery and collections facility. From the very beginning, the Museum focused on proper display and housing for the watercolors when designing the new building, the William E. Upjohn Exhibit Wing (named for Mary Meador’s father). An area of the second floor, near exhibit galleries on Roman Italy, was set aside to house the watercolors. Curators at the Museum wanted to remain true to Kelsey’s vision of giving viewers the experience of visiting Room 5 at the Villa of the Mysteries, so a rotating display of selected watercolors was rejected. Given the size of the watercolors, repeated temporary exhibitions of the entire set, followed by long rest periods, did not seem like a practical solution either.

In the galleries, open-storage was planned to make more of the Museum’s collection available to visitors. Many display cases were designed to have study drawers beneath the vitrine. Visitors could pull out the Plexiglas-topped drawers to view, for example, a large selection of brightly-painted mummy masks, or sandals from ancient Egypt. For the so-called Barosso Room, the Museum decided to take a similar hybrid approach to the question of display versus storage; they elected to do both simultaneously. The result is a room which can be open to the surrounding galleries and function as part of the permanent exhibition, or it can be closed with the watercolors installed on the walls, but still accessible to visiting scholars and students.

Lighting in the room is provided by light emitting diode (LED) lamps, which do not produce light in the ultraviolet spectrum, as well as by MR16 floods with ultraviolet filters. To further protect the watercolors from light, all lighting for the room is motion-activated. Visitors activate the room lights by crossing through the threshold of the door, and the lights remain on only as long as the motion-detector senses movement. Two other sources of light, a backlit photograph in the room’s “window” (the photograph is of a Roman-style garden) and a display case which faces the room’s door, are also motion-activated. The window light is activated along with the rest of the room lights, while the case light turns on only as long as a visitor remains in front of the case; a motion detector is located in the case’s base. The room is lit to a mere 3 foot candles, or 30 lux, but due to careful control of ambient lighting in the surrounding galleries this low light level appears surprisingly bright. So bright, in fact, that several of the Museum’s curators expressed concern about the high light level!

The Museum’s closed-circuit television system records when the room’s lights turn on and off. Examination of the recordings reveals that the lights are on for an average of 55 minutes per day and a total of 6.5 hours per week. Thanks to the findings of Dr. Paul Whitmore, Kelsey Museum conservators will be able to correlate any changes to blue wool cards, placed discretely in the room, with actual changes to the watercolors.

INSTALLATION

The Barosso Room was designed and built to replicate Room 5 of the Villa of the Mysteries, with a large door and window built in, as they were in the Villa. The room was carefully scaled to the watercolors, a design feature which contributes to the feeling of being present at the Villa in Pompeii. Of course, this also made installation of the mounted watercolors a challenge, since there was very little room to maneuver in this tight space.

The fifteen smaller watercolors were mounted to their panels at the ICA. Because the six larger watercolors were too long to be transported safely on the panels, they were rolled around two foot diameter, Tyvek covered Sonotubes.
for transport and mounted on-site at the Kelsey Museum. Prior to ordering the panels, the team met in the new galleries for a walk-through to determine the best way to allow for both the alignment and attachment of the sixteen and twenty foot long panels in the space. Because the Barosso Room is on the second floor, there were questions about the feasibility of moving twenty foot panels through the loading dock, around a tight corner, up the stairs, and ultimately into the gallery. Initially the idea was to order the longest panels in two sections and join them in the gallery prior to mounting. Fortunately, during the initial walk through, the team discovered that it would be possible to maneuver a twenty foot panel through the space allowing Small Corp to manufacture them as continuous panels.

To permit the ICA team to complete the mounting and installation of the watercolors in-situ, the Kelsey Museum left several walls in the adjacent gallery unconstructed. This allowed for the use of the floor space in that gallery and provided an unobstructed path into the room. To mount the six largest panels on-site, a table capable of accommodating the panels was constructed from plywood mounted on saw horses and covered with thick blotters. The panels were aligned on the floor in one gallery, mounted on the table in another, and finally installed in the Barosso Room (figs. 4–5).

It was during the mounting and installation that additional advantages of BEVA film were revealed. During the mounting, the hinge on the longest top panel had to be replaced to accommodate the eight inch difference between it and the adjacent panel. Because there was no place large enough at the ICA to lay the panels next to each other, it had not been possible to determine where the space would fall prior to the alignment at the Kelsey Museum. Once the two panels were properly aligned, the gap fell entirely to the left edge, requiring the five inch hinge attached two months prior at the ICA be replaced. With a moderate application of heat, the hinge was easily removed. Because there was no moisture involved, a new hinge was attached and ready in less than an hour.

Another advantage was that the ICA team could attach the film to the poplar edges of the largest panels before arriving at the Kelsey Museum, significantly reducing the time needed on-site. In addition, after allowing the watercolors to acclimatize to the conditions at the Museum, adjustments could be made to the tension of the watercolors on the panels where necessary. With the watercolors weighted face down, any slack could be taken in by warming the BEVA film and gently pulling the hinges tighter. While it was never the intention to have the watercolors drum tight, it was also undesirable to have the watercolors sag on their mounts.

While some members of the team mounted the larger panels, the smaller panels that had already been mounted at the ICA could be installed by the remainder of the team. A simple wooden cleat system was used to attach the watercolors to the wall, and an eighth inch gap was left between the
panels in each set so they would not be resting directly on each other (fig. 6). This meant that the panels had to be installed from the bottom up and there needed to be enough room left at the top to lift the last panel up and over the cleat without bumping into the ceiling. The cleat system also allowed for the smaller watercolors to be easily removed from the wall and the tension adjusted where necessary.

CONCLUSION

From the time the watercolors were loaded onto the truck in Cleveland following treatment to the time they were on the wall in Ann Arbor, five people spent four days working normal business hours. The short time frame was made possible by the amount of planning and preparation that was done prior to arriving at the Kelsey Museum. Several aspects of the project were altered during the initial walk-through of the space, including the areas of the galleries that were to be left unfinished and the discovery that the largest panels could be fabricated in full by Small Corp. The close coordination between the conservation and installation staff at the ICA and the conservators and design team at the Kelsey Museum was integral to the success of this project.

In addition, this project highlights the advantages of BEVA film in mounting oversized objects to panels, reducing the chances of distortion and allowing large works to be mounted in-situ. The open nature of the labs at the ICA allows for cross-pollination of techniques and collaboration between textile, objects, paintings, and paper conservators. BEVA film is not often used in paper conservation, and, while it may not be appropriate in many cases for hinge to object attachment, it is a great option for hinge to panel attachment. The use of BEVA film as a hinging adhesive was not only a more stable choice for these watercolors, but also considerably less difficult to manage on such a large scale than a wet process.

These watercolors are a significant part of the Kelsey Museum’s collection and to have them displayed in the new galleries, finally bringing the dream of Francis Kelsey to fruition, was a wonderful opportunity that could not be missed (fig. 7). Overall, this project was a great success despite, or perhaps because of, the unwieldy and sensitive nature of the watercolors which were its focus. It highlighted the benefits of cross-disciplinary collaboration not only between conservators, but also exhibit designers and technicians, as well as curatorial and public programs staff members. The responsibility of all involved was to display these watercolors in such a way that honored the Museum’s mission to be good stewards.
of cultural heritage while providing access to these incredible works of art for many years to come.

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• The Kelsey Museum of Archaeology and the University of Michigan.

REFERENCES

Archives of the Kelsey Museum of Archaeology, Papers of the Kelsey Museum of Ancient and Mediaeval Archaeology and Francis W. Kelsey, Bentley Historical Library, University of Michigan.


SOURCES OF MATERIALS

Japanese paper for hinges—Yukyu-Shi Medium
Hiromi Paper
2525 Michigan Avenue
Santa Monica, CA 90404–4091
(310) 998–0098
http://store.hiromipaper.com

BEVA 371 film
Conservators Products Company
PO Box 601
Flanders, NJ 07836
(973) 927–4855
http://www.conservators-products.com

Aluminum honeycomb panels faced with 2-ply conservation mat board
Small Corp
P.O. Box 948
Greenfield, MA 01302–0948
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Identification of Historic Pigments by Direct Microscopical Visual Analysis

ABSTRACT

Although it is believed that the eye can discriminate millions of colors, the perception of them is produced in the brain. Fortunately, for the scientific analysis of artists’ materials, paint is a physical substance produced on Earth. Here, there are far fewer choices—namely a hundred common pigments or so—that can be grouped loosely by colors commonly found in nature and pleasing to the eye: blue, green, yellow, orange, and red, together with neutral colors like brown, black and white. Within each color group, there are usually only about a dozen or so common possibilities.

Each pigment has its own shape, size, color, refractive index, birefringence, etc., and, therefore, it is distinguishable from all others microscopically by direct viewing with the polarized light microscope (PLM). There is no video or digital imaging, chart recording, or computer printout that needs to be interpreted. Because the microscope enlarges each pigment up to the size we see everyday objects, it frequently leads to the identity and the exclusion of all others. Particles with the same or differing color and quality, or mixtures of pigments, are easily recognized. Results from the PLM produce a narrow range of likely choices requiring far less time and expense by comparison to other indirect, non-visual methods. The microscopist only needs to prepare the dispersion, properly learn the pigments, and look through the PLM first. A flowchart and key based on the one originally developed by Dr. Walter C. McCrone, and used to teach classes frequently offered by the McCrone Research Institute for the identification of pigments, will be presented together with descriptions for successful positive identifications using the Polarized Light Microscope.

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Afghanistan Digital Library: Conservation Challenges

ABSTRACT

The Afghanistan Digital Library is a collaborative cultural heritage project established to preserve the printed history of Afghanistan from the advent of Afghan book printing in 1871, through 1950. The project is led by New York University Division of Libraries and funded through the National Endowment for the Humanities and private foundations. The long-term preservation standards for digitization, metadata, imaging and storage were implemented to provide full and free access to the digital collection throughout the world. Private collectors and libraries throughout the world provided the texts for imaging.

Consultant conservators and the staff of NYU Division of Libraries Barbara Goldsmith Preservation and Conservation Department prepared the physical materials for digitization while working to ensure that all text and imagery were accessible. The majority of the volumes were stab sewn rather than sewn through the existing folds. If the text was obscured by the sewing, or by the limited opening of the text block, disbinding was necessary. Volumes disbound prior to imaging were rebound after digitization.

This paper describes how conservation treatment decisions were directly influenced by the access to the texts provided by the digital library. This paper will cover the various binding styles encountered and how the quality of the digitization effort allowed conservators to return the volumes to their pre-scan structures even though those structures often restricted content accessibility. The Afghanistan Digital Library project is an example of a complex global collaborative digitization effort that required conservators to re-examine assumptions and rethink the role of accessibility in treatment.

PROJECT BACKGROUND

In 2002, Robert D. McChesney, then New York University (NYU) Professor of Middle Eastern Studies and History at the Department of Middle Eastern and Islamic Studies proposed the creation of the Afghanistan Digital Library with the intent of providing free unfettered access to texts printed in Afghanistan from the advent of book printing there in 1871 through 1930. To support the project, Professor McChesney generated an exhaustive bibliography of works published in Afghanistan including monographs, serials and documents. Few of the publications in the bibliography are published in publicly accessible libraries or archives in the United States, Europe or Russia, and decades of war and upheaval have left the copies of the publications inside Afghanistan uncataloged and inaccessible (The Afghanistan Digital Library, 2004, 2005).

NYU Division of Libraries (NYU Libraries), with Professor McChesney as a project advisor, was awarded funding from the National Endowment for the Humanities, the Reed Foundation, the W.L.S. Spencer Foundation and the Gladys Brooks Foundation to create the Afghanistan Digital Library in 2005. In addition to some texts provided by NYU Libraries, publications indentified in the bibliography were borrowed from a number of private collectors and research libraries worldwide. Once received by the staff at NYU Libraries, the materials underwent conservation treatment when necessary and were cataloged, digitized and made publicly accessible through the Afghanistan Digital Library web-site (http://afghanistandl.nyu.edu/).

The project was expanded in 2006 to include a partnership between NYU Libraries and the Afghanistan Ministry of Information and Culture to allow for the digitization of publications in Kabul. Additional funding awarded by the National Endowment for the Humanities supported the establishment of conservation and digitization facilities at the National Archives in Kabul and the training of personnel by NYU Libraries staff and consultants. Digital image files generated in Kabul were forwarded to NYU Libraries for processing into the Afghanistan Digital Library.
Although external funding expired in 2009, the project continues and has expanded to include publications printed in Afghanistan until 1950. As of May 2010, full access is available to 383 Afghani publications through the Afghanistan Digital Library web-site. NYU Libraries is committed to the long-term preservation and continuance of the Afghanistan Digital Library. NYU Library staff continue to collaborate with private collectors and research libraries to digitize publications as they become available and carry out digital preservation activities to ensure long-term accessibility and preservation.

HISTORY OF PUBLISHING IN AFGHANISTAN

The fact that printing was not adopted in Afghanistan prior to 1871, is not surprising given the practical and social constraints at that time. Arabic script, the script used for the languages written in Afghanistan, is cursive and therefore presents a typographical problem for letterpress printing as spaces between characters comprise the legibility of the script. In Islamic societies, Arabic script and the act of writing are revered and scribes and calligraphers are esteemed professionals (Bloom, 2001; Schimmel, 1970). Only with the development of lithography, and later, offset lithography, was a printing technology available that allowed for the exact replication of script. Many of the initial publications in Afghanistan were lithographic reproductions made in the hand of revered scribes (Heravi, 1972). Lithography was widely adopted in the 19th century in Islamic societies for printing texts, except for the reproduction of the Qur’an, which continued to be mostly hand copied by scribes.

Printing in Afghanistan began in 1871 with the purchase of a lithographic press by the Amir Shir Ali Khan (r. 1863–1866; 1868–1879) and the publication of a tract against the Wahhabi movement. His successor, Amir Abd Al-Rahman Khan (r. 1880–1901), purchased a new lithographic press in India in 1884 and commissioned numerous works, including administrative manuals and propaganda addressing the geo-political situation in Afghanistan at the time. Texts that promoted Islam and the Amir’s reign along with warning about the dangers of the neighboring Christian imperial powers of Russia and Great Britain, as well as literary and historical works were printed.

The Amirs of the twentieth century expanded printing beyond Kabul to Herat and Mazar-i Sharif and published governmental degrees, laws, military manuals, text books, as well as historical, literary and scientific works. The majority of these publications were in the Dari Persian or Pashto languages, although some later works included texts in French and English. Subsequent printing developments included illustrated newspapers and periodicals.

DIGITIZATION WORKFLOW AND STANDARDS

Specific standards were selected for each aspect of digitization to ensure ongoing preservation and access of the Afghanistan Digital Library. The workflow for the creation of the Afghanistan Digital Library is based on the Open Archival Information System (OAIS) model, which is an open source conceptual model that allows for preservation of material, management of the material and delivery of content (Garrett, 2006).

Imaging standards used in the creation of the Afghanistan Digital Library allow for full representation of the appearance of the materials. To enable full color imaging a bit depth of three channels of eight bit color (often called 24 bit color) is used. The digitization stations are calibrated end to end to insure that the color of an artifact is correct on capture. The file masters are Tiff 6 uncompressed using a CIE RGB as its color space for master files. The long-term color stability of files is crucial and CIE RGB is among the few color spaces that has the following characteristics: it is non-proprietary; it is an open international standard; it is in broad usage; and it is a large color space.

Items are photographed at a pixel per inch setting that captures all surface detail and is responsive to the original object and the human vision system. Images are captured using either an Epson 10000dx flat bed scanner or a PhaseOne P65+ camera. Equipment is calibrated on a scheduled basis using a photo-spectrometer to insure that the entire system, the monitor, scanner and any peripherals are all calibrated. The targets are Xrite ColorChecker Chart by Gretag/Macbeth and either the Kodak Q-13 or Kodak Q-14. The PhaseOne P65+ hi-resolution camera allows the photographers enough control of the chip that calibration can be done directly to the camera with an appropriate target.

After image capture the master files are viewed in Adobe Photoshop to verify that the target values are colorimetrically correct. Upon creation, the master files are validated using Harvard University’s jHove tool. A cropped and straightened derivative-making file is created from the master. All access copies, either jpeg or jpeg2000 are made from this intermediary file and derivative jpeg files are produced.

NYU Libraries Digital Library staff collects and encodes extensive metadata at all points in the life cycle of a digital file to ensure its ongoing viability as a preservation master file. Descriptive metadata for the Afghanistan Digital Library project is provided by the Librarian of Middle East Studies in MARCXML, which is then converted to the metadata scheme MODS. Technical metadata on the files conforms to the Library of Congress MIX 2.0 and includes additional NYU defined fields. A METS Rights file is used to contain appropriate copyright information. All the metadata files are associated with the digitized assets through the METS file, which also provides the structural metadata and provenance.
information. The metadata files are kept separately from the master files but are united by unique identifiers.

Once all the metadata is assembled and the files are validated, the files are submitted to the NYU Libraries Preservation Repository. The files are actively managed by the NYU Libraries Digital Library team and tests such as check-sums are regularly scheduled to verify the authenticity of the files. Access to the files and descriptive metadata are provided through an HTML web-page. Images are currently presented as jpeg derivatives, and as a navigable jpeg2000 file. Users are able to download copies of the original TIFF as there are no access restrictions to the Afghanistan Digital Library.

CONSERVATION

All conservation treatments supporting the Afghanistan Digital Library, from September 2005 through August 2009, were developed, documented, and performed by consulting conservators funded by the National Endowment for the Humanities. During this time, 390 individual volumes were treated and/or rehoused in the Barbara Goldsmith Conservation Laboratory of NYU Libraries. After 2009, all conservation work has been carried out by the staff of the Barbara Goldsmith Conservation Laboratory.

To support the project goal of complete capture of the text during imaging, conservation treatments were performed on selected individual volumes. Conservation treatments were required when physical damage, planer distortions and restrictive binding structures prevented full image capture of the text. Treatments ranged from the intensive, such as disbinding, to the very slight, such as flattening dog-eared corners.

Copies of volumes described in Professor McChesney’s bibliography were identified and borrowed from individuals or institutions and deposited with the ADL Project Manager. The Digital Content Manager and the Conservation Librarian assessed each volume and when a volume required conservation prior to imaging, it was routed to the Barbara Goldsmith Conservation Laboratory for pre-scan treatment. Following digitization, items were routed back to the conservation lab for evaluation and necessary treatment. Individual custom boxes and folders were constructed for all pamphlets, paper-bound books and fragile bindings, which constituted the majority of the volumes.

From 2007 until 2009 the majority of the 390 volumes were treated in the lab by consulting conservator Georgia Southworth. The volumes treated were categorized into four distinct groups: pamphlets; western bindings; vernacular bindings; and Kabul Binder bindings. These groups were defined by their binding structures, materials, and type of treatment required for imaging.

The simplest volumes were either unbound or bound pamphlets of one to twenty pages. Some pamphlets had paper wrappers attached with staples or adhesives. The lithographically printed text blocks were composed of thin machine-made paper. Wrappers, when present, were either of the same stock as the text block, or a brightly colored and block-printed paper (fig. 1).

The volumes from the second group, lent to the project from a private collection, were bound in western style case bindings. The lithographically printed text blocks on off-white machine-made paper, in bifolia, were sewn though the folds, and tightly cased into full cloth cases. Some volumes had original wrappers bound as part of the text block. The bindings had relatively thick boards in relation to the size of the text blocks, with covering material of strong woven linen book cloth, and machine-made tipped on endpapers. These bindings usually had stuck on endbands and stamped leather labels adhered to either the spine or the front board. Although the text blocks of these volumes were sewn through the folds, there was clear evidence that previous stab sewing threads had been removed (fig. 2).

Volumes bound in Afghanistan using locally available materials in a consistent binding style were referred to as the vernacular bindings group. These bindings, though structurally similar, were highly individualized due to the variety of materials used in covering the boards. As with the previous categories, all of the text blocks were composed of bifolia, printed lithographically on thin machine-made paper, and stab sewn. None of the text blocks were rounded and
The bindings on the Kabul Binder volumes included in the project were not original to the text blocks. They exhibited signs of earlier sewing, evidenced by at least one, and sometimes multiple, sets of empty stab sewing holes. Some volumes included electrostatic copies, often of the title page, but occasionally of entire sections. These copies appeared to be replacements for damaged or missing leaves, most likely created and inserted to complete the lithographed texts.

Kabul Binder text blocks were newly stab-sewn through three holes with a double pass of thick stiff thread, knotted in back at the center hole. These text blocks were aggressively trimmed, stuck on endbands were adhered, and single bifolio endpaper sections of poor quality machine-made paper were tipped on to the first and last pages. Text blocks were cased into the bindings using just the newly added endpapers. The case bindings were covered with a blue-black plasticized textured bookcloth. Most volumes were blind stamped on the boards and some had bibliographic information written in white paint.

The final group of volumes was the most challenging in regard to conservation treatment. The contemporary bindings on these volumes were almost entirely uniform in style and appearance, and were bound by a bookbinder currently working in Kabul (fig. 4). The books bound by the binder, or under his supervision, are referred to here as the Kabul Binder bindings. During May 2007, when members of the Afghanistan Digital Library team traveled to Kabul and established conservation and digitization facilities at the National Archives they met the Kabul Binder. The project conservation consultant, John Dean, gained valuable insight into the Binder’s working practices and the materials used. According to Dean; “Local binding materials tend to be idiosyncratic because of the unavailability of conventional supplies. Local binding cloth is either made from Rexine (a furniture covering) or unsized cotton fabric from the market. Local adhesive seems to be regionally-made polyvinyl acetate, which is not internally plasticized, or a gum-like paste which sets very hard. Local board is from Pakistan and is very fibrous and absorbent and is designed to cater to the shoe making industry” (Dean, 2007, 2–3).

The bindings on the Kabul Binder volumes included in the project were not original to the text blocks. They exhibited signs of earlier sewing, evidenced by at least one, and sometimes multiple, sets of empty stab sewing holes. Some volumes included electrostatic copies, often of the title page, but occasionally of entire sections. These copies appeared to be replacements for damaged or missing leaves, most likely created and inserted to complete the lithographed texts. Kabul Binder text blocks were newly stab-sewn through three holes with a double pass of thick stiff thread, knotted in back at the center hole. These text blocks were aggressively trimmed, stuck on endbands were adhered, and single bifolio endpaper sections of poor quality machine-made paper were tipped on to the first and last pages. Text blocks were cased into the bindings using just the newly added endpapers. The case bindings were covered with a blue-black plasticized textured bookcloth. Most volumes were blind stamped on the boards and some had bibliographic information written in white paint.
PRE-IMAGING TREATMENTS

During the pre-imaging phase of conservation, minimally invasive treatment options were employed to permit full imaging of text and maintain the project timeline, while respecting the preservation needs of the objects. Treatments ranged from simple wheat starch paste mends of tears at risk of becoming more severe during imaging and mold remediation, to local humidification and flattening of text-obscuring creases and folds. More complex treatments involved the removal of old mends and adhesives in the gutters that concealed text, and the complete disbinding of volumes with particularly restrictive binding structures. Despite having text blocks made up of bifolia, the volumes were deeply stab-sewn, and the constraint of these volumes' opening action made imaging of the text impossible. A number of text blocks contained extremely water-soluble stamps or manuscript inscriptions. The stamps are important evidence of provenance. The few water-soluble stamps that interfered with aqueous removal of adhesives during disbinding were temporarily fixed with cyclododecane (Brückle et al. 1999).

The pamphlets were the least challenging for imaging and conservation. Staples, many of which were deteriorating, were removed to allow imaging on the Epson 10000xl flat bed scanner. Those held together with adhesives did not require any pre-imaging disbinding, as their leaves proved flexible enough to image without disbinding using the PhaseOne P65+ camera and a customized book cradle. The western style cased bindings were lent from a collector who rarely permitted conservation treatment as part of the lending agreement. Yet, with text blocks that were sewn through the bifolia folds, combined with the case binding structure, most of these borrowed volumes were flexible enough upon opening to allow scanning without requiring any pre-imaging conservation treatments. A small number of thinner volumes were returned to the lender without imaging as the bindings were too restrictive to allow imaging of the complete text.

The vernacular bindings were constructed from generally poor quality materials and revealed evidence of heavy use. They required extreme care during handling, as their conditions included delaminating and bumped boards, torn and delicate papers within the text blocks, deteriorating cloth coverings, and weakened or broken joints and hinges. Treatments included bridging or mending tears in pages that might worsen with handling, using sympathetic kozo-fibered Japanese papers and wheat starch paste, mold removal with a HEPA-filtered vacuum, and the stabilization of headcaps or board corners at risk of further damage. Endpapers tipped onto the front and back of the text blocks very often obscured text. Testing revealed that the adhesives were water soluble. Lifting the tipped-on leaves was best achieved using poultices of warm deionized water and/or a three percent solution of methyl cellulose. Cyclododecane was employed to fix water soluble stamps in the text blocks of the vernacular bindings when necessary. Careful monitoring of water temperature during aqueous treatment was required to avoid exceeding the melting point (60.7 °C) of the cyclododecane fixative (Kremer, 2005).

As stated earlier, the Kabul Binder bindings presented the greatest conservation challenge in the project. The restrictive binding structures and tipped on endpapers hindered imaging of the text. When it was not possible to find other copies of these works in less restrictive bindings, the volumes were disbound. The Kabul Binder bindings were constructed with newer materials, using a tenacious adhesive, stiff new threads and tight stab-sewing, all of which slowed down disbinding. The binding adhesives were not water-soluble, but did swell in warm or hot water. This swelling was likely assisted by the relatively recent application of the adhesive. Swelling the adhesives combined with mechanical action successfully released the adhered pages allowing for full text imaging using either the Epson 10000xdl flat bed scanner or the PhaseOne P65+ camera.

POST-IMAGING TREATMENT

Following digitization, volumes that had been disbound were returned to the Barbara Goldsmith Conservation Laboratory to be rebound. Pamphlets were sewn with protective acid-free, medium weight paper wrappers (Zerkall Nideggen) through the original staple holes with tackets of linen thread. If the staple holes required mending prior to resewing, repairs were made with kozo-fibered Japanese paper and wheat starch paste. Rebinding the disbound Kabul Binder volumes and some of the disbound vernacular bindings was complicated by the fact that the original structures hindered access to the text. In some cases, the sewing threads passed directly through text. Rebinding the volumes in a manner that would allow full readability needed to be weighed against preserving the integral qualities of the volumes without radically altering the structures and materials. While the grant stipulation required returning borrowed volumes to their original structures, the majority of the disbound Kabul Binder and disbound vernacular volumes belong to NYU Libraries allowing for more flexibility in post-imaging treatment. Though some of the sewing may not have been original to the text blocks and restricted text access, the bindings as a group are a tangible example of hand bookbinding in the 20th and early 21st century Afghanistan.

Conservation in consultation with Afghanistan Digital Library Project staff and NYU Libraries special collections curatorial staff decided that the binding structures should be preserved rather than rebinding the volumes in conservation style bindings. The Afghanistan Digital Library’s preservation quality images and commitment to ongoing access informed this decision. While rebinding the volumes in their original
structures would hinder physical access, the digital library images provided are adequate surrogates.

Given the poor quality of the boards in the Kabul Binder volumes and the discovery from surface pH tests that the endpapers were acidic, a decision was made to rebind these volumes in the post-scan treatment phase with new endpapers. This treatment involved applying new acid-free, lignin-free, buffered endpaper bifolia that physically resemble the Kabul Binder endpapers. It is important to emphasize that these endpapers visually resemble the discarded endsheets and serve as an important physical barrier, blocking direct contact between the binding boards and the text blocks. The final treatment protocol was to resew the text blocks through the existing sewing holes with hand-softened linen thread. The bifolio endpapers and medium weight Kitikata Japanese paper hinges, used to strengthen the case binding attachment, were bound with the text block. Wheat starch paste was the adhesive used in the attachment of the hinges and endpapers to the case.

The sewing holes were very rarely perpendicular to the text block resulting in a difficult rethreading of the sections. For thicker texts, a sewing jig was created out of an Ethafoam base with a binders’ board deck to accommodate the text block. Resewing through the angled holes of the text blocks was eased by the ability to set pre-threaded binding needles into the Ethafoam at the angles of the stab-sewing, and to then ease the end sheets, hinges, and bifolia onto the deck one by one, recreating the text block. (fig. 5).

CONCLUSION

Conservators are well aware of the influence that digital imaging requirements have on pre-imaging treatment of bound volumes, often requiring invasive treatment processes such as disbinding. As access to the physical text is no longer a primary objective, conservators are free to employ more conservative treatments in the post-imaging treatment phase. Providing a preservation quality digitally imaged record allows conservators to approach the volumes under consideration as artifacts to be preserved and not exclusively as volumes to be rendered accessible to scholars interested in the content. Conservation treatment decisions can be directly influenced by the high quality access provided by the digital library, and more specifically, the quality of the digitization effort allows conservators to return the volumes to their pre-scan structures even if these structures restricted content accessibility. Thus content and artifact are preserved with limited compromise.

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NOTES

1. All reflective items 8 x 10 inches or smaller are photographed at 600 ppi; items larger than 8 x 10 and smaller than 12 x 18 are photographed at 400 ppi; items larger than 12 x 18 are evaluated individually and often such items need to be photographed in sections resulting in several master files associated with one item, which are then stitched to create a use file that represents the object.
2. The pseudonym Kabul Binder is used to protect the identity of the individual.
3. The team included Melitte Buchman, New York University Digital Content Manager, Peter Magierski, New York University Middle Eastern Studies Librarian, and John Dean, Project Conservation Consultant.

4. It is estimated that the majority of the Kabul Binder volumes included in the project were bound within a year or two of treatment.

REFERENCES


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INTRODUCTION

Groups of individual pamphlets bound as books have often been later broken apart in the name of conservation, cataloging, access, or the ability to sell duplicates. Between 1994 and 1996 I worked as grant funded project conservator on a collection of over 300 damaged bound pamphlet volumes. The grant specified treating the bound pamphlets as books, and rejected the option of disbinding. This paper will assess the observed functionality of these treatments after twelve years, including information about the actual use each volume has received since treatment. Observed natural aging of long fiber paper board-reattachments, and traditional leather re-backs will be discussed. Beyond the technical treatment observations, the overall question of disbinding bound-pamphlet volumes will be examined, using casual comments from historians, special-collections librarians, conservators and rare book dealers.

USE BEFORE 1996

The Huntington Library purchased the collection Bridgewater bound pamphlet collection in 1917. In the 79 years between 1917 and 1996, each book of pamphlets was used a median of 36 times, or .45 times per year. This use included microfilming, and the removal of duplicate pamphlets for sale. The highest use for a single volume in the collection between 1917 and 1996 was 180 times.

USE BETWEEN 1996 AND 2009

After 1999, with the advent of full text access to the contents of many of these bound pamphlets through the Early English Books Online, there was speculation that use would diminish. This was not the case at the Huntington Library with these bound pamphlets. Between 1996 and 2009 when the NEH funded treated bound pamphlets were examined for this research, the median use was 6.5 over the 13 years, or .5 times per year. The highest use for a single volume in the collection between 1996 and 2009 was 35 times. There has been a slight increase in both the median and highest use figures for the bound pamphlet collection since the collection was treated in 1996.

TREATMENT FAILURES

Out of the 134 long fiber board attachments from the project examined in 2009, 3 had a board completely detached, for a 2% failure rate. Out of the 73 textblock consolidations/leather rebacks examined in 2009, none had failed. This confirms the general conclusion that long fiber paper board hinging is adequate to the task of board re-attachment for special collection materials, especially given its speed and minimal intervention into the original book structure. Leather rebacking here had no failure rate after 13 years, though it will be important to examine its failure rate after a longer period of time has passed.

COLLECTED PAMPHLETS BOUND AS BOOKS: DIFFERENT PERSPECTIVES

A call for responses from the library, book history, and conservation community on the topic of special collections pamphlets collected into groups and bound and was issued in the Conservation Distribution List and the SHARP (Society for the History of Authorship, Reading and Publishing) List serve. Several responses were summarized in this talk. Logistically, some institutions favored leaving the bound pamphlets intact until special circumstances of use required disbinding. Some discussed the shelving problems presented by disbound pamphlets kept in slender, easy to lose pamphlet binders, and problems with older, acidic pamphlet binders proving more damaging to the pamphlet pages than the binding structure they had been removed from. A general sensitivity to the material culture tradition of putting collected pamphlets into bindings was found in many
responses from book historians, librarians and conservators. The importance of saving the original contents list, notes on the endpapers and binders tickets was emphasized. The ethical problem of disbinding bound pamphlets was central to responses from rare book dealers influenced by John Carter in his *ABC for Book Collectors*. Some libraries are using digital tools to reunite collected pamphlets routinely disbound for cataloging many years before.

CONCLUSION

After 13 years of natural aging and use in a special collection setting, the examined bound pamphlet volumes from this NEH project show standard long fiber paper board attachment and rebacking as a textblock consolidation techniques are both working as expected. Despite speculation to the contrary, in this Huntington collection the availability of digital tools for researchers has not yet diminished physical use. Responses to the problems of bound pamphlets, shared in this talk by librarians, book historians, and conservators working with special collections, emphasized bound pamphlets as complex entities. Disbinding was to be considered as an option resulting in practical and ethical problems, as well as an option sometimes affording enhanced access to the contents of the pamphlets.

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Reading Between the Lines:  
Would You Know Invisible Ink If You Saw It?

ABSTRACT

Many people dismiss sympathetic inks, more popularly known as invisible inks, as a novelty or amusement, of interest only to spies and schoolchildren. In reality, their use may have been much more widespread, and even today they are a part of popular culture, as witness the phrase “reading between the lines,” which refers to the practice of writing invisible ink messages in between the lines of innocent looking correspondence written in ordinary ink. Recipes for making these inks have been available in published sources since the 15th century, and some are even now finding new audiences through the internet. Formulas for sympathetic inks have appeared in chemistry textbooks for centuries to illustrate chemical reactions to students, and this use still continues in science classes.

Chemically, many sympathetic inks are related to the materials of early photography, document copying, and dyeing, and also to the so-called security or safety inks and papers used to prevent forgery and counterfeiting. In recent decades, especially as fluorescent and infrared-readable inks have been introduced, there has been a resurgence of interest in sympathetic inks, as a security measure for printing business and official documents, as well as for marking property. This paper will present a brief history of the most commonly used sympathetic inks, their treatment in scientific and more general literature, and their connection to various branches of arts and sciences, plus some of the modern developments. The experimental section will include examples of writing done with the most commonly cited formulas as a visual reference; it will also demonstrate how to detect developed and undeveloped sympathetic inks on paper through modern non-destructive forensic methods.


ABSTRACT

Chemical analysis was the only readily available method for testing materials in the conservation lab when I began a conservation career in the late 1970s. Many conservators saw reference resources such as Browning’s *Analysis of Paper* as the “Holy Bible” for conducting chemical tests for paper fibers, adhesives, resins, and coatings that are associated with paper-based objects. It is still an extremely useful resource for a paper conservator, but the destructive nature of chemical analysis is a drawback. The results aren’t always conclusive either, and only a very limited amount of information can be derived from such a test. Polarized light microscopy is also available, but it’s a destructive technique and the resulting information is somewhat limited.

Technical analysis has come a long way since the 1970s. Progress in the 21st century has brought advances in spectrographic instrumentation, bringing conservation analysis into the realm of the practical. It has resulted in producing research-grade instrumentation that is small, compact, and relatively inexpensive, yet as sensitive in data gathering as the full-size bench top units. The pint-size instruments are also extremely simple to use. Spectroscopic analysis is nondestructive in many cases and sampling takes hardly any time at all to perform. It provides a comprehensive analysis of materials.

The paper conservation lab at Princeton University Library has acquired a number of spectroscopic instruments over the past several years that are small in size yet powerful and economical. This paper will review the practical capabilities of analytical equipment that is presently available and demonstrate their everyday use in the conservation lab. Spectroscopic techniques such as fiber optic Raman, FT-IR/ATR, FT-IR/DR, and fiber optic UV/VIS for analyzing various paper-based objects will be covered.

A Survey of Leather Conservation Practices

ABSTRACT

A survey of leather conservation practices was sent out to fellow conservators as well as allied professionals via various Listservs. The goal of this survey was to ascertain what types of treatments and repairs were currently being practiced on leather bindings in a variety of professional settings. The authors wish to present the results of this survey and analyze them to show the continuum of leather treatment within and without the conservation community, highlighting not only emerging trends and established treatments, but also when, why, and by whom more traditional treatments, such as leather dressing, are still being practiced.

The scope of the survey collected data in four areas. The first series of questions collected information on the survey respondents. The second collected data on different methods of repair for leather bound books and the different types of materials used for those repairs. The third set of questions collected information on materials used in treatments of original leather bindings, focusing on frequency of use of materials such as adhesives, dyes, surface consolidants, lubricants, and cosmetic surface treatments. The last set asked this same series of questions, but in regard to treatments on “new” leather used as a repair material.

The survey gathered detailed data from 57 respondents, many of whom are conservation professionals and support staff, but also with significant responses from library preservation staff, special collections professionals and staff, and book dealers. The results show that newer leather treatments are being integrated by conservation and its allied fields, but that traditional treatments such as the application of leather dressings and cleaning with saddle soap are also still used. Further analysis of how these respondents received their training may show a direct correlation between educational experience and the types of treatments they undertake, as well as other trends.

Conservation of a Series of Mural Cartoons:
High Hopes on a Low Budget

ABSTRACT

This paper outlines the challenges faced by a regional Canadian museum to undertake the conservation of a significant set of works in its collection. Resources for museum projects that exceed the limits of the budget and exhibition schedule are never easy to find. Such is the case for the conservation treatment of the New Brunswick Museum (NBM) Saint John Tuberculosis Hospital mural cartoons (1941–42) by Saint John New Brunswick Book and Paper 20 artist Miller Gore Brittain (1912–1968). Miller Brittain is amongst Canada’s most important twentieth century artists; the cartoons are the crowning achievement of his pre-war career.

Depicting the causes, effects, treatment, and cure of tuberculosis, Brittain’s compositions are developed to varying degrees using layers of fabricated chalk and fixative. Each of the eleven cartoons measures approximately nine feet square and is made up of three nine-foot lengths of Kraft paper, joined with gummed brown-paper tape. Where the tape has failed or the paper is torn, the drawings have been previously and extensively “repaired” with masking tape. These are not uncommon condition problems in the field of paper conservation. However, the scale of a conservation project to address this damage is daunting. Not until 2006, when the cartoons were examined and their condition was assessed for the first time in over twenty years, was a treatment plan possible.

After a brief introduction to the NBM and to Miller Brittain and his work, this paper will describe the multi-phase conservation treatment plan for the cartoons. The first phase, the development of a treatment protocol, was completed in 2009 in the context of the Canadian Conservation Institute (CCI) Visiting Professionals program. The author will describe the research and development of the treatment protocol as well as plans for future phases of the project.

Calcium Phytate Treatment on 19th Century Iron Gall Ink Documents:
Overall Summary of Research Results and Implications on Treatment Decisions

ABSTRACT

The effectiveness of calcium phytate in protecting works on paper containing iron gall ink has consistently been demonstrated since its first introduction by Neevel in 1995. In July 2007, an optimal procedure was published by the Netherlands Institute for Cultural Heritage (ICN), with details, among other topics, about the pros and cons of the treatment. Nonetheless there are still reservations and discussions about if and when this treatment should be used. In 2002, nine original iron gall ink documents, typically found in Canadian Archives, were subjected to 18 separate aqueous treatments comparing the standard calcium phytate—calcium bicarbonate (Ca-phy Ca(HCO₃)₂) treatment to deacidification with Ca(HCO₃)₂ and magnesium bicarbonate (Mg(HCO₃)₂), paper simmering, and other modified phytate treatments. Five sets of these treated samples were further subjected to exposure to heat and humidity (80°C, 65%RH, 8 weeks), high intensity light (3.71Mlux-hr, 14–40W Vitalite fluorescent tubes, no UV filter), and elevated humidity at room temperature (85%RH, 22°C, 22 weeks). Changes were evaluated against unaged or untreated controls. Methods of evaluation include hyperspectral imaging, colour measurement, pH, bathophenthroline test and microfade testing. Results from this study have previously been reported in part in different venues as they became available. This paper will present a summary and overview of all the results, including those from microfade testing, and will present the key conclusions from this study that will help conservators make decisions about when phytate is most beneficial.

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Think Oversize! The Challenge of Mounting, Installing, and Storing Very Large Contemporary Works of Art on Paper During Times of Constraint

ABSTRACT

With the opening of newly built contemporary galleries at the Art Gallery of Ontario, the opportunity to showcase some unusually large contemporary artworks was enthusiastically embraced. A variety of oversize works on paper were requested for the inaugural exhibition and the success of these installations has opened the door for further requests on an ongoing basis.

Tasks associated with the examination, documentation, mounting, installation and storage of these artworks ranged in complexity and required interdepartmental participation during a very busy pre-opening period and later with reduced staff after opening. Innovative systems were developed and implemented along with use of typical conservation methods and materials. Decisions were affected by financial, time, and space constraints.

This presentation and paper will follow the process of examination to installation and storage of a number of contemporary works ranging in size and varying in materials. The largest works are an unframed collage on Mylar 25 feet by 11 feet and a temporary mounted/framed hand coloured aquatint, in six sections 2.5 feet x 17 feet long. The suitability and success of the materials, techniques, and systems used are reviewed and discussed. Extensive photographic documentation and diagrams are provided for both the presentation and publication.

JOAN WEIR
Conservator
Works on Paper
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The Book and Paper Group Annual 29 (2010) 83

The speakers covered a broad range of challenges and solutions. In addition to their presentations, participants provided handouts with further information and resources and ended with a question and answer session. A summary of each presentation and the resultant discussion is provided below.

MICHAEL LEE
OPERATING A REGIONAL CENTER IN THE PRIVATE SECTOR DURING AN ECONOMIC DOWNTURN

The first speaker was Michael Lee, Director of Conservation at Etherington Conservation Services (ECS), in North Carolina. Lee shared his insight into the operation of a regional center in the private sector during an economic downturn. To start, Lee emphasized the importance of keeping the employees safe, happy, and productive. The company must be clear about what to expect from staff. A single bad decision can result in poor morale, as well as loss in productivity and business. The company should trust that the staff is on its side and the staff should trust that decisions are made in their best interest. Clear direction helps everyone stay motivated, and those in charge of staff must serve many unexpected functions, including cheerleader, jester, sage, and mentor, keeping things fun and making sure the job is enjoyable. Additionally, Lee stressed that it is very important for those in charge to earn respect by demonstrating that they do work at the highest level. Motivation and productivity is lost as soon as technicians start questioning the ability of those above them.

Next Lee defined what a regional center is, including the services offered. Regional centers, whether non-profit or for-profit, are businesses, varying from other familiar cultural institutions. For-profit businesses such as ECS are not entitled to grants so the conservation and preservation services they provide are the sole source of income. Lee stressed that there is no magic involved in running a center, but much hard work and persistence keeps the business running, especially when extremely difficult decisions are made. The most difficult decisions typically relate to staffing levels. A significant
part of the overhead is labor, and those in charge must look after their staff but they must also let them go for the greater good and well being of the company. Lee emphasized that this is extremely difficult.

Lee provided some basic principles to follow for optimum success, which are applicable beyond a regional center. One should treat everyone equally and fairly and focus on the group. It is also important to match a staff member’s skill level to the type of project assigned in order to make best use of time and resources. Ensuring that the appropriate time is allocated for a project is also important, with the goal of never over-estimating. When it comes to clients one must define and meet their needs and personalize the service, defining client value. Clients should be given options and they must make the final fiscal decision. It is also important to reinvest in the staff and company when funds allow. Professionalism and integrity is of the utmost importance, and Lee stated that one must never compromise on quality in order to save money. In conclusion, Lee provided sound advice when he reiterated how important it is to clearly state project priorities, develop a standard work methodology, incorporate the lessons learned from past challenges into daily work and apply them to future projects, and always keep an open mind to new business ideas.

Michael Lee, Director of Conservation, Etherington Conservation Services

SUSAN LUNAS
BOUND AND DETERMINED: CHALLENGES IN PRIVATE PRACTICE

The second speaker was Susan Lunas, Chief Conservator at Many Moons Book Conservation in Oregon. Lunas clearly illustrated what life is like as a private book conservator who must also serve as the sole breadwinner. The largest challenge lies not in treatment but in simply running the business. A private conservator must wear many hats and carefully balance personal and work life. It is difficult to find balance when working out of one’s own home. Lunas has discovered the importance of outside hobbies to take care of stress relief. Another challenge common to all private conservators is cash flow. When an item requires many hours of treatment, money may not come in for long periods of time. In order to face these challenges Lunas has developed techniques for working faster and more efficiently and has looked at ways to supplement her income. There has been a noticeable decline in business during the past few years, with the number of clients decreasing between 2008 and 2009. Lunas also addressed a pertinent issue that many conservators face today—a spouse or partner loses his or her job due to the poor economy resulting in the family relying on the conservator’s sole income.

Along with herself, Lunas discovered that several colleagues became the sole breadwinner within the past year.

Additionally, marketing to find new clients is a challenge. When Lunas moved to Eugene, Oregon there was already a well-established book conservator. Once this conservator retired Lunas was able to take over the business, which provided new opportunities to develop her clientele. A listing in the yellow pages did not prove to be as useful as Lunas originally hoped, so she decided to invest in a website. Trading work with a web designer allowed for Lunas to develop a website she may not have been able to afford otherwise. Ultimately her workload went from twenty or thirty clients to over seventy with the help of taking over the business of an established conservator and marketing online.

When working with such limited resources, Lunas had to think of how she could outfit her studio with the necessary equipment in the most economical way. She successfully acquired equipment from an estate sale, created a washing table out of a shower floor and bathroom vanity found at a recycling center, made use of her husband’s carpentry skills to build a combination press, portable vacuum table, and light table, and scoured through used office stores for other useful and adaptable furniture. When small hand tools are required Lunas uses shaped popsicle sticks for paper splitting and lifting, a street sweeper bristle shaped into a microspatula, and watercolor fan brushes for paste and glue, which are easier to clean. She emphasized that with some adaptations she is still able to use the same equipment found in any lab, even within her limitations.

Lunas explained that the majority of her work includes family and hand bibles, religious texts, halftone prints, cookbooks, marriage certificates, and etchings. She shared a few tips that have helped with speed and efficiency, including using her fingers to achieve a more controlled lifting of pastedowns, using bulldog clips to hold down lifted leather or cloth while re-backing large books, and using cork to remove sticky tape residue. She must always think of ways to adapt treatments to fit the budget and intended use. Lunas explained that some clients are difficult, especially when it comes to demanding fast turn-around time. As a result she charges a rush fee to cover this problem. She also expressed her grief over losing an elderly client by the time a treatment was completed, which is something that is not typically addressed by conservators in private practice.

In order to keep her skills current Lunas attends the AIC meetings and currently serves as an officer for the Conservators in Private Practice (CIPP) group, looks for workshops, and consults her personal conservation library as well as colleagues. The isolation of working privately can be extremely difficult. She reaches out by giving presentations at universities, senior groups, and regional conservation gatherings. She also emphasized how invaluable phone calls to fellow conservators can be in order to discuss challenges,
clients, and treatments. She formed a bookbinding group, which meets once a month to share techniques, vendors, suppliers, and discuss terminology. In order to get out of her studio, she also volunteers at the Oregon Genealogical Society’s book repair unit, where she supervises other volunteers in book repair. Despite many challenges, Lunas has used her creativity, determination, and flexibility to run her private business through difficult times.

*Susan Lunas, Chief Conservator, Many Moons Book Conservation*

**WENDY BENNETT**  
*CONSERVATOR: SELL THYSELF!*

The third speaker, Wendy Bennett, has been in private practice for fifteen years as owner and paper conservator for Fine Art Paper Conservation in Pittsburgh, PA. Bennett responded to the session topic, namely highlighting the practices of paper conservators in the private sector during uncertain economic times, because she felt it was time to reenergize her business. Bennett’s talk focused on how to spread the word about your business and presented ideas on making the business more visible. Bennett shared her own experiences including what has worked, what she is in the process of trying, and ideas she has not yet put into practice.

A couple of years ago Bennett moved and in the process downsized her life and conservation business. During the transition, she took on the directorship of a small non-profit organization with the goal of later continuing her business full-time. Bennett learned much from her directorship position and was able to apply what she learned about marketing in order to start to build her own brand. This brought up an interesting question: exactly what does building your own brand mean as a conservator? Conservators are fond of identifying with doctors and lawyers, yet they would not advertise in the same manner. In fact, selling yourself as a white collar professional was considered taboo until the mid 70’s, when a Supreme Court decision lifted bans on advertising by physicians and attorneys. Now ads for these occupations are ubiquitous for doctors and lawyers, but conservators represent a much smaller niche and they generally don’t have thousands of dollars to spend on this type of advertising. Additionally, the opinion persists that it is unseemly to advertise in this manner. Therefore Bennett asked: what can we do as conservators to spread the word about our profession and our businesses?

Bennett suggested that conservators advertise in a subtler manner, which can still be effective. The AIC Code of Ethics considers the marketing of conservation services an essential link between professional service providers and those who are responsible for making decisions regarding the preservation of cultural property. The Code states that honest and well-conceived marketing tools serve to promote the profession as a whole. Conservators are advised not to advertise unless they are Professional Associates or Fellows, and conservators are cautioned against giving public presentations in the hopes of attaining business. Care should be exercised to avoid undo self-promotion and it is usually safer to present in the name of education.

Again referencing the Code of Ethics, Bennett outlined techniques she has used to generate work and make her business more visible. She explained that if one of the centerpieces of our Code of Ethics is to be proactive in teaching the public about conservation, then one of the best tools as a private conservator is a clear online presence. Having a website is critical as a way to communicate these days. It is important to make your website graphically clear, be vigilant about keeping it updated, include a LinkedIn profile with professional recommendations, and add current activities. It is also advisable to maintain a blog. Bennett mentioned examples of good conservation blogs such as those by Ellen Carrlee, Jeff Peachy, and Beth Heller. For those just starting out, Bennett suggested joining the Emerging Conservation Professionals Network, now hosted on the AIC website. New conservators can also blog or upload photos of projects. This group also has a Facebook page and a Twitter feed.

Bennett also emphasized collaboration. She described a group of private conservators in the Philadelphia area who have joined together to create a cohesive and attractive online presence. They did a particularly good job of building many opportunities for educational outreach, including lectures on a broad range of collections care topics and a section on careers in conservation, as well as a page of conservation tips. Bennett explained that a brochure she made with two other conservators inspired the collaborative website. This brochure now needs to be updated, but it served the conservators in Bennett’s own small group quite well for about seven or eight years and Bennett still gets work due to its distribution. Bennett and her two colleagues checked out many other brochures and worked with a graphic artist to develop their own. She found that this collaboration was a great way to share costs. The brochure was particularly useful to leave at frame shops. It was first distributed to a targeted mailing list of museums, historical societies, and private individuals chosen by income within a fifty-mile geographic radius. There are many companies that compile these types of lists on the Internet.

In order to cover advertising costs, Bennett suggested bartering for professional graphic services. She also mentioned the importance of taking some time to select the quality of the paper and the design of the letterhead to reflect your care as a paper conservator. Take advantage of the fact that people receive fewer interesting pieces of mail these days. Making something beautiful will catch potential clients’ attention. Other mailing suggestions include compiling a database of clients, including staff members at institutions, private...
individuals, frame shops, and galleries. If you move be sure to send cards with your new address, and it is a good idea to send annual holiday cards. Additionally, Bennett suggested creating a calendar to give to special clients.

Another useful tool for a private conservator is a portfolio to highlight your range of work. A portfolio is an excellent way to illustrate your capabilities and skills as a conservator and it is useful for new and potential clients who may be unfamiliar with the concept of conservation. A portfolio is helpful when it is not practical to go online to share your website and it is a good visual aid to pass around at smaller speaking engagements. Bennett also emphasizes the use of bartering to save money on a variety of services. She exchanges conservation treatments for artwork, landscape design, and help with legal documents. Bartering also helps spread the word about your services, often leading to cash-paying customers. Bennett barters informally, but there are also formal networks including the Green Apple Network, YouExchange.com, and Craigslist.

Joining the board of directors at a small non-profit or municipal arts commission is also beneficial to the business. Bennett was invited to join the board of the new ToonSeum in Pittsburgh, which is one of only three cartoon art museums in the country. Bennett represented the ToonSeum board at a Lawyers in the Arts gathering and a ToonSeum Needs Assessment group at Carnegie Mellon University, where she made some connections both for the ToonSeum and for her own business. Bennett also suggests seeking opportunities to find adjunct professorships. Bennett is teaching a preservation course this summer and fall at the University of Pittsburgh where she will have students develop a survey and disaster plan for the ToonSeum. Bennett is also working with the curator of the Cartoon Art Archives at Ohio State University to develop a checklist of conservation guidelines for cartoonists, which will be presented at the National Cartoonists Society Annual Meeting.

When it comes to professional development there are many opportunities for conservators to attend classes such as the Campbell Center and continuing education through FAIC. Bennett explained that she has made some great contacts this way while at the same time brushing up on her skills. She also suggests making friends with people in the local media and talking to the public relations staff at museums and other institutions because they may be able to feature a conservation project. Also most universities have their own magazines, so contacting an editor may lead to some exposure if they are able to feature a project that will tie into something happening at the university. Your alma mater magazine is also a useful source of exposure. Publishing is a great way to promote your brand and spread the good word about conservation.

Bennett also suggests keeping current with grant deadlines listed in the AIC newsletter and website and share them with local institutions. Offer to write the conservation section of the grant because whether or not you’re successful in getting the grant, you have helped the institution get a fix on the project they’re interested in pursuing and you’ve also identified yourself as the contact for conservation. Bennett is currently working with two institutions on grant projects. Additionally, considering the model of the Antiques Road Show, your community may sponsor an antique preservation fair where you can serve as a conservation expert. These venues are good vehicles to explain conservation to the general public. For example, a book appraiser Bennett met at a recent fair gave her name to someone who found a rare circus poster in the attic of a house, leading to an excellent project. You can also raise your visibility by making a gift to a silent auction for the charitable organization of your choice. Bennett recently donated a Japanese triptych to her local Cystic Fibrosis Foundation fundraiser. Rather than donating an item, you can also donate your services as a conservator or consultant.

Though conservators in private practice don’t have as much time to conduct research, it may be possible to offer to make a presentation, related to what is happening curatorially at a local museum. Bennett pointed out that conservators should not pass up opportunities to speak at high schools or community groups because you never know whom you will meet. Recently Bennett obtained a FAIC Professional Development Grant to attend the History and Use of Pastels course in Buffalo. Upon learning that Bennett received the grant, the curator she had asked to write a recommendation invited her to present a talk about pastels to compliment an upcoming Degas exhibit at the Carnegie Museum of Art.

In conclusion, Bennett suggests that conservators should attend museum and gallery openings and lectures. Go to art auctions and attend or volunteer for art fundraisers. In this way you identify yourself as an active participant in the arts community in your region. One of the reasons Bennett decided to make this presentation was because she wanted to challenge herself to follow through with some of these ideas given the tough economy and her transition back to full-time conservation. By implementing some of the ideas she shared, Bennett has been able to generate fresh sources of work and new opportunities for her business. Certainly there are tips that have been left out, and Bennett is eager to learn from others.

Wendy Bennett, Fine Art Paper Conservation

JIM HINZ

OIL AND BORAX: CONSERVATION OF THE PENNSYLVANIA GENERAL ASSEMBLY COLLECTION

The last speaker was Jim Hinz, currently the Head of the Book Section for the Conservation Center for Art and Historic Artifacts (CCAHA). Through a contract with the State Library of Pennsylvania, Hinz shared some of the day-to-day issues confronted by regional centers. Initially,
CCAHA worked with the State Library of Pennsylvania to identify and write a Save America’s Treasures grant for the conservation treatment of the library’s General Assembly Collection. CCAHA contributes much of its time to assisting with grants and the center is currently working with other institutions on similar projects. The State Library ultimately received the grant, which in turn benefitted CCAHA in receiving the work.

The Pennsylvania General Assembly Collection was the 422-volume library of Independence Hall in Philadelphia. Currently residing in the Rare Books Room of the State Library of Pennsylvania, the General Assembly Collection slipped out of history after its move from Philadelphia to Harrisburg in the early years of the nineteenth century. It was only in the 1960s that dedicated researchers from Independence National Historic Park and the State Library of Pennsylvania realized the historical value of this collection, also discovering that all the volumes were still together.

Benjamin Franklin and Isaac Norris II spearheaded the drive to establish the Pennsylvania General Assembly’s library and make it one of the finest in the colonies. In 1745–1746, while Clerk of the Pennsylvania Assembly, Franklin purchased the core books of the library from William Strahan, a London bookseller. He chose these books to serve as a practical law library for statesmen, covering the breadth of English and international law. Franklin and Norris then chose to round out the collection with additional volumes on philosophy, art, architecture, and the natural sciences. Today, the books selected offer remarkable insight into the worldview of a Colonial statesman. Even more remarkably, this was the resource library available to our Founding Fathers as they debated and wrote the Declaration of Independence in 1776 and the U.S. Constitution in 1787.

In summer 1776, the General Assembly Collection was maintained in the Library and Committee Room of the State Assembly Building, now commonly known as Independence Hall. Access to the Library and Committee Room was through the back door of the main Assembly Chamber allowing for easy access to the books for reference. Appropriately, the library prominently contained not just law, but the works of John Locke, whose influence permeates the Declaration, inspiring the immortal phrase, “Life, Liberty and the Pursuit of Happiness.” Eleven years later, the eyes of America once again focused on the State Assembly Building as the Constitutional Convention met in secret to draft a new set of laws to govern the young nation. Once again, the General Assembly Collection served as a readily available resource library to the assembled statesmen. Edmund Randolph wrote the first draft of the Constitution, which was then rewritten by James Wilson of Pennsylvania, and polished by a committee of Alexander Hamilton of New York, William Samuel Johnson of Connecticut, Rufus King of Massachusetts, James Madison of Virginia, and Gouverneur Morris of Pennsylvania.

Along with the bound Journals of Congress containing the Proceedings from 1775 to 1788, the Rare Books Room of the State Library contains one of the 18 known surviving copies of the first public printing of the U.S. Constitution, both important components of the General Assembly Collection. But the General Assembly Collection is more than a witness to these foundational moments in American history. Through the 100 volumes of official minutes and laws, it traces the Eighteenth Century history of the Pennsylvania General Assembly as it negotiated with the Penn family, as it appointed Benjamin Franklin to serve on a series of momentous missions to England, and as it reacted to the burdensome laws and tax levies that formed the prelude to revolution. English law and philosophy forged the men who served in the Pennsylvania General Assembly, the Second Continental Congress, and the Constitutional Convention. The volumes of the General Assembly Collection, including the works of John Locke, the Statutes at Large, and the works of Coke, Puffendorf, De Vatell, Grotius, and many of the other great European legal authorities, represent the legal universe that gave shape and legal credibility to the revolutionary documents of that time. As has been said, the fingerprints of the Founding Fathers are all over these books.

The condition problems with the collection were typical for eighteenth century calf bindings, such as split boards and detached spines. Most of the sewing was in good shape, but often the cords were broken, resulting in detached boards from the text block. Loose sections of the text block were discolored, torn, and detached due to failed sewing. There was also surface soil on the leaves and end sheets were discolored, torn and sometimes detached. The leather covers were overdressed with Neatsfoot oil and lanolin, which became tacky to the touch. The leather on the covers was occasionally desiccated, split at the joint, and had many losses, concentrated along the joints and headcaps.

Solutions to these common problems included:

- Surface cleaning with grated eraser crumbs.
- Reduction of leather dressing in the fume hood with the organic solvent benzine, which was not always successful.
- Board-tacketing to the text block with new linen thread and reinforcing the cords.
- Washing of end sheets and loose sections of the text using calcium-enriched deionized water, followed by mending with mulberry paper and wheat starch paste, and re-sewing.
- Providing new end sheets when necessary.
- Mending leather with acrylic-toned mulberry paper laid down with wheat starch paste and polyvinyl acetate, ensuring that the mends adhered to the over-oiled leather. The mends were finished with an acrylic-polymer/wax emulsion.
Notes written by Robert Bray Wingate were discovered at the State Library from the 1970s. Wingate worked for the State Library as a Chemist and Head of the State Library’s Rare Book Room. He performed conservation treatment on the Assembly Collection and his notes on leather and paper treatment were helpful in determining CCAHA’s treatment approaches. For example, the notes revealed that borax was used on paper. As a result, CCAHA staff was instructed to perform surface cleaning of paper in a fume hood. The leather appeared to be over oiled and scented. The notes revealed that Wingate wanted the books to smell like Russian leather. Along with Wingate’s notes at the State Library, he also published an article titled “Kitchen Chemistry” in the AB Bookman and another article in the Abby Newsletter. Records indicated that Wingate was the last to treat the Assembly Collection and publications by the author indicate the use of Neatsfoot oil and other treatment techniques. It was later discovered that Wingate did not actually hold a chemistry degree, and was eventually fired from his positions at the State Library as a result. Another useful resource during treatment at CCAHA included instructions from a publication of the Koninklijke Bibliotheek, The National Library of the Netherlands titled “Guidelines for the conservation of leather and parchment bookbindings.” Using these guidelines, CCAHA further amended treatment approaches for the General Assembly Collection. These guidelines were a valuable source that Hinz recommends exploring.

In summary, the total budget for the project was $300,000–$400,000, including grant and matching funds from the State Library. In the end, nearly 200 books were treated. With a tight deadline, the conservators had to work quickly while ensuring adherence to ethical guidelines. Since many books were similar in terms of treatment needs, CCAHA developed methods of working more efficiently and Hinz agreed to elaborate on that aspect of the project during the final discussion. In conclusion, Hinz shared the way CCAHA is set up and how it operates with efficiency and speed when it comes to large projects.

Jim Hinz
Head of Book Section
Conservation Center for Art and Historic Artifacts

DISCUSSION

An informative discussion followed the presentations, starting with a question for Hinz regarding how elaborate his methods were to estimate the time it would take to complete the project he discussed. Although he did not do the estimation, CCAHA usually generalizes how long a project will take factoring in many issues. Problems may go unseen in the beginning therefore leading to underestimation. An employee’s skill and speed, reflecting on previous projects, and the type of client will factor into the estimate. Most of CCAHA’s work comes from institutional clients, which often have more leeway. Lee added that it is crucial to manage employee time through the recording of billing hours. Once a project is finished, the manager must study the hours to determine whether the estimate was over or under. If an employee is slow at a particular task, you must adjust the estimate to fit their work but also make sure to train them so that each individual is up to speed. Hinz pointed out that there is not always time to study the hours of each employee and it can be very difficult to track hours.

Next, there was a question about whether the panelists have a system for fees. Do they custom-fit the fee according to the project or have set fees? Lee stated that there is a set billing structure at ECS. The billing structure is arranged according to time and materials. Clients always like to know what they are paying for, so you can’t expect to take on a project without stating the costs up front. Institutions have very strict budgets and they set their conservation priorities in order to get the most bang for their buck, focusing on valuable items. Lee explained that the cost is not adjusted or catered to the treatment or money available. Options are provided so that the client can choose a treatment that falls within their budget.

An audience member shared her years of experience in private practice and pointed out that the same problems seem to come up time and time again. She has noticed that the more polished and professional conservators appear, the more off-putting they are to the public. The public may not know what conservators are, so fancy brochures and marketing tools may give off the impression of being expensive. She stated that she gets more bookbinding work than actual conservation treatment, suggesting that the conservation end of the business often intimidates or scares people away. In order to gain an approachable image it is best to show the actual work, rather than fancy brochures, photos, or portfolios. Allowing people to see your handwork in person will grab their attention and bring the work to the community. Bennett asked how the audience member shows her actual work to people, and the audience member stated that she brings samples to trade and craft shows, resulting in the majority of her business. She also emphasized the importance of working on items that many view as less desirable such as cookbooks and bibles. Working on these things allows for a conservator to learn how to work quickly and efficiently. Lee stated that the same applies to a large regional center. He recommended not marketing yourself as so high up that you are unattainable. Many clients express hesitation when approaching a conservator with an item to be treated. They are fearful of the cost and don’t know what it will require. Conservators should project a good bedside manner and make the clients comfortable. Once a client understands a conservator’s work and feels comfortable and
satisfied with the services provided, word spreads around leading to more business.

Another question was raised from the audience regarding the amount of time private conservators spend on the different facets of their business, especially when it comes to administrative versus bench time. Hinz explained that at CCAHA there is a full-time employee dedicated to each task in the business, such as a photographer, biller, and forty conservators, etc. Lee explained that as the head conservator he spends 30% of his time doing bench work. When he first started working at ECS he was doing bench work 75% of the time, indicating that the longer you work the more you are responsible for administrative duties. He also pointed out that it is beneficial to do some work at the bench even when your responsibilities have expanded to administration because if you demonstrate your abilities to your conservators and technicians they are more likely to support and rally around you. This is an important thing to keep in mind as a mentor. Lunas spends 80% of her time at the bench and 20% on administrative duties, but this is because her husband assists in many of the administrative tasks such as photo documentation, checking items in and out, and writing treatment proposals. Without his help her bench to administrative time would be 50/50. Bennett divides her time 50/50, but has been thinking about marketing a lot more lately so this ratio varies. She used to get private work without marketing but now wants to improve the quality of items she works on. The economy does affect the business. People who used to bring items for treatment without a second thought are now more careful when considering getting work done.

A member of the audience shared some quick ideas that she has put into practice in her own business. In order to demystify conservation, she offers an open house twice a year. Clients are invited and often bring interested friends. Treatments are demonstrated and projects are displayed, showing the care and attention that goes into the work. The clients become familiar with conservation and the friends joining them often become new clients. Another activity that leads to more business includes presenting how to value, care, and preserve work to galleries. A framer, appraiser, and conservator can make a presentation to those responsible for works on paper in galleries. When asked how to get the word out when there is an open house, the audience member emphasized that she keeps the group to twenty people by invitation only. She particularly pays attention to those who express curiosity and interest when dropping an item off, noting their names for future invitations. A third activity that has been successful is to give a lecture to a local community in order to help raise money for the treatment of a special item at a historical society of other small institution with a limited budget for conservation. The conservator can talk about related objects and explain the value of the work and why it is important to treat a particular object. This type of lecture raises money and the community is delighted. Hinz explained that CCAHA also hosts open houses, where invitations go out to board members, the center’s mailing lists, friends, and family. Special tours for other institutions also lead to useful connections.

Another audience member shared her experiences with taking out a business loan to purchase cast iron equipment. She also came across small organizations that have proven to be useful, such as the Women’s Economic Self-Sufficiency Team for small business owners in New Mexico. They offer short lunchtime classes and provide a way to meet other local business people. There may not be many conservators, but the insight of other business owners helps, such as putting pricing into a more realistic scope.

One audience member who works at another regional lab stated that the name of the business can influence the amount of work that comes in. The Intermuseum Conservation Association was often viewed as vague and many people were confused whether they did work only for museums or if they also worked for individual clients. The business decided to change their name slightly to prevent confusion. The audience member also asked the panel how much they quote versus how much they estimate when it comes to pricing. Conservators may be compelled to quote a higher price to ensure that their time is sufficiently covered, but perhaps a range is more realistic or fair. Hinz explained that at CCAHA they give advanced estimates and build in a 10% cushion. They also give a range. Lee explained that at ECS they provide one figure to the client, so what they see on paper is what they pay. Adjustments are made only for things out of the ordinary because it is very difficult to make changes. Occasionally the business has to negotiate and split the difference. Bennett gives a range and is happy when she can sometimes go to the low end of the range. It is very awkward to make adjustments. She also finds herself using a sliding scale depending on how much the client seems to be able to afford. Lunas uses a flat fee for simple treatments, but the flat fee is still an estimate. Things may look simple at first but they can end up very complex, so she calls the client and explains why the price must be raised.

An audience member shared that the best way to run a business is to start with the budget before thinking about anything else. For a private business with staff, standardized forms are a way of giving employees a goal of how much they quote versus how much they estimate when it comes to pricing. Conservators may be compelled to quote a higher price to ensure that their time is sufficiently covered, but perhaps a range is more realistic or fair. Hinz explained that at CCAHA they give advanced estimates and build in a 10% cushion. They also give a range. Lee explained that at ECS they provide one figure to the client, so what they see on paper is what they pay. Adjustments are made only for things out of the ordinary because it is very difficult to make changes. Occasionally the business has to negotiate and split the difference. Bennett gives a range and is happy when she can sometimes go to the low end of the range. It is very awkward to make adjustments. She also finds herself using a sliding scale depending on how much the client seems to be able to afford. Lunas uses a flat fee for simple treatments, but the flat fee is still an estimate. Things may look simple at first but they can end up very complex, so she calls the client and explains why the price must be raised.

An audience member shared that the best way to run a business is to start with the budget before thinking about anything else. For a private business with staff, standardized forms are a way of giving employees a goal of how much work they should do relative to their salary. This record keeping provides a way of determining whether there will be a profit or not. A bonus system also encourages employees to work beyond their goals. Lee agreed and stated that the salary, plus taxes, retirement plans, and other benefits all add up, so the business must generate enough to cover everything for each individual. Obviously time-consuming work such as conservation is not a big moneymaking proposition.
A question arose regarding works on paper and photographs. The audience member asked how the panelists address the highly variable time it may take to inpaint during treatment, compared to the cleaning and repair steps that may be required. Lee explained that if he imagines that something will take an hour it will really take twice as long. There is no set formula, so even doubling the time is often incorrect. When it comes to difficult inpainting for things such as photographs, it can be impossible to make up the time elsewhere.

A conservator from the audience who works abroad explained the way conservation varies in Argentina compared to the US. Working on contract since 1993, she never realized that she technically falls under the “private” designation. Often institutions need a conservator for two days a week, so she works on contract between different institutions dividing her time in two-day intervals. Additionally private collectors do not always want to move their items so she will work off-site. Working offsite makes it easier to keep track of time since the clients see exactly how many hours she has worked. The clients can also see how delicate and difficult treatments can be, and how much time it can take. When they see the work being done they deliver more praise and appreciation, boosting the conservator’s confidence. Giving lectures for artists on how to properly mount and handle their work has also proven to be beneficial because they learn about conservation before it is too late. A bonus is that more people are exposed to conservation and the conservator is able to identify the needs of artists and clients more readily.

The last question from the audience was whether the panelists add state sales tax. Bennett looked into sales tax with the help of an accountant but determined that it was not practical for her business, so she does not charge sales tax. She does pay sales tax when purchasing materials. Lunas was required to collect and pay sales tax when her practice was in New Jersey but because there is no sales tax in Oregon she no longer has to worry. Lee stated that ECS incorporates sales tax into the treatment costs. An audience member pointed out that there is no sales tax on labor, but sales tax must be charged for any materials, such as cut mat board. Lunas ended the session by sharing an interesting multi-purpose pen tool that incorporates a laser pointer and UV and LED lights (purchased from ThinkGeek.com).

ACKNOWLEDGMENTS

The co-chairs of the ACDG would like to thank Michael Lee, Susan Lunas, Wendy Bennett, and Jim Hinz for sharing their experiences, tips, achievements, and challenges. Thanks also go to those who participated in such a lively discussion following the presentations.
addition, there was increased pressure throughout the library to demonstrate cost-effectiveness of the program. With the help of a part-time staff member transferred from another department, the UVA Library has been able to invest in the preservation review process without hiring additional library staff. The Preservation department developed this staff liaison position to do the legwork on cost benefit, and to follow up with subject selectors to make sure that decisions are made in a timely manner. Ms. Gilligan described the new workflow and the specially designed form they use to track progress. This process has resulted in increased collaboration with other departments, raised awareness of the overall condition of the library collections, focused the treatment program on books most needed in the collection, and fostered understanding that the preservation department is doing its very best to make cost-effective choices. The selection form was provided as a handout at the discussion session, and is included in this publication. (See handout 1.)

Eliza Gilligan, Conservator for University Library Collections, University of Virginia Library

FLETCHER DURANT
digitization-driven large-scale treatment projects: old volumes with new needs and considerations

Mr. Durant’s presentation illustrated a case study for large-scale, digitization-driven conservation projects of non-traditional materials. In 2009, with support from the National Endowment for the Humanities (NEH), an ambitious project involving extremely fragile Chinese rare books was undertaken by the New York Public Library (NYPL) that resulted in increased access to this special group of materials. The project included cataloging, conservation treatment, and digitization of a selection of rare Chinese manuscripts and printed volumes from the NYPL’s research collections. Six diverse titles, composed of 93 volumes, deemed to be the most historically important of the group, were selected for conservation.
The selected volumes also reflect a variety of prior intervention decisions. In 1935, curators had decided that the traditional format was problematic. The volumes, as was often the case with Asian materials in Western collections, were treated like pamphlet volumes. They were bound together into multi-volume sets using standard buckram bindings. Two sets of 1000-page volumes were created, and some larger volumes were treated as single volumes. Later the volumes exhibited extensive damage in the gutter, and the bindings were too tight to allow for access. Later, in 1991, with a grant from the Luce Foundation, 255 volumes were treated and recased into library bindings and placed into drop spine boxes. One volume was taken apart to have a photocopy reproduction made, and a full conservation treatment was done at the time.

Over the Library’s hundred-year history, evolving conceptions of the book as object influenced prior treatment decisions. However, for this project Mr. Durant, working with the curator, came to the conclusion that it was crucial that all volumes be returned to more historically appropriate structures to be more sympathetic to the original structure as well as assist in the digitization work flow. Due to concerns over issues with pagination, it was decided that the volumes would be treated and bound prior to digitization. The conservation work was broken into three parts: lifting and treating areas in gutters where previous mends had lifted; minor treatment on two accordion bindings included mending, hinging and pigment consolidation; and binding, washing, and select mending of 10,000 leaves that were ultimately rebound into 45 fascicles. Mr. Durant also created custom book cradles to accommodate the Asian-style stab bindings during digitization.

Mr. Durant found that as conservators increasingly manage projects that confound normal workflows, they need to balance curatorial requirements, digitization needs, and handling and capture issues in order to ensure sympathetic and successful treatments within a demanding timeline. (See handout 2.)

Fletcher Durant, Project Conservator, The New York Public Library

ANN CARROLL KEARNEY
THE USE OF PAPER AS AN ALTERNATIVE TO LEATHER IN BOOK RESTORATION IN UNIVERSITY LIBRARIES’ PRESERVATION DEPARTMENTS

Many libraries and archives do not routinely use leather in their book conservation treatments, either due to the high cost of leather or the problem of inherent vice associated with leather as a material. Consequently substitute repair materials are often employed. Following the example of Don Etherington in his use of Moriki paper, a number of

University Libraries’ Preservation Departments have adopted the use of Japanese papers as alternatives to leather in conservation procedures. Ms. Kearney developed and conducted a survey of Preservation/Conservation departments. She solicited information on the use of Japanese papers for such repairs. The survey asked about the types of Japanese paper being used, the reasoning behind paper selection, and the identification of ongoing issues with this usage. Ms. Kearney will be analyzing and evaluating the data, and would like to draw conclusions based on these findings. Her hope is that this study will fill an unmet need for documentation of the use of both leather and paper in university conservation labs. In addition, it will offer groundwork for expanding the alternatives for materials and procedure selection in the conservation of leather volumes. (See handout 3.)

Ann Carroll Kearney, Collections Conservator, University at Albany

GRACE OWEN AND SARAH REIDELL
SYNTHETIC LEATHER FOR BOOK REPAIR

A novel treatment system is being developed at The New York Public Library’s conservation laboratories for the conservation treatment of leather bindings. Ms. Owen began the presentation by describing the background of ‘synthetic leather’. After years of working with limited resources and time for performing complete leather book conservation treatments, she looked to other conservation professionals for alternative treatment ideas. Book conservation treatments often incorporate paper, cloth, or a combination of both when attaching boards or replacing lost or badly damaged material. These repairs are met with varying success at creating a new surface that truly blends with and is sympathetic to the original material. When making a fill or repair, objects and painting conservators routinely use casting techniques to capture the surface texture of an object. Drawbacks to simply adopting the methods used in other areas of conservation, include the fact that the newly cast pattern is often created directly from the original object, and it is usually applied to the original with either heat or pressure, it is inflexible, and the pattern capture from the object requires the use of solvents and a fume hood. Some drawbacks to the book conservation technique are lack of strength and durability, mends are more noticeable, and there can be problems with adhesion. The technique being developed at NYPL is a combination of the two repair procedures mentioned here. By creating a cast from on a surrogate piece of leather, a repair material is created that can be attached to the object. Ms. Owen went on to describe the components of a composite material made of acrylic gel medium, additives, and acrylic paint. NYPL conservators have experimented with reinforcing substrates of paper,
woven polyester, cloth, and leaving the material free of any backing. The technique uses a silicone rubber mold created using surrogate leather to define a texture. A library of molds can be made from leathers with different grain patterns. The molds can be reused indefinitely. Ms. Reidell described the process of using the silicon molds to create the repair material. Heavy body acrylic paints are mixed to match the color of the leather being mended then they are mixed with gel medium and applied to the mold with a spatula. A substrate may be adhered and the material attached using different adhesives—such as starch, vinyl and acrylic—which may be heat or solvent activated. The mends produced with this ‘synthetic leather’ are less invasive, can be extremely thin yet strong, and visually more compatible than traditional treatments with leather or toned Japanese papers. This technique is simple, uses readily available materials, does not require the use of a fume hood, and is inexpensive. It will require more testing but is a logical step forward from existing (and accepted) book conservation practices. (See handout 4.1–7)

Grace Owen, Senior Conservator, The New York Public Library for the Performing Arts

Sarah Reidell, Associate Conservator, The New York Public Library, Goldsmith Conservation Lab

GARY FROST
CONTINUING ROLE OF PRINT COLLECTIONS IN A CONTEXT OF THEIR DIGITAL DELIVERY: PRESERVATION RISKS, RESPONSE, AND ACTIONS

Use of research library collections is shifting from physical circulation to digital reformatting and screen delivery. Does this suggest a continuing role of physical collections or does screen delivery inherently suggest print disposal? Mr. Frost’s presentation suggested that there is a growing interdependence of physical and digital collections. He described attributes of print books, such as fixity, mechanical navigation, persistent re-access across time, and the self-authenticating nature of the print book, and how these all pair nicely with screen attributes of live content, automated search, cloud repository, and electronic delivery. Mr. Frost went on to discuss actions they have taken at the University of Iowa Main Library to advocate for this interdependence, and for a continuing role of print collections. For example, they created a Print Alcove where new print acquisitions are displayed, print newspaper machines, a Zine Machine, as well as a Columbian Press (1843). In addition, they are promoting the concept of a Print Master collection. Currently, this collection consists of original brittle books that have been replaced by preservation photocopies. The library also sponsors and hosts short workshops and longer for-credit seminars that investigate the future of the book. (See handout 5.1–4.)

Gary Frost, Conservator, The University of Iowa Libraries

DISCUSSION SESSION

Immediately following the final presentation, the co-chairs opened the discussion period for comments and questions/answers. Questions and comments from the audience are summarized and paraphrased below following the order of the presentations.

SHRINKING RESOURCES? INVEST IN THE DECISION MAKING PROCESS!

Q: When you say circulation time, what is the time frame for the books?
A: Ms. Gilligan explained that on-line records for the books were uploaded in 1996, and they were able to look at circulation records from that period on. They also rely on the knowledge of the staff at the departmental libraries to have a sense of the use of various books and collections.

SYNTHETIC LEATHER FOR BOOK REPAIR

Q: How thin can you make the synthetic film?
A: Ms. Owen and Ms. Reidell used a caliper to measure the thickness which was averaged 0.006in, about twice as thick as many mending papers. Basically, you can make it as thin as any paint layer.

Q: Have you found that use of bone folder diminishes surface texture?
A: It does withstand the pressure. Previously, BEVA was tried but it did not create the desired texture. Ms. Owen searched for materials that would accept pressure and low heat. The acrylic gels used have a higher melting point than what would be used on a tacking iron for a rare book, and was found to be the most effective material.

It was explained that in the NYPL lab they often use short hand for describing various materials. So far they have been calling this material pleather or archive-a-hide. However, since the use is not limited to leather bindings, and there are plans to experiment with the material to repair cloth Publisher’s bindings, they would like to come up with a catchy new name, and are interested in suggestions.

Q: Has this technique been used for suede textures?
A: No, thus far Ms. Owen and Reidell have been developing and trying different mends, and for more exact comparisons they have only been using one grain pattern.
DIGITIZATION-DRIVEN LARGE-SCALE TREATMENT PROJECTS:
OLD VOLUMES WITH NEW NEEDS AND CONSIDERATIONS

Q: Was leaf casting considered for mending?
A: It was considered only briefly. The leaves were too difficult to handle when wet because the long fiber paper was too thin and brittle. Out of 10,000 pages, 4,000 needed to be lined. This gave strength to the whole sheet rather than adding materials to essentially the weakest part of the page.

ACKNOWLEDGMENTS

The co-chairs of LCCDG wish to express their gratitude to speakers Eliza Gilligan, Fletcher Durant, Ann Carroll Kearney, Grace Owen, Sarah Reidell, and Gary Frost for their presentations and handouts. Their willingness to share their experiences in institutional settings is greatly appreciated. The co-chairs also thank Laura O’Brien Miller and Marieka Kaye for coordinating a complementary discussion session and helping with handouts and session information.

WERNER HAUN
Collection Conservator
The New York Public Library
Barbara Goldsmith Preservation Division
New York, New York
Werner_Haun@nypl.org

JODY BEENK
Book Conservator
Princeton University Library
jbeenk@princeton.edu
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<td>Y  N</td>
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<tr>
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<td>Other</td>
</tr>
</tbody>
</table>

Name of subject librarian:

Name of subject librarian:
Project Outline: In July of 2008, the New York Public Library was awarded a Preservation and Access Grant by the National Endowment for the Humanities to catalog, preserve, digitize, and make accessible on the web a selection of rare Chinese language materials. Six titles were selected for conservation treatment, including two illustrated accordion volumes, a series of rare printed pamphlets from the T'ai P'ing Rebellion (1850-1864), and three manuscript titles from the James Legge Collection. The treatment goals for these items were two-fold: 1. to provide for the long-term preservation of the materials and 2. to allow for safe and complete capture during digitization.

Prior Interventions: In addition to the research value of the materials selected for treatment, the six titles also displayed the varied history of the treatment of East Asian bound materials in the NYPL's predominantly Western collections through the physical evidence of at least two prior interventions. The first intervention ca. 1935 appears to have integrated the materials into the the traditional bindery work flow for Western monographs and pamphlets, resulting in library bound volumes and collections of pamphlets. A second intervention took place under the auspices of a Luce Foundation grant, 1988-1992, with the decision-making clearly influenced by Peter Water's philosophy of "Phased Conservation." 255 volumes were re-cased and housed in drop-spine boxes. 1 title was considered for preservation re-formatting, but the original stab-sewing prevented reproduction. The 24 volumes of the T'ai P'ing Rebellion Pamphlets were provided with a single-item level treatment of disbinding, washing, lining, and rebinding in historically sympathetic stab-sewings.

Lessons:
1. Oversewing obscures text in gutters, restricts openings, and creates a breaking edge for even flexible papers.
2. Use as light a weight of lining paper as possible to encourage flexibility in gutters.
3. Extending the lining on shattered spine edges provides locations for the lining to separate.

Current Treatments: With preparation for digitization as a primary consideration in treatment, the two illustrated accordion volumes and T'ai P'ing Rebellion Pamphlets received minimal intervention for stabilization prior to digitization. The remaining three titles, containing 45 bound volumes and 10,000 pages of brittle and discolored Chinese manuscripts are receiving a full treatment including disbinding, washing, lining (as needed), and rebinding in historically sympathetic bindings.

Issues to consider in large-scale project planning:
1. Tracking unpaginated Chinese manuscript leaves.
2. Allowing for digitization of disbound materials.
3. Efficiency of work space. Every step adds up.
4. Materials, as much as time, serve as a limiting factor in quantity of treatment.
**THE USE OF JAPANESE PAPERS IN THE REPAIR OF LEATHER VOLUMES IN ARL ULIBRARIES**

**PRESERVATION DEPARTMENTS SURVEY RESULTS OUTLINE**

Ann Carroll Kearney

LCCDG Presentation   AIC Annual Meeting 2010

Survey List developed by reviewing ARL University Libraries identifying Level 3 procedure performance

Surveys Distributed:  68

Surveys returned:  32  (3 N/A respondents)

1. **Do you use paper instead of leather when performing leather repair procedures?**
   - Yes: 15
   - No: 5
   - Often/V.Often: 3
   - Sometimes: 2
   - Occasionally: 3
   - Rarely: 2
   - Minimally: 1
   - Only: 1

2. **In which procedures do you use it?**
   - Joint repair/board reattachment: 9
   - Reback: 8
   - Hinge repair: 4
   - Spine repair: 3
   - Corners: 2
   - Endcaps: 1
   - Tears: 1
   - Case reconstruction: 1

3. **What type/types of paper do you use? (Several respondents provided more than one answer)**
   - Japanese tissue (unspecified): 17
   - Moriki: 10
   - Kozo: 4
   - Hiromi Kozo: 2
   - Barrett: 1

4. **What are your criteria for Questions #3?**
   - Strength: 8
   - Color: 7
   - Weight: 7
   - Flexibility: 6

5. **Do you size, tone or line the paper? (10 Participants combined this answer with following (#5) answer)**
   - Yes: 19
   - No: 2

6. **If “Yes,” could you identify the products or items used?**
   - **SIZE:**
     - Klucel-G: 5
     - SC6000: 4
     - PVA/Wheat starch: 2
   - **TONE:**
     - Acrylics: 14
     - Golden Acrylics: 5
     - Watercolors: 4
     - Colored Pencil: 2
     - SC 6000: 2
     - Pastel: 1
     - Dr. Martin’s: 1
   - **LINE:**
     - Linen: 8
     - Japanese Tissue(unspecified): 8
     - Cotton: 3
     - Tyvek:

7. **Do you use a consolidator, i.e., SC6000? What do you use, under what circumstances do you use it, and to what end?**
   - SC 6000: 12
   - Klucel-G: 5
   - SC 6000+RG: 2
   - SC 6000+ETOH: 2
   - Cellugel: 2

8. **Can you suggest advantages/disadvantages/comments about using paper instead of leather in book repair procedures?**

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<th>PROS:</th>
<th>CONS:</th>
<th>COMMENTS:</th>
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<td>Color fades: 2</td>
<td>“Don’t Like Using”: 1</td>
</tr>
<tr>
<td>Quicker: 9</td>
<td>Not durable: 2</td>
<td>“no paring”: 3</td>
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<tr>
<td>Stronger: 7</td>
<td>“Not leather”: 2</td>
<td>“very few minuses”: 1</td>
</tr>
<tr>
<td>Less expensive: 6</td>
<td>Felting issues: 1</td>
<td>“can be done on short notice”: 1</td>
</tr>
<tr>
<td>Minimal training: 4</td>
<td>Handling issues: 1</td>
<td>“don’t use on pre-1850”: 1</td>
</tr>
<tr>
<td>More stable: 3</td>
<td></td>
<td>“not routine for circulating</td>
</tr>
<tr>
<td>Fewer supplies needed: 3</td>
<td></td>
<td>collections”: 1</td>
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Handout 3.
CAST COMPOSITES: A SYSTEM FOR TEXTURING REPAIR MATERIALS IN BOOK CONSERVATION
Grace Owen and Sarah Reidell

ABSTRACT
This paper presents the development of an experimental conservation treatment system that replicates the patterns of original covering materials on bound volumes. The cast composite system has potential application in simple and complex treatments of bound volumes. The technique uses supplies widely used in book conservation and adapts surface casting methods common in objects and paintings conservation. Silicone molds are used to replicate the surface textures of original covering materials on bound objects. A blend of acrylic gel, additives, and paint media is specially formulated to retain the surface texture from the silicone mold. The textured cast is then used as a repair material either alone as a film or with supporting substrate(s) like paper, non-woven polyester, or textile. Features of the original materials can be matched by adjusting components of the cast composite system using the customization tips for replicating surface textures, original finish, opacity, and color. Cast composites are easy to create from affordable materials readily available from conservation and artist material suppliers. Completed cast composites are less invasive, thinner, and visually more compatible than bound volume repairs with new leather or Japanese papers.

INTRODUCTION
Cast composites are a key component of an experimental conservation treatment system in development at the Barbara Goldsmith Conservation Laboratory of The New York Public Library. The system can produce repair materials that are suitable for bound volumes covered in almost any kind of textured material. Repairs made with the system incorporate supplies widely used in book conservation, adapting surface casting techniques common in objects and paintings conservation.

The methods and procedures for producing silicone rubber molds and cast composites are presented in conjunction with customization tips. Impressions are taken from surrogate material to make a mold that closely matches the original covering surface. The acrylic media are blended to reproduce the color, sheen, and opacity of the original covering, then cast on the textured mold. Layered application of the blend produces aesthetically superior repair materials. Cast films can be used alone or as composites with support substrates like paper, non-woven polyester, or textiles. Without a support layer, they can be used to fill abraded areas of a covering material. Cast films with supports can be used to repair joints, reattach boards, and fill losses. Substrates can be embedded into the acrylic blend directly during the casting on the mold or adhered later to the dried film.

As a repair material, cast composites can be used to complement a variety of common book treatments. The advantages of the cast composite system include affordability, availability, low toxicity, and increased aesthetic matching of original covering materials. By modifying the components in the acrylic blend, the system can be utilized for a range of simple to complex treatments. Cast composites can be less invasive, thinner, and visually more compatible than traditional repair materials. The cast composite system can be scaled up or down to fit the needs of special or general collections.

BACKGROUND
There are many conservation techniques for addressing the physical damage often found in bound volumes, including: board reattachment with threaded tassets; long-fibered kozo paper or cotton-linen textile extended spine linings; rebackings with leather or textile; toned paper joints; or paper infills. Methods to maximize visual unity between repair and original materials include toning or dyeing repair components and inpainting. Current conservation techniques for repairing damaged three-dimensional objects can be of limited use when applied to book conservation. Conservators routinely capture and replicate surface textures on three-dimensional objects, typically using a mold system (O’Donnell 1997, Nieuwenhuizen 1998, Sturges 2000, Kronthal et al 2003, Kite and Thomson 2006). The mold is then used to texture infill material placed in the lost area while soft. Textures can also be transferred to infills with heat. The fill material is often colored before and inpainted after the textured repair is in place. Heat application of a pattern to a mend on a book is difficult and often not possible in crowded shoulder joints and caps.

Texturing techniques described in other disciplines such as paintings and objects conservation have not been widely adopted by the book conservation community, in part due to concerns about physical compatibility and toxicity. Most of the objects treated in this manner are static. Bound materials differ from other kinds of three-dimensional artifacts because they are dynamic. The use of BEVA 371 resin solutions, advocated in the other disciplines for filling losses, requires solvent-extraction units to which many book conservators do not have routine access. BEVA
film, which does not need solvents and can be heat activated, is difficult to incorporate into book conservation treatments because it can be hard to melt and color, and must be textured after application.

The historic bridge between conservation and bookbinding might have influenced the use of like materials: leather to repair leather covers, and cloth to repair cloth bindings. Using leather as a repair material is sympathetic to the original but is not always desirable because of concerns about cost of materials, the need for highly developed hand skills, and inherent vice. Toned paper repairs are a common and very useful technique for treating bound materials with lost or damaged leather (Etherington 1995), but there are drawbacks. Chief among these are problems of durability and aesthetic compatibility. More recent techniques that take advantage of the reactivation properties of certain acrylic adhesives such as Lascaux 498HV overcome some of the physical drawbacks to toned paper repairs, but still have dissimilar surface textures to the original covering material (Anderson and Puglia 2003).

CAST COMPOSITES

In light of these issues, we have experimented with adapting the pattern-capturing techniques used by paintings and objects conservators, and incorporating them with common book repair methods into a cast composite system. “Cast composite” is a term borrowed from materials science to describe a product composed of two or more substances of very different physical characteristics whose performance is significantly better than the performance of each substance individually. The result is a strong lightweight material with a custom-colored textured surface which can be used with supporting substrates as an alternative to leather or cloth for the repair of bound volumes.

For our technique, a silicone mold is created to bear the impression of the surface of a surrogate leather or textile. Acrylic paints are mixed to match the original color and sheen of the covering material, and then added to a combination of acrylic gel medium and additives. This formulation is spread onto the textured mold in at least two thin layers. Acrylic films can be reinforced with one or more supporting layers of fibrous substrates, to become cast composites.

SURFACE TEXTURE

Mold kits are used in many different areas of everyday life such as the dental or food industries. The Rebound 25 Smooth-On Silicone Rubber mold kit is inexpensive and readily available. Molds can be reused indefinitely with proper care. Rebound 25 was chosen because it is a room temperature vulcanizing (RTV) product that sets in ambient laboratory conditions; it has no toxic fumes, and has good tear resistance.

There are three options for replicating a given surface texture using Rebound 25, including an impression taken (1) from a surrogate; (2) from the book; or (3) from a book of no value with a similar pattern. The first method, taking an impression from a new piece of leather with a similar grain pattern, a textile with similar weave/weft size, or other materials, is recommended. The second method is risky because the liquid silicone rubber can penetrate and discolor porous surfaces. Additional physical damage can occur when removing the dried silicone rubber from the original material, particularly if there is unconsolidated or deteriorating leather. Finally, using a non-collection book of little to no value such as the third option requires money, time, and attention. Another drawback for both the second and third options is that the size of the finished mold is limited to the surface area of the cover. Traditional bookbinding materials such as leathers and book cloth are ideal, but are not the only sources for textures. Patterns on many common materials such as synthetic leather handbags, textured VHS plastic boxes, ribbed fabric, ribbons, sandpaper, or polyethylene foam can be used for making molds. These materials offer a wide variety of grain or weave patterns. Many impressions can be taken from the same textured piece. New leathers can be plated, stamped and finished using a variety of bookbinding methods to approximate historical decorative techniques. Soft surfaces with nap such as reverse calf or velvet are not suitable for the cast composite system.

TECHNIQUE: SILICONE RUBBER MOLD

For the purposes of this article, the mold making method will refer to surrogate leather that approximates the original surface of a volume bound in full tanned leather. The method for creating a mold that captures the surface texture of embossed or patterned book cloth is almost identical to that of hide leathers. Molds created from original or deaccessioned bound volumes may represent a valid treatment option but will not be discussed further due to the potential damage from liquid silicone, as described above. There may be other mold kits available that can be used on original material without staining.

The process requires a walled tray with straight sides of at least one inch in height. The 15 x 6 x 2” Rubbermaid plastic drawer organizers are ideal for this purpose and their size approximates the average height and spine width of most bound volumes in most collections. A single-use tray could also be constructed out of binder’s board and customized to match the dimensions of larger volumes.

Handout 4.2.
The surrogate leather must be kept flat for the duration of the mold fabrication. A piece of binder’s board is trimmed so that it will fit snugly in the bottom of the tray, abutting all sides. The leather is fully adhered to the binder’s board with a modified polyvinyl acetate resin emulsion (PVA) or pressure sensitive film. Lifting tabs can be created by attaching a thin strip of polyester film with double-sided pressure sensitive tape on the verso of the panel. The panel is placed into the tray (fig. 1).

Rebound 25 has two components which must be mixed together in equal portions in order to solidify properly. Molds should have a final thickness of approximately 1/8 to 1/4 inch. A tip from the manufacturer’s website helps to determine the volume of silicone liquid needed. Uncooked rice is poured into the tray to the desired thickness of the finished mold. The rice is transferred to a measuring cup to record the total volume of silicone required. The total volume is then halved to determine the required volume of each component liquid.

An equal amount of each liquid is poured into a container and mixed until thoroughly blended (refer to package directions for more information). A disposable stiff-bristled brush is used to paint a thin layer of silicone onto the leather surface. This step reduces the formation of air bubbles. The rest of the silicone rubber is slowly poured into the tray (fig. 2). The tray is tilted so that the silicone liquid flows over the leather completely and evenly. The bottom of the tray is rapped onto a flat surface several times to force out any additional trapped air. The tray should dry undisturbed on a level surface for at least 6 hours or overnight. Minus drying time, the mold-making process should take 10 to 15 minutes.

The lifting tabs can be used to pull the panel out of the tray. The silicone mold is peeled away from the leather (fig. 3). It should separate without difficulty. Sticky residues left on the tray can be removed with isopropyl alcohol and paper towels. The cleaned tray and leather panel should be saved and can be reused for additional mold making. The silicone mold can be used immediately and reused many times.

CAST COMPOSITE FORMULATION

Cast films are a blend of Golden Heavy Body Acrylic Colors, Heavy Gel Medium, GAC 200 and GAC 500. Golden has a long track record of collaboration and open dialogue with conservators (Bernstein and Evans 2008). Golden Heavy Body acrylcs are widely used in conservation because they include the fewest additives and have high pigment loads (Golden n.d.). They come in both jar and tube, but tubes are preferred for easier measuring. The acrylic paint, combined with the Heavy Gel medium and additives, creates the film, which captures and holds the surface texture. Gel mediums are available in a range of finishes. The semi-gloss and matte work best to match original leathers and book cloth. GAC 200 and GAC 500 are acrylic polymers that modify the paint/gel properties, increasing film hardness and reducing tack.

Reinforcing substrates such as paper, non-woven polyester, or textiles can be embedded into the wet acrylic film during the casting on the mold, or can be adhered later to the dry cast film. Long-fibered kozo papers are the most versatile because they are available in a variety of thicknesses from many suppliers. Suitable textiles such as unbleached, unsized airplane linen or cotton muslin can be used for more robust repairs.

TECHNIQUE: CASTING

The most useful formulation for making cast films is a ratio of 1 part (by volume) Golden Artist Colors (GAC) Specialty Acrylic Polymer 200 additive, 1 part Golden Artist Colors (GAC) Specialty Acrylic Polymer 500 additive, 2 parts Golden Heavy Gel medium (matte or semi-gloss), and 4 parts Golden Heavy Body paints color-matched to the original covering material. This is a slight adjustment from the ratio recommended during the Library Collections Conservation Discussion Group of the 2010 AIC Annual Meeting.

The characteristics of each component can be compared (fig. 4) and if desired the basic formula can be adjusted to customize the result for the intended application. Many formulations of the acrylic components are possible and will work as repairs with subtle differences in the final product. Tips on customization of the formula are included in a later section. Most films created for silicone molds made in Rubbermaid trays required no more than 1 ½ to 2 teaspoons (or about 8-10 mL) for full coverage.

The custom-mixed paint is added to the selected volume of Heavy Gel medium, GAC 200 and GAC 500. A clear container will help to determine that all three components are distributed in a homogeneous mixture. Half of the blend is spread onto the silicone mold with a wide, flexible silicone spatula (fig. 5). Long even sweeps will help to fill all of the depressions in the mold and create a uniform film. The remaining gel mixture should be covered and set aside. This first layer should dry before proceeding. A hair dryer may be used to speed drying time.

The remaining acrylic blend is spread onto the mold with the spatula. At this point in the process there are many options for customization. Further information is presented in the customization section, but the general procedures are presented here. Varying the color and transparency of the layers applied to the mold will produce aesthetically superior repair materials.
The chosen support can be laid onto the second layer. It should be done while the acrylic blend is still wet. The support is dropped onto the surface and pressed into the blend to ensure complete bonding and detail capture without striking through (fig. 6). The blend should partially penetrate, but not saturate, the support. The cast composite (whether film alone or film and support) should dry for 8-10 hours depending on ambient room conditions. If the casting is removed from the mold too soon, its patterned surface may be compromised. The dried film or composite is removed by placing the mold face down on a work surface, rolling it and peeling the film away from a corner. The material will continue to cure until dried fully for 24 hours or longer before use. The mold can be cleaned with soap and water then towel- or air-dried. Abrasive pads will scratch the surface of the mold.

TECHNIQUE: CAST COMPOSITE REPAIRS

Incorporating cast composites into standard treatment practice is simple with the preparation of the repair and selection of flexible adhesives. Bound volumes should be cleaned to reduce surface grime. Leather bindings should be consolidated to prepare all surfaces for treatment. The CCAHA “red-rot cocktail” (a 1:1:1 solution of SC6000 acrylic wax emulsion, Klucel G 2% in ethanol, and ethanol) works well (Haines 2002, Brewer 2003). After replicating the covering material texture on a damaged book (fig. 7) and creating a cast composite, the cast composite is trimmed or torn to the desired dimensions (fig. 8). A needle or scalpel can be used to shape the mend and create irregular edges which help to visually integrate it with the original covering material. Films without a supporting substrate are not strong enough to use in areas of a book that require structural reinforcement. They are better used as cosmetic fills where the original surface layer is lost or abraded.

Cast composites create less obvious repairs when the support is removed along the edges of the torn repair strip, exposing the cast film (fig. 9). Paring and sanding are two of many techniques to create an extended edge and remove visible fibers on an irregularly shaped fill. Pressure sensitive tape can be used to pull away paper fibers along the edges. A damp swab can be used to push and rub away a narrow margin of the paper substrate on the verso of the cast film along the torn edge. Textiles can be cut and threads pulled from the edges to create a shaggy soft edge. Adhesives used to attach the mend to the book will soften the edge of the cast film after application, allowing it to conform and blend into the surrounding texture on adjacent covering material (fig. 10).

Adhesive selection is crucial to successful repairs with cast composites and should be based on desired repair characteristics. Acrylic adhesives provided the best results. Lascaux 498 HV is used by many conservators to apply the solvent-set toned Japanese paper hinge repairs (Anderson & Puglia 2003). Early testing using Lascaux 498HV adhesive, thinned with water, was disappointing. The nature of the cast composite is to slightly rebound after flexing; this caused Lascaux 498HV-adhered mends to pull away from the leather when the cover was opened. Many conservators treating leather use adhesives that remain slightly tacky after drying, such as Rhoplex N-580 and Lascaux 360, prompting concerns about shifting mends, blocking, and adhesive flow. These issues are especially pertinent for books which are often shelved tightly.

A mixture of Lascaux acrylics (1 part Lascaux 360HV, 2 parts Lascaux 498HV, and 2 parts deionized water by volume) worked well as an adhesive for adhering cast composites. Solvents are not recommended to dilute the adhesives as they can soften the textured surface of the cast film. The Lascaux mixture works best applied in thin layers. The first layer should air-dry, creating a barrier. The second coating of the Lascaux mixture is applied and the cast repair is adhered to the book. Reactivation of the dried adhesive is possible with heat or with an organic solvent (from the verso). Mends immediately conform to the volume and require little weight and pressure to set. Theoretically, these repairs can be removed with solvent if necessary, but the book surface could be altered. No matter how benign the adhesive, the possibility of damage is always present when working with fragile leather. Reversible PVA (neutral pH) is another adhesive that adhered the cast composites well. It can be applied wet, or the dried adhesive can be water re-activated. The working properties were just as favorable as the Lascaux mixture.

After selecting and applying the adhesive to the verso, the mend is put in place and dried undisturbed to avoid shifting. Adhesive residues can be cleaned with a damp cotton swab. The head and tail of joint repairs should be turned at a later stage to discourage lifting and shifting.

Heat-setting can be a fast method of preparing and applying cast composite materials. Silicone-coated polyester film barriers can gloss the surface of the cast composite repair when using heat to apply a cast composite. Silicone-coated paper can decrease gloss. Other barriers such as non-stick oven liner cut into strips did not seem to alter the finish of the repair.
CUSTOMIZATION
Utilizing the various components (fig. 4) it is possible to customize the cast composite to modify color, opacity, sheen, decoration, and support substrates. The most successful combinations for realistic and natural-looking composites for leather and book cloth repairs exploit some aspect of all of these characteristics. Matching the color saturation and hue of the original covering materials is the most challenging aspect of the cast composite system. The opacity/transparency rating of each acrylic color is crucial. The Golden Opacity/Transparency system, a relative ranking with 1 being most opaque and 8 being most transparent, should be consulted to help guide color selection. Layered application of acrylic blends with high transparency ratings (4 or above) produces aesthetically superior repair materials. Changing the color of a subsequent layer (or layers) of the acrylic blend applied to the mold adds vibrancy, avoiding a flat, “painted’ look. Radical color differences of the layers can add depth to the dry film. Original speckling can be replicated with acrylic paint on a toothbrush, in an aerosol sprayer, or in an airbrush setup. This is most effective when added after a transparent first layer of the wet blend during the casting process.

Subtle shifts in perceived color can also be achieved by toning the substrate before or after the composite has been made. The support can affect brightness; light-colored muslin will produce a repair material that is lighter than dark linen. The color of a repair can be adjusted after it is adhered to the volume with spot application of acrylic paints as a final treatment step.

Every volume will have a unique sheen that may change after consolidation and surface cleaning. The acrylic polymers tend to be shiny. Products with matte finishes (Heavy Gel Matte medium or Heavy Body Matte acrylic paint) can be substituted to adjust the sheen of the cast repair. The flat look of patterned book cloth, particularly those of the 19th century, is most successfully replicated by increasing the opacity and decreasing the sheen of the acrylic blend applied to the mold. Combining the matte gel medium and matte acrylic paints will result in the flat, dull look that is characteristic of many book cloths.

The properties of the support substrates can be manipulated by applying them in multiple layers. Multiple supports could provide greater variation with wet or heat-set adhesive application and increased treatment options. Layered supports such as non-woven polyester plus Japanese paper could be used as a modified split-flange board attachment for increased strength (Brock 2001). Non-woven polyesters are trickier to use as a support because they require special adhesive selection. BEVA film is often used by other conservation disciplines for adhering non-woven polyesters.

CONCLUSION
Cast composites show great promise as a repair material for book conservation treatments. The cast composite system is a low-cost and simple technique that can produce high quality materials that replicate the textures of original coverings. They can be fast and easy to make once the technique is learned. Supplies for the repairs are easy to source and are relatively inexpensive. The system is customizable and opens up a range of techniques for repairing bound materials and matching surface textures.

There are several factors to consider with respect to using the cast composites. The technique should be considered experimental until suitable aging and physical testing can be conducted. Until then, we are reliant on testing carried out to date and product information supplied by the manufacturer. Inherent vice of the object, especially degraded leather, will complicate these issues as it routinely does in book conservation.

The cast composite system can be scaled up or down to fit the needs of special or general collections. Films can be cast in bulk to make a modular system with pre-made films and supports. The time and effort to create cast composites is comparable to similar repair materials like solvent-set tissues. With multiple surrogates and molds, a “library” of textured patterns can be compiled to be readily available for use. Overall, the cast composite system leads to less invasive treatments and more complimentary repair materials for book conservators.

ACKNOWLEDGMENTS
The authors would like to thank their colleagues at The New York Public Library, the Barbara Goldsmith Preservation Division, The New York Public Library for the Performing Arts: Jerome Robbins Dance Division, the Library Collections Conservation Discussion Group co-chairs Werner Haun and Jody Beenk, Norman Weiss, Ulysses Jackson at Golden Artist Colors, and Karen Yager for their assistance.

SUPPLIES
Most supplies discussed in this article are available at common conservation suppliers like Talas (330 Morgan Ave, Brooklyn, NY 11211, http://talasonline.com/) or Conservation Resources (5532 Port Royal Road, Springfield, Virginia 22151, http://www.conservationresources.com), local art stores or internet retailers such as DickBlick Art

Acrylic paints, gel media, and additives
Golden Artist Colors, Inc. 188 Bell Road, New Berlin, NY 13411-9527
http://www.goldenpaints.com/products
Heavy Body Acrylic Colors, 2 oz tubes (art supply store)
Heavy Body Matte Colors, 2 oz tubes (art supply store)
Gel Mediums, Heavy (Semi-Gloss) and/or Heavy (Matte), 8 oz jars (art supply store)
GAC 200 Acrylic and GAC 500 Acrylic, 8 oz bottles (art supply store)

Adhesives
Lascaux Acrylic Adhesive 360 HV (Talas)
Lascaux Acrylic Adhesive 498 HV (Talas)
Reversible PVA (neutral pH) WS3978 (Conservation Resources)

Oven liner
Betty Crocker Clean Cookin’ Oven Liner, 23” x 16.25” (housewares store)

Silicone mold kit
Rebound® 25 Smooth-On Silicone Rubber (art supply store)

Textiles
Airplane linen, 54” wide, 100% linen, 6.33 oz/inch² (Talas)
Cotton muslin, 44” wide, 100% cotton fabric (Talas)

Tray
Rubbermaid Drawer Organizer, 15” x 6” x 2” (housewares store)

REFERENCES


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**NOTES**

1. Adapted from presentation given at the Library Collections Conservation Discussion Group, AIC 38th Annual meeting, May 11-14, 2010, Milwaukee, Wisconsin.

2. All safety precautions should be followed as per the manufacturer’s instructions.
<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>CHARACTERISTICS</th>
<th>USE IN CAST COMPOSITE FORMULA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Golden Heavy Gel Medium</td>
<td>Increases body of acrylic paints. Holds peaks from the texture on the silicone rubber mold. Adds dimensionality to the paint mixture without diluting it. (Golden 2007)</td>
<td>Capture and hold peaks from textured mold. Increase film hardness. Select either Semi-gloss or Matte finish to match original surface sheen.</td>
</tr>
<tr>
<td>Golden GAC 200 Specialty Acrylic Polymer</td>
<td>Liquid acrylic polymer emulsion that is the hardest and least flexible of GAC acrylics. Increases film hardness and reduces dry film tack. Decreases flexibility when used as major ingredient. (Rice 2004)</td>
<td>Extender additive for acrylic blend to aid in peak hardening and tack reduction.</td>
</tr>
<tr>
<td>Golden GAC 500 Specialty Acrylic Polymer</td>
<td>Liquid acrylic polymer emulsion with leveling ability and increased mar resistance. Forms a hard, glossy film. The hardest polymer that is suitable for flexible supports. Mix with acrylic colors to increase film hardness and reduce dry film tack, while maintaining flexibility. Particularly useful for extending acrylic colors with minimal property change. (Rice 2004)</td>
<td>Extender additive for acrylic blend to aid in peak hardening, tack reduction, and flexibility. Adds gloss.</td>
</tr>
</tbody>
</table>

Fig. 4. Comparative table of acrylic component characteristics. Use as an aid for customizing the formulation.

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Handout 4.8.
“Continuing Role of Print Collections in a Context of their Digital Delivery; Preservation Risks, Responses, and Actions”

Gary Frost, conservator of Libraries, University of Iowa

Risks

A cascade of white papers and reports confirm that libraries are in a transition to mixed print and screen based services and that this transition is not yet completed (see bibliography). Accordingly, demand for direct access to books is projected to diminish as screen delivery proves more popular. What implications can this transition have for library preservation and the status of physical collections? As whole sectors, ranging from election tabulations, to music recordings, to financial derivatives, to automotive controls have experienced subtle and then devastating consequence derived from transaction of physical to electronic delivery, will the library collections be next to experience unintended consequence? Do we wish to transmit culture directly or via simulation and is the use and study of print collections now subjected to this negotiation?

Should we dispute growing linkage between certification of digital reprography and discard of print sources? Should we pause to consider the influence of the high density storage paradigm if it proves to diminish the status of physical collections? Should we advocate for certification of print masters alongside certification of their screen simulations? What additional risks of transition can be particular to preservation work flows. Recall that libraries long fulfilled preservation responsibilities without named “preservation” departments. Is preservation a direct corollary of library ownership of collections which is not well suited to an ear of subscribed and leased digital resources?

Responses

What should we do in such a vortex? One option going forward is investment in a logic of the interdependence of print and screen access to better assure sustainability of research library services. In this perspective the physical collections and their screen simulations interplay to provide a cohesive service. Print attributes such as fixity, haptic refinement, materiality, and reliable re-access across time, all pair nicely with screen attributes of immediacy, automated search, electronic delivery, and live content.

We should also certainly defend print attributes in an environment of exuberance over screen attributes. Useful attributes of print navigation, legibility, persistence, authentication and constraint are still essential. Let’s review some of these in context with screen delivery.

Navigation

This is the attribute of haptic communication in which the manipulation of the mechanical format conveys additional meaning without distracting comprehension of content. Primate dexterity and a deeply embedded capacity for hands to prompt the mind are fully optimized by the codex mechanism.

Legibility

There is nothing more illegible than a black screen. Network lading and interruption, application, device and platform incompatibilities, battery drain and power requirements impair screen
legibility. Browser default line length and justification distortions reach extremes of legibility. The page is immediately legible.

Persistence
Print is passively persistent and provides both storage and display functions for a single, one-time cost. Screen persistence is not assured due to content decay and mutability, provider interventions or demise and media, software and hardware obsolescence. Fail-safe eye legibility is an exclusive print attribute.

Authentication
Print is self-authenticating with a capacity to sustain continued forensic and bibliographic investigation. The overt nature of print content confirms a positive or negative result for queries. Print content and its material presence is inherently immutable.

Constraint
The constraints of print are attributes. The material constraint eases economies of authorship and production, and packages research and creative investment. Constraints of book design, typography, paper-making, printing and binding assure elegant, efficient delivery to readers. Assured re-reading across time and cultures provides research validity and organization.

Actions
Many enjoyable and crucial actions can be taken to advocate for the interdependence of print and screen collections and for a continuing role of print in a context of their digital delivery. Here are some examples of activities initiated by the Preservation department of the Libraries at the University of Iowa. These include our Print Alcove, our Leaf Master collections and our instructional outreach regarding the future of the book.

Print Alcove
The Print Alcove is situated in a section of the entrance level of the Main Library. This gathering area includes a compelling and attractive display of the new print acquisitions. There is also an array of print newspaper dispensing machines and our cool Zine Machine stocked with student productions. In the very corner, is the bizarre Columbian press (1843). This printing press is an endless prompt of curiosity and an effective billboard for lectures and events of our Center for the Book. The Print Alcove also serves as a demonstration area for our annual, Library sponsored, Book Festival. Hopefully, the Print Alcove gives focus to the Library’s interest in the strategic future of tangible collections and the scholarly future of print.

Leaf Master Collection
The concept of a “leaf master” print collection sequestered to act as sources for digital copies is proposed as a component of interdependence of print collections and their screen delivery. To date our “leaf master” collections consists of original brittle books that have been replaced by preservation photocopies. These are shrink wrapped and classified both by shelf mark and year of replacement copy.

The “leaf master” collection implies a further proposal for certification of print masters generally, modeled on certified designation of alkaline paper. While automated certifications of digital repositories are being developed we should also consider the function of print collections, composed of certified copies, which can act to confirm authenticity of screen simulations.

Instructional Outreach
Wide redefinition of the interaction of print and screen books is in progress in fields of diverse as neurology of reading, digital preservation, e-book marketing, and technology of print on demand. Discussion extends from blog rants on the death of the book, to touch-screen haptics, to cloud libraries. Over arching this dynamic is the eulogized role of the physical book and its imprint on the future of cultural transmission.

We produce both short workshops and longer credit seminars which investigate the future of the book in a context of its mixed print and electronic delivery. Students survey issues and experience distinctive affordances of the paper and screen book. The sessions include visiting book in a context of its mixed print and electronic delivery. Students survey issues and produce both short workshops and longer credit seminars which investigate the future of the book in a context of its mixed print and electronic delivery. Students survey issues and experience distinctive affordances of the paper and screen book. The sessions include visiting student presentations. Such instructional outreach is of interest to those in book studies, communication studies and library and information studies. It has also proven popular with bibliophile and continuing education enclaves. Two up-coming Preservation department sponsored seminars are “Future of the Book,” Center for the Book, fall 2010 and “Strategic Future of Print Collections in Research Libraries” ALA/ALCTS: PARS and RBMS, June 27, 2010.

Bibliography

1. “Certification of Portico and HathiTrust,” Center for Research Libraries. (Report forthcoming, 2009). This assessment will ink electronic-only resources with decommissioning of print. The gratuitous “hybrid” approach will “move more aggressively to reduce the costs of redundant print holding.”
4. “Final Report, Provost’s Task Force on the University Library,” University of Chicago, July 2006. “…it is clear that most of the technologies that today aim to automate or simplify or replace parts of library research do not in fact accomplish what it accomplishes now, but rather do something different to a greater or lesser extent.”
9. “Library Storage Facilities and the Future of Print Collections in North America,” Lizanne Payne, OCLC, 2007. This report considers the future of library print collections. Reduction of legacy print collections is considered in context with a distributed print repository network. “Academic institutions are questioning whether their already low-use print collections will be made obsolete by more flexible and accessible digital book collections.”
10. “Managing the collective collection,” Jim Micalko and Constance Maipas, No.12, June 2009, OCLC. This evaluation of projects hub repositories for print and associated reduction in aggregate academic duplication of print. Deacquisition processing would use interlibrary loan infrastructure.
11. “Mass Digitization: Implications for Preserving the Scholarly Record,” Trudi Hahn, LRTS, 52/1, 2008. This report admonishes the preservation community to stop being so reactive and to take a more strategic approach to preservation of digital access to books. There is a view that research library custodial care of books should not be relinquished to search utilities.
14. “Preservation in the Age of Large-Scale Digitization,” Oya Reiger, CLIR, 2008. “The goal of this white paper is to consider the potential links between large-scale digitization and long-term preservation of print and digital content, with emphasis on research library collections.” Mechanisms of interdependence between print and digital book collections are discussed with reference to back-up, mastering and authentication roles and costs.


17. “The Research Library Role in Digital Repository Services,” ARL, Task Force, 2009. This report contends that sustainable repository responsibility must be extended to digital research materials and resources and that the legacy function of research libraries must be continued.


Abstract

The William Barrow Laboratory’s pioneering 1974 analysis of 1,470 historical papers from the 16th through 20th centuries demonstrated that early, well-preserved papers were made from pure cellulose (rags), were neutral or slightly alkaline in pH, and contained an alkaline reserve (likely calcium carbonate). Because the Barrow work was based on destructive tests, exceptionally stable 15th century papers were not included in the study due to their rarity and value.

With funding from the IMLS, the University of Iowa, and the Kress Foundation, and with support from a number of collaborating institutions, in the Fall of 2009 we completed a two-year study of 1,580 primarily European papers using non-destructive methods. Book, manuscript, and printmaking papers made between the 14th and the 19th centuries were tested using XRF and UV-Vis-NIR instrumentation. For each specimen, we gathered data on 15 chemical or physical variables as well as publication information (date, title, author, country, etc.). The data show that the 15th century papers tested were thicker and had higher gelatin and calcium concentrations compared with papers made in subsequent centuries. Preliminary results also indicate that lighter color was generally associated with higher levels of gelatin and calcium, and overall superior materials and workmanship. In two related experiments, we are investigating the ability of non-destructive XRF, UV-Vis-NIR, and ultrasonic methods to predict changes in the concentrations of Ca, Fe, alum, and strength in historical papers as a result of typical aqueous conservation treatments.

All research methods and results of the study will be published as an interactive website in 2010. Research results are expected to be of interest to conservators, paper historians, and those who manufacture modern archival papers. The data will also serve as a key reference for any future accelerated aging studies designed to investigate the causes of paper aging.

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The Role of Electrophilic Metal Ions AluminumIII and MagnesiumII in Paper Degradation and Deacidification

ABSTRACT

While conservation scientists acknowledge the oxidative degradation of cellulose in paper to be complex, they overwhelmingly present hydrolysis as proceeding in just one way in paper degradation, via a proton-catalyzed mechanism. Researchers report in the scientific literature, however, an important additional mechanism of degradation where aluminumIII (AlIII), the metal cation in papermaker’s alum, is present. This competing mode of degradation has a differing pH dependence and temperature dependence, thus affecting deacidification measures and influencing accelerated aging tests, respectively.

At the 38th Annual Meeting of the American Institute for Conservation (AIC) in Milwaukee (spring 2010), Heritage Science for Conservation presented an ongoing study targeting these competing reactions. Innovative approaches include systematic incorporation of macromolecular structure and phase interactions into aging studies, and sample formulation techniques that better isolate mechanisms and improve ionic strength and pH control. Results show unambiguous destabilization of samples by AlIII, controlling for critical variables including pH. Preliminary pH dependence results suggest that the effect may disappear between pH 5.0 and 6.9, supporting deacidification as an effective means of limiting both mechanisms of degradation.

INTRODUCTION

Aluminum salts were traditionally applied in Western papermaking to limit gelatin putrefaction and to harden gelatin size (Brückle 1993). While the prevailing use of them during the 19th and 20th centuries for the first major internal sizing—rosin-alum sizing—has now been diminished by alkyl succinic anhydride (ASA) and alkyl ketene dimer (AKD) sizing systems, aluminum salts remain ubiquitous in modern papermaking as retention, drainage, and flocculation aids, to control pH, and to fix resins and dyestuffs (Scott 1996). Commentators explicitly documented the relationship of aluminum salts to poor permanence early in the 19th century (Stanley 1992), and conservation scientists now attribute this degradation primarily to the behavior of water-coordinated AlIII as a Bronsted-Lowry acid (W. J. Barrow Inc. 1974; Priest and Farrar 1994). A Bronsted-Lowry acid is any ion or molecule that loses or “donates” a proton, H+. As illustrated in figure 1, protons readily catalyze the hydrolysis of cellulose, and there is no doubt that this mechanism is a significant component of paper degradation in libraries, museums, and archives.

hydrolysis of cellulose in the presence of ironIII chloride, enabled by suspected ironIII coordination with the leaving group. Baty and Sinnott did find efficient electrophile-catalyzed hydrolysis under the conditions tested, but the pH range was limited to where the sample could remain a homogenous aqueous solution (3.0 –3.5), avoiding crystal entrainment of either products or reactants preferentially, which would skew results. Further limitations of the study were that while the cellulose model compound mimicked cellulose perfectly in terms of steric and inductive effects around the glycosidic linkage—the site of hydrolysis—it did not incorporate the macromolecular structure that is retained in paper, nor the particular way in which water is present adsorbed onto the paper fibers in heritage collections.

Periodically, however, reviewers have suggested that the picture is more complex for papers containing AlIII salts such as papermaker’s alum. Parks concluded in 1971 that destabilization of cellulose by aluminum sulfate is qualitatively different from destabilization by sulfuric acid, which should not be the case if the AlIII is acting exclusively as a Bronsted acid. From a kinetics study, Barański, Dziembaj, and coworkers (2004) concluded that in addition to proton-catalyzed hydrolysis, some other mechanism must be simultaneously at work. Gurnagul, Howard, and coworkers noted in a 1993 review that “it is a matter for some astonishment that we still do not know for certain . . . the exact mechanism by which aluminium compounds affect permanence . . . .”

A previous study (Baty and Sinnott 2004; 2005) tested the hypothesis that AlIII is directly catalyzing cellulose hydrolysis relevant to paper-based heritage materials degradation. Such catalysis could proceed from the coordination pattern illustrated in figure 2. Notice that the C6′-OH group is well positioned to behave as a second ligand to chelate, “bite,” the AlIII in place, though this coordination has not been proven. The 2004–2005 Baty and Sinnott study was prompted by the realization that physical organic chemists have known of an electrophile-catalyzed hydrolysis of glycosides with relatively stable leaving groups (the part of the molecule that breaks off) for some time (Clark and Hay 1970; Clark, Hay, and Dea 1973), although the same hypothesis could equally have been prompted by Popoola’s (1991) observation of enhanced hydrolysis of cellulose in the presence of ironIII chloride, enabled by suspected ironIII coordination with the leaving group. Baty and Sinnott did find efficient electrophile-catalyzed hydrolysis under the conditions tested, but the pH range was limited to where the sample could remain a homogenous aqueous solution (3.0–3.5), avoiding crystal entrainment of either products or reactants preferentially, which would skew results. Further limitations of the study were that while the cellulose model compound mimicked cellulose perfectly in terms of steric and inductive effects around the glycosidic linkage—the site of hydrolysis—it did not incorporate the macromolecular structure that is retained in paper, nor the particular way in which water is present adsorbed onto the paper fibers in heritage collections.
There are also electrophilic metal centers other than Al$^{III}$ that can be present in paper-based heritage collections, and we hypothesize that these may catalyze the hydrolysis of cellulose in a similar way. These other metal ions include magnesiumII ($\text{Mg}^{II}$) and ironII. In this study we are particularly interested in $\text{Mg}^{II}$ because it is present in many compounds such as magnesium oxide and magnesium carbonate that conservators use in deacidification (Baty, Minter, and Lee 2010).

**MATERIALS AND METHODS**

**Substrates—Macerated and Intact Paper**

Overcoming the limitations of previous work to assess the scope of Al$^{III}$ catalysis of cellulose hydrolysis in paper (limited pH range, no macromolecular effects incorporated) must involve the use of a heterogeneous sample—paper itself. Whatman 42 filter paper was used in this study because it was the next gradual step from small molecule studies. Whatman 42 contains the relevant cellulose macromolecular and water sorption properties, but lacks hemicellulose, lignin, and salts that can be found in paper-based heritage collections. These other components and structural features must be added systematically in future experiments to measure their effects against adequate controls.

This research project consists of two phases: (1) The Whatman paper is macerated and aged while immersed in an aqueous mixture. (2) The various compounds of interest are deposited onto the Whatman paper and aged with the amount of water that is adsorbed (~5.5%) at ambient conditions (TAPPI Standard Conditioning Atmosphere (1998)). In the first phase, the ratio of oven-dry equivalent weight paper to aqueous mixture was that of the TAPPI hot extraction pH test method (1.00 g : 70 mL, TAPPI 2002). This TAPPI standard dates to the 1930s and is a key component of the concept of paper pH. By completing the first phase in aqueous mixtures, it was possible to draw the analogy between what was measured in this study and previous small molecule studies. Also, since each replicate was easier to perform in the aqueous system, it helps to identify suitable conditions for aging the paper intact.

**Buffering Systems**

In this study, common-ion-effect buffers were used, which hold the pH at a certain set point via Le Chatelier’s principle, as opposed to alkaline reserve buffers, which hold the pH at the pK$_a$ of the alkaline agents until they are depleted (if ever) by Brønsted acids. Using these buffers ($5.1$ molar ionic strength buffer: molar anhydroglucose units of cellulose) in this innovative fashion enabled studying paper degradation at a specific pH, rather than allowing the variable of pH to “float” during aging. Since this was an Arrhenius study conducted at elevated temperatures, care was taken to select buffering systems with a low pH dependence on temperature—a low dpH/

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**Fig. 3. Useful pH ranges of select common-ion-effect buffering systems**

$dT$ (Dawson, Elliott et al. 1986). Figure 3 shows the approximate useful ranges of four buffering systems selected for this study: succinic acid pH$_{pK_a}$/sucinate, acetic acid/acetate, monobasic/dibasic phosphate, and dibasic/tribasic phosphate.

**Catalysts and Catalytic Controls**

Aluminum sulfate, a.k.a. papermaker’s alum (20 mM Al$_3$(SO$_4$)$_2$) was the first salt studied in this project for its hypothesized role as a catalyst. In order to see the effects of the Al$^{III}$ metal center, sulfate had to be present in the same amount in the control. Accordingly lanthanum sulfate was used, since the lanthanumIII cation (La$^{III}$) is much larger and heavier than Al$^{III}$, thus not a candidate for electrophilic attack. The addition of this salt to the control series also controlled for the kinetic ionic strength effect, which is the phenomenon whereby reactions are observed to proceed faster with a higher overall concentration of salts (that do not necessarily participate in the degradation mechanism). While Mg$^{II}$ opposite a number of anions is of continuing interest in this study given the many Mg$^{II}$ compounds used over the years for aqueous and non-aqueous deacidification (Baty, Minter, and Lee 2010), the first step was to study Mg$^{II}$ opposite sulfate to draw the analogy from the aluminum/lanthanum series—isolating the effects of the cation. Still, this comparison cannot be a direct one because Mg$^{II}$ is divalent and Al$^{III}$, La$^{III}$ are trivalent.

**Reaction Vessels**

This section is expanded to present a case study of particular concern to conservation—reaction vessels for accelerated aging. Although there is no apparent consensus among conservation scientists on the preferred method of accelerated aging between humid oven and sealed vessel methods, for this study the sealed vessel approach, advocated for example by the Library of Congress (2009), was selected for two reasons: (1) An inert atmosphere can more easily be achieved in a sealed vessel. (Nitrogen gas was used to control for oxidative mechanisms
Admittedly, a vessel with ample liquid water in it will have additional pressure (attributable to the saturated vapor pressure and the thermal expansion of the aqueous phase) than just water vapor or adsorbed water at the same temperature. Note however that (1) the saturated vapor pressure is not an overwhelming component of the total pressure at temperatures commonly used for accelerated aging, and (2) many vessels tested in this study failed at temperatures 10–20°C below the specified standard temperature (100°C).

To overcome this obstacle of failing aging vessels and to create a useful tool for conservation scientists and conservators, considerable effort was expended to develop an aging vessel testing procedure. The concept was to specify a volume of deionized water to put into vessels and to specify a temperature at which to heat the vessels overnight that will exert the same pressure on the vessels as the actual aging test will. No loss of the deionized water by the following day would establish the suitability of the vessel for the aging application. At press time the approach of basing the procedure on existing saturated vapor pressure equations has just been abandoned and the authors are now working on a procedure derived from empirically determined data specifically for this application.

A second concern for the sealed vessel aging study, voiced by the senior project conservator, was the possibility of off-gassing caused by plastic caps and seals. While the physical scientists on the team were not initially concerned about the use of solid fluoropolymer (e.g., Teflon) or fluoropolymer-lined caps or gaskets exposed to the headspace, that argument assumed that the fluoropolymer be of good quality and completely cover any other material of concern throughout the course of an experiment. Because the means of verifying that off-gassing was not occurring (e.g., solid phase microextraction/gas chromatography) was not readily accessible to this laboratory, nor is it accessible to most conservation and conservation science laboratories, considerable effort went into the development of a glass-on-glass seal for an accelerated aging vessel. Currently this vessel is in development but not yet incorporated into this study. Rather, two different vessels were selected following preliminary testing. For temperatures ≤ 50°C, glass bottles (100 mL, part number 21 801 24 09) and fluoropolymer-lined polybutylene terephthalate (PBT) screw caps (part number 29 240 28 07) were obtained from Schott North America Inc.; for temperatures above 50°C, Ace Glass Inc. pressure bottles (part number 8648-194 modified to have a flat bottom for a maceration surface), were used out of an abundance of caution. These were sealed with their fluoroelastomer-with-tetrafluoroethylene-additives (FETFE) O-Rings and solid polytetrafluoroethylene (PTFE) plugs (part number 5846-51).

**Reaction Vessel Loading and Maceration**

Whatman 42 paper was cut into chips (0.5–1.0 cm each dimension, as in TAPP1 2002), conditioned, and divided into aliquots (1 ± 0.01 g equivalent oven-dry weight). In a glove
bag, buffering solutions containing catalysts/catalytic controls and a specific make of stir bar (Fisherbrand octagonal 3/8 x 1 1/2 in., part number 14-513-52) were sparged (1 hr., UHP 99.999% grade N₂) under a blanket of N₂ measuring ≤0.5% O₂, the paper added and the vessels sealed. The paper was macerated by magnetic stirring (2 hrs.) on stir plates measuring 750 RPM under a standard condition. Each sample was rotated among all stir plates during the maceration to equally distribute any differences in mechanical action delivered by the different stir plates.

Incubation

Temperatures were controlled to within ± 4°C (Fisher Isotemp 725G, Lunaire Steady State Stability Test Chamber CEO910-3). Incubation temperatures and time are reported in the results section. Since the exposures are days to weeks in duration, warm-up time was negligible. After incubation, samples vessels were weighed to detect failures and cooled at 4°C prior to analysis.

Analysis

Each sample pH was determined to verify buffing during incubation, the fibers rinsed in DI H₂O/EtOH (anhy) with the filter cake collected from EtOH (Büchner filtration, 20–25 μm pore size Whatman Quantitative Grade), which was dried (105°C, 4 hrs.). Tricarbanilate derivatization was performed according to Stol, Pedersoli and co-workers (2002) as follows: Into a glass reaction vial, dry sample (5.0 ± 0.2 mg) was tweezed, 1.00 mL anhy. pyridine solvent, and 0.100 mL phenylisocyanate reactant added. After derivatization (48.0 hrs., 80 ± 0.4 °C), the reaction was stopped with 0.100 mL MeOH, the solution allowed to cool, and diluted with 2.03 mL tetrahydrofuran.

The solutions were filtered (0.20 μm) using a syringe-mounted filter and analyzed via Gel Permeation Chromatography–UV detection, using a Shimadzu Prominence GPC (LC-20AT pump, CBM-20A lite controller, SPD-20A UV detector). Separation in tetrahydrofuran of injection volume 40 μL was achieved on one Waters Sytrigel HR 4 and one Waters Sytrigel HR 5 in series at 35°C, flow rate 0.500 mL/min, the system calibrated with polystyrenes. All samples, controls, and initial condition measurements were run in triplicate.

RESULTS AND DISCUSSION

Figure 5 shows the useful ranges of the buffering salts given in figure 3, plotting the data sets obtained thus far at combinations of temperatures 40, 50, and 90°C; and pH 3.3, 5.0, 6.9, and 8.2. To date, all results are from the first phase of the research, in which we aged the fibers in excess water. Aluminum sulfate, a.k.a. papermaker’s alum, is currently the primary salt we are investigating for catalysis of degradation in this study, since it overtook potassium aluminum sulfate during the 19th century as the prevailing industrial aluminum salt (Brückle 1993). We selected the concentration (20 mM Al₃(SO₄)₃) to draw the analogy between our results and those of the previous small molecule study (Baty and Sinnott 2004; 2005) in which the ratio of metal cations to cellulose monomers is the same. The concentration selected for this (and the previous) study we expect to conservatively underrepresent the Al³⁺ concentration of, for example, 20th century publication papers: Priest, Stanley, and coworkers (1998) found a range of 1.3%–6.7% Al₃(SO₄)₃ (average 3.8%) for such papers using atomic absorption spectroscopy of acid extracts. To observe the role of the Al³⁺ ion while controlling for sulfate concentration and ionic strength, we set aluminum and lanthanum sulfate at a consistent concentration throughout the series, 20 mM with respect to the salt and 40 mM with respect to the cation. Two different concentrations of the magnesium sulfate (and the aluminum and magnesium salts together) represent a change in our thinking for the magnesium salt concentration. At first we held the overall salt concentration equal to the aluminum/lanthanum series. Later, since the objective was to test destabilization due to the cation (Mg²⁺), we doubled the concentration to hold the cation concentration the same as those of the aluminum/lanthanum series. But note that this adjustment then makes the sulfate concentrations different.

Figures 6–9 show the weight average molecular weights of tricarbanilate-derivatized cellulose for the initial condition, samples, and controls. Since we calibrated the columns using polystyrene standards, the reported weights are offset by some as yet undetermined factor. While we are currently working to determine the absolute molecular weight using multiangle light scattering detection (MALS), for many useful kinetics criteria we do not need the absolute molecular weight. Moreover, we clearly see unambiguous effects of the catalyst relative to the initial condition and kinetic ionic strength effect controls in these results. Specifically, figures...
show significant destabilization of the cellulose by the $\text{Al}^{\text{III}}$ cation, controlling for (1) the pH, (2) the kinetic ionic strength effect, and (3) the anion identity—sulfate. The hypothesis that acidic papers degrade significantly via an $\text{Al}^{\text{III}}$-catalyzed route is therefore strongly supported here. We expect the sulfate anion to influence the rate of degradation in this reaction, rendering the $\text{Al}^{\text{III}}$ center less active than it would be opposite chloride, both of which Chamberlain (2007) has measured. This decreased activity may be due to anation of the $\text{Al}^{\text{III}}$ by the sulfate (Baty and Sinnott 2005).

Despite this likely reduction in rate caused by the anion, we still see unambiguous effects. This effect of cellulose destabilization in the presence of $\text{Al}^{\text{III}}$ is apparently pH dependant, however. Notice in figure 9, showing aging at pH 6.9, there is no significant difference between the $\text{Al}^{\text{III}}$-containing sample and controls, supporting the premise that neutralization via deacidification of these papers may be an effective means of limiting the $\text{Al}^{\text{III}}$-catalyzed mechanism of degradation, as it is for the proton-catalyzed route.

Similarly encouraging is the apparent benign behavior of $\text{Mg}^{\text{II}}$, which we tested here for its possible role as an electrophilic catalyst for hydrolysis. Throughout these tests, we observe no significant difference in degradation between the $\text{Mg}^{\text{II}}$-containing samples and the controls. While the data do not establish significance, the seemingly wider distribution of weight average molecular weights of the magnesium-containing sample sets relative to the $\text{Al}^{\text{III}}$ and $\text{La}^{\text{III}}$ samples seen in figures 6, 7, and 9 is worthy of further study. Some presently unseen variable may be at work slowing or promoting the mechanism under these conditions.

Finally, results from those samples containing both $\text{Al}^{\text{III}}$ and $\text{Mg}^{\text{II}}$ together (figs. 6–8) offer no surprising results. We added both of these two metal cations to samples to see
whether acting together they will increase or decrease catalytic activity, a phenomenon that Shahani, Hengemihle, and Kresh (1995) observed previously in the oxidative degradation of paper-based heritage collections. This phenomenon is especially pertinent to Al\textsuperscript{III}, which will readily form polynuclear coordination complexes under certain conditions in aqueous environments. The degradation we observe to date, however, may be approximately that which we would expect from the suspected catalysts acting independently with no “sympathetic” effect in evidence.

CONCLUSIONS

1. We observe significant loss of cellulose degree of polymerization of paper fibers due to the presence of Al\textsuperscript{III} at pH 3.3 and 5.0, while controlling for critical variables including:
   A. pH
   B. Ionic strength
   C. Counterion identity—sulfate

   This result strongly supports the hypothesis that cellulose hydrolysis proceeds substantially via a different chemical mechanism in Al\textsuperscript{III}-containing papers than the proton-catalyzed mechanism conservation scientists previously believed to be the primary cause of this degradation.

2. Preliminary pH dependence results suggest that, as pH reaches 6.9, destabilization by Al\textsuperscript{III} is no longer active, supporting the hypothesis that deacidification is an effective means of stopping the electrophile-catalyzed hydrolysis.

3. Because, like Al\textsuperscript{III}, Mg\textsuperscript{II} is also electrophilic, we tested it for its ability to catalyze cellulose hydrolysis. Under the conditions of this experiment, however, we did not observe destabilization by Mg\textsuperscript{II}, revealing no evidence of new concerns for its use in a deacidification agent.

FUTURE WORK

This research agenda will continue through summer 2011, during which time we will carry out the evaluation of pH dependence of the Al\textsuperscript{III}-catalyzed cellulose hydrolysis in conditions relevant to paper-based heritage collections, since this dependence appears to be discontinuous. As presented above, preliminary data suggest that this mechanism is highly significant at pH 5.0 and below—but not observed at pH 6.9—suggesting that deacidification should be an effective means of conserving papers containing Al\textsuperscript{III}. It is important to determine, however, that there are not any “hot spots”—meaning pH ranges or other factors at which increased catalytic activity is observed—the knowledge of which could aid in deacidification strategy. We will also continue to study two metal centers present together in the paper, particularly the combination of Al\textsuperscript{III} and Mg\textsuperscript{II} for its relevance to deacidification.

Reinforced by the pH dependence data, we will acquire additional temperature dependence data for the Al\textsuperscript{III}-catalyzed mechanism, from which the important criterion of activation energy is soluble. This criterion is needed to forecast the significance of the mechanism to ambient (library/museum/archival) conditions. Also, since the mechanism clearly works in combination with the proton-catalyzed path, activation energy is needed to gauge its contribution to overall degradation at different conditions.

Finally, we will extend the experimental design set up for this work to the study of other metal centers that have the potential to be catalysts for hydrolysis or oxidation. Since we have taken particular care in this method to limit oxidation (and to control proton-catalyzed hydrolysis using common-ion-effect buffers) this is a unique opportunity to see how these mechanisms “fit together” to work the degradation in paper-based heritage collections.

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Quantitative Hyperspectral Imaging Technique for Condition Assessment and Monitoring of Historical Documents

ABSTRACT

Quantitative hyperspectral imaging (QHSI) is a non-destructive remote sensing technique which can detect small changes of the optical characteristics of material surfaces before they become visible for the human eye. The Nationaal Archief (National Archives of the Netherlands, The Hague) is conducting an applicability study on the use of QHSI for detecting, measuring and visualizing optical changes in historical documents caused by aging process and conservation treatments.

Repeated hyperspectral measurements of a document, taken for example before and after an exhibition, can be used to detect, map and classify subtle changes of the document condition with very high spatial resolution. Due to small differences in the position and deformation of the document during a storage or exhibition period, the measurement data first need to be spatially aligned. Mathematical transformations have to be applied to the hyperspectral image data in order to ensure that any particular pixel coordinate refers in both measurements to exactly the same location on the object. Then the differences between two corresponding spectral images from the first and second measurement can be calculated pixel-by-pixel. Non-zero differences of the pixel values mark optical changes within the document, which can be visualized in grayscale or color-coded images that help the conservator to identify the most critical areas on the document.

By calculating the differences, not only for individual spectral images but for the entire two hyperspectral data cubes, it may be possible to distinguish various degradation effects and provide a detailed statistical description of the spectral changes of the recorded sample. This makes the QHSI technique a valuable tool for an objective assessment of the document condition.

INTRODUCTION

Most archival institutions regularly assess the condition of their collections in order to determine whether documents are suitable for transport, public exhibition and access by researchers. This procedure typically includes a detailed visual inspection of the documents by an expert, supplemented by a photographic documentation and possibly the application of non-destructive measurement techniques at a few selected locations. However, conventional condition assessments can easily fail to detect subtle changes of the varied materials composing historical documents. There is in fact the risk that small optical changes over large areas or large changes in very small areas are overlooked, because they were not documented with sufficient precision in previous condition reports.

Quantitative hyperspectral imaging (QHSI) is a non-destructive imaging technique that allows one to measure and document the optical characteristics at millions of object points simultaneously and with high accuracy. The Nationaal Archief (National Archives of the Netherlands, The Hague) are investigating the potential of this technique to quantify and map optical changes of documents resulting from deterioration processes with high spatial resolution. Samples were manufactured from different materials and artificially aged in several steps to simulate the effects that exhibitions can induce in original documents under controlled conditions. After each aging step or exhibition period the samples were measured with the SEPIA quantitative hyperspectral imager owned by the Nationaal Archief.

In addition to these measurements on artificially aged samples, hyperspectral measurements are carried out also on a series of original documents in order to monitor natural aging process and the effect of exhibition environments directly on the original artifacts.

In this article we discuss techniques to compare the hyperspectral data sets obtained from repeated measurements of the same object so that it becomes possible to characterize and visualize local changes in the reflectance spectra.
MEASUREMENT PRINCIPLE

The SEPIA quantitative hyperspectral imager used in these experiments is based on two wavelength Tunable Light Projectors (TULIPs), which illuminate the document under an angle of 45°. These TULIPs are combined with a monochrome digital camera which records the document from above (fig. 1). The TULIPs subsequently illuminate the document with a series of 70 well-defined optical wavelengths in the ultra-violet, visible and near-infrared wavelength range (365–1100 nm). At each wavelength, a 4 megapixel grayscale image of a document area of 125 mm x 125 mm is recorded, corresponding to a resolution of 60 μm x 60 μm per pixel (ca. 400 dpi).

To translate the pixel values into quantitative measurements of the local spectral reflectance of the document, the recorded images at each wavelength band have to be compared to recordings of a reference target. In this case a white reference target (Spectralon target, supplied by Labsphere inc.) with known reflectance is used for this calibration step. After this calibration, the value of each image pixel represents a precise measurement of the fraction of light reflected from the corresponding tiny document area at this particular wavelength and can be regarded as a local quantitative reflectance measurement. This hyperspectral imaging technique is therefore referred to as quantitative hyperspectral imaging [Klein et al. 2008]. The entire set of these (calibrated) spectral images is called the hyperspectral data cube. It contains for each pixel the entire spectral reflectance curve (fig. 2).

The spectral information in the hyperspectral data cube can then be used to distinguish different writing materials such as inks and pigments, to enhance the legibility of degraded texts, to determine deterioration effects on a document following an exposition or treatment, and to measure spectral changes caused by aging processes.

ALIGNING HYPER SPECTRAL MEASUREMENT DATA

In order to develop and test different techniques for analyzing series of hyperspectral recordings a number of discarded documents of the Nationaal Archief were artificially aged in 5 steps. During each aging period, the samples were exposed to changes of temperature, relative humidity and to a certain light dose, as described in detail in [Padoan et al. 2009]. In particular, the light dose and the spectral content of the irradiation were set to simulate in each accelerated aging step the effect of 1 month of light exposure received by documents in the exhibition room of the Nationaal Archief. The lighting conditions for the documents in this exhibition room are expected to induce only a minimal cumulative light aging effect [Johnston-Feller 2001, Schaeffer 2001, Thomson 2002].

Before, between and after the artificial aging steps hyperspectral imaging measurements of the sample were carried out. These hyperspectral measurements are referred to as recording R0, R1, R2, R3, R4 and R5.

Figure 3 shows color images of one of these documents (a 19th century printed paper cut in a format of 63 mm x 20 mm) that were calculated from the hyperspectral data measured before aging was applied (R0), after 2 aging steps (R2) and after 5 aging steps (R5), respectively. A careful comparison of these calibrated images indicates that the artificial aging has induced a very small intensification (darkening) of the foxing that had developed due to more than 100 years of natural aging before artificial aging was applied.

In order to be able to quantify for all points on the document the spectral changes caused by the artificial aging, the corresponding spectral images of all three hyperspectral measurements have to be aligned relative to each other with pixel-accuracy. Figure 4 illustrates the importance of the alignment of the hyperspectral data prior to the pixel-by-pixel analysis. Figures 4A and 4B show in grayscale the difference of

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**Fig. 1.** Schematic overview of the QHSI instrument setup

**Fig. 2.** Schematic representation of the hyperspectral data cube
without prior alignment of the two measurements, any (small) change of the spectral characteristics of the sample induced by the artificial aging will be completely obscured by the large calculation error caused by the spatial misalignment. Figure 4B shows the difference image of the same 900 nm spectral images after a so-called image registration algorithm was applied to correct the shift, rotation and warp of the R5 image relative to the sample area recorded in the R0 image. The homogeneous medium grey proves that the alignment of both 900 nm images has worked very well especially around the text areas. By applying exactly the same spatial correction to all other hyperspectral images of the R5 recording, each of them becomes fully aligned with its counterpart in the R0 recording. In this way it becomes possible to directly compare the entire spectral reflectance curves of even very small sample areas such as thin ink lines or small foxing spots.

Fig. 3. Photos of artificially aged original document before aging, after 2 and after 5 aging steps simulating as many months of exhibition in a suitable environment

Fig. 4. Difference of calibrated 900 nm spectral images recorded before artificial aging and after 5 aging steps. White=positive values, dark=negative values, medium grey = zero difference; A) without alignment of hyperspectral data cube; B) with alignment of data cube

Fig. 5. A) Regions-of-interest (ROIs) that were defined on the artificially aged object sample for foxing (F), paper (P) and ink (I) areas. For all aging steps exactly the same areas were used due to the alignment of the hyperspectral data. B) Spectral reflectance curves of all ROIs for the three aging steps showing changes of several percent for the foxing area

The homogeneous medium grey proves that the alignment of both 900 nm images has worked very well especially around the text areas. By applying exactly the same spatial correction to all other hyperspectral images of the R5 recording, each of them becomes fully aligned with its counterpart in the R0 recording. In this way it becomes possible to directly compare the entire spectral reflectance curves of even very small sample areas such as thin ink lines or small foxing spots.

AGING-INDUCED CHANGES OF SPECTRAL CURVES IN REGIONS-OF-INTERESTS

Having aligned the R2 and R5 recording relative to the R0 recording of the artificially aged document sample, any regions-of-interest (ROIs) that are marked in a spectral image of one of the recordings mark exactly the same document areas in all spectral images of all three recordings. Figure 5A
shows three ROIs that were manually marked on the 500 nm spectral image of the R5 recording, covering small areas of ink, paper substrate and foxing, respectively. For each of these ROIs, the mean calibrated spectral reflectance curves of their pixels were extracted from the three hyperspectral measurements. Figure 5B shows these spectral curves with a different color for each of the three measurements.

The three curves for the ink area overlap perfectly, which indicates a high reproducibility of the measurements in combination with the spatial alignment. While the artificial aging obviously has not affected measurably the optical characteristics of the ink, this high reproducibility guarantees that any observed spectral changes are indeed significant and not a measurement error.

The curves for the paper ROI show a small, systematic reduction of the spectral reflectance at the shorter visible wavelengths (365–600 nm) with a maximal difference of less then 2% between the R0 recording and the R5 recording. In the infrared, an increase of the spectral curve from the R0 to the R2 recording, but no further change from the R2 to the R5 recording is observed. The maximal difference is less then 2% in the infrared, as well.

The foxing areas show a much stronger reaction to the artificial aging with a considerable drop of the spectral curve over the entire visible range up to about 800 nm. In the green and red spectrum, the absolute change peaks at about 9%. Such a large change of the (visible) reflectance spectrum—especially in comparison with the normal paper substrate itself—could be expected to be clearly visible also in the calibrated color images of figure 3. However, the foxing is not homogeneous and the high-intensity foxing area marked as the ROI is very small, so that such very local changes can be overlooked or underestimated considerably in a visual comparison of the color images.

**AGING EFFECTS AT SELECTED WAVELENGTHS**

Comparing the mean spectral curves of ROIs provides valuable quantitative information about the influence of artificial aging on the optical characteristics of different document areas. However, by selecting the ROIs the spatial variation of the optical characteristics within the measured document area is completely neglected. There is the risk that the results obtained for the ROIs are not representative for the entire area, because the manual definition of ROIs is always subjective to some degree. Since all spectral images of all measurements are aligned, it has become possible to compare the document before and after aging on a pixel-by-pixel basis, i.e. with high spatial resolution. From the ROI analysis we know how the spectral curves for foxing areas and normal paper areas change. Based on these results the wavelengths 450 nm, 610 nm and 710 nm were chosen for the pixel-by-pixel analysis. For each of these wavelengths, the grayscale calibrated spectral image of the R0 measurement (no aging applied) was subtracted from the corresponding grayscale spectral images of the R2 and of the R5 measurements. The resulting three difference images for each the R2 and the R5 measurement were assigned to the blue, green and red channels of the two false-color images shown in figure 6(A) and 6(B), respectively. Neutral gray indicates areas which have no measurable change in reflectance in any of the three wavelengths. If an area has a measurable change in any of the three selected wavelengths the corresponding pixel is colored.

In both false-color images the ink areas have in fact a neutral gray, which means that these areas were not influenced in a measurable way by the artificial aging. As opposed to this, the paper substrate and especially the foxing areas are shown in color already in the R2 image. This color intensifies in the R5 image and additional foxing spots become visible. This visualizes the progression of the spectral changes caused by the repeated artificial aging.

**COMPARING SPECTRAL CURVES WITH PIXEL-RESOLUTION**

All spectral images within the data cube of a single hyperspectral measurement are aligned with pixel-accuracy. This means that for the tiny area on the object corresponding to each pixel the entire spectral reflectance curve is available for processing. Due to the alignment of the entire hyperspectral data cubes with respect to each other, it is possible to compare for all pixels the spectral curves measured for the R0, R2 and R5 artificial aging steps.

When comparing two spectral curves of the same object area measured before and after aging it is very convenient to express the similarity of both curves by a single number. In our case one has to use a suitable function to calculate from the 70 pairs of corresponding spectral values this...
single number that measures the similarity of the two curves. There are many different functions that serve the purpose of comparing spectral curves, such as the Spectral Distance Similarity (SDS) and the Modified Spectral Angle Similarity (MSAS) function [Homayouni et al. 2004] which are commonly used in geosciences for the analysis of hyperspectral data of the Earth surface.

To compare the spectral curves of the R2 and of the R5 measurement with the R0 measurement, the SDS values for all image pixels were calculated for the visible part of the spectral curve (380 to 750 nm), in which the ROI analysis had revealed the most significant effects of the artificial aging. Figure 7A and 7B show the color-coded results of the SDS calculation respectively for the R2 and the R5 measurement with the R0 measurement. Pixels that have similar spectral curves before and after artificial aging (high SDS value) are colored blue. This means that if the aging had induced no spectral changes at all on the document, both images would be completely blue. Those pixels whose spectral curves were changed significantly by the aging are shown in green color and object areas suffering the largest effects are indicated by red pixels.

Figure 7 shows that the text area on the document has practically not been affected by the artificial aging, as has already been indicated by the results of the previous analysis steps using selected ROIs and selected wavelengths. The comparison of Figure 7A (2 aging steps) with Figure 3A reveals that the largest changes occur in areas where foxing is already present. In Figure 7B it can be seen how this foxing then further intensifies by the artificial aging up to R5. The comparison of the (calibrated) color images in figure 3 shows only very small changes in the document, which can be easily overlooked. By applying the SDS analysis to the aligned hyperspectral data cubes, such changes can be measured and visualized with high contrast.

The SDS analysis based on the aligned data cubes demonstrates the capability of the QHSI technique to measure small changes of the spectral characteristics of the document, even if induced by only a few months of exhibition in an optimal environment.1

SUMMARY AND CONCLUSIONS

The quantitative hyperspectral imaging technique provides calibrated spectral curves of the measured document area with the high spatial resolution of digital images of several million pixels. In this paper we demonstrate how this technique can be used to investigate aging effects as they occur for example when documents are displayed in museums or other public exhibitions for extended periods of time. By applying artificial aging to a sample document the effects of a few months of exhibition of a historic document in a well-controlled environment were simulated. At different stages of the artificial aging, hyperspectral measurements of the sample document were carried out.

On the hyperspectral images, three regions-of-interest (ROIs) were defined manually. Especially the ROI defined in an area strongly affected by foxing showed changes of several percent of the spectral reflectance values in the visible spectral range for a simulated aging of several months of exhibition, whereas the print areas showed no change at all.

As opposed to comparing individual (spectral) images taken at the different aging steps, such ROI analysis has the advantage of allowing a comparison of the entire spectral curves. However, the manual definition of regions-of-interest is always subjective and it involves a high risk that the obtained spectral curves are not representative for the entire document. This problem can be overcome by using the hyperspectral image data to compare in parallel for all document locations the spectral values measured at the different stages of aging.

In order to fully exploit the high spatial resolution of the technique, image processing has to be applied to align spectral images taken at different aging steps with pixel-accuracy. Then it is possible to calculate for each pixel of the spectral images the changes of the spectral values induced by the aging. By combining the difference images between the artificially aged and not-aged sample document calculated for the wavelengths 450 nm, 610 nm and 710 nm, a false-color image was generated. Such false-color images calculated for two different aging stages visualize how the foxing spreads and intensifies on the paper substrate. They also show that the paper substrate itself shows only little changes, while no change at all is seen in the ink areas.

This type of false-color images maintain the full spatial resolution of the hyperspectral measurements, which allows one to detect with high sensitivity spectral changes at any location on the document for the three select wavelengths. However, especially in the case of historical documents, the
pre-selection of only 3 specific wavelengths will in general not suffice to detect and visualize the spectral changes of all materials present on the artifact with the required sensitivity. Due to the alignment of all spectral images it is possible to compare for each pixel the entire spectral curves measured at the different stages of aging. By using the so-called spectral distance similarity (SDS) function, false-color images were generated that show spectral changes on the document at all wavelengths in the range from 380 to 750 nm.

In conclusion, the pixel-wise full-spectrum analysis discussed in this paper is a unique feature of the quantitative hyperspectral imaging technique that enables the detection of spectral changes without a prior, subjective selection of the analyzed area or wavelength. This feature is of particular importance due to the great diversity of materials and degradation effects that can be encountered even on a single document. For studying and documenting optical changes of historical documents during storage or exhibitions quantitative hyperspectral imaging is therefore a very valuable addition to the toolbox of non-destructive measurement techniques that are available to the book and paper conservator to assess and monitor the condition of historical documents.

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NOTE

1. In the internal exhibition room of the National Archief documents are displayed at a temperature of 20°C and a relative humidity of 49%. The illumination is set to 50 lux with UV filtering applied. Documents are displayed for 48h per week over a period of three months, following a rotation procedure that generally allows a rest period of two years for each exhibited document.

REFERENCES


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Study of the Aging Behavior of Rosin-Alum Sized Papers by Analysis of Mechanical Strength, Optical Properties, and Chemical Composition Following Accelerated Aging

ABSTRACT

Librarians and archivists, as well as book and paper conservators, note that paper produced in the 1700s or even earlier seems to be in much better condition than the paper made from about 1850 to 1950. Researchers have studied this phenomenon by measuring the pH of paper extracts via the TAPPI cold extraction method. This method entails maceration of one gram of paper in cold distilled water (70 ml, 25±5°C), carbon-dioxide-free air or nitrogen gas sparging, and finally pH measurement. In the 1960’s, the W. J. Barrow Research Laboratory found a strong correlation between the extract pH of paper and the loss of paper strength, and other researchers have subsequently confirmed this correlation. In order to understand the reason for this aging, we need to briefly shed light on the history of paper sizing methods from the technologist’s perspective.

A paper composed of just cellulosic fibers will be water-absorbent because of the hydrophilic nature of cellulose and the porous structure of paper into which water can be readily absorbed. Manufacturers size paper to impart hydrophobicity on the surface of cellulose and/or to reduce the pore structure in order to hold out ink for printing and writing.

Initially papermakers added flour and/or starch to the pulp for internal sizing. The Chinese had used starch for sizing from A.D.768 to the 14th century when they substituted animal glue. Surface sizing with gelatin and potassium aluminum sulfate was introduced in the 13th century. Zinc sulfate occasionally replaced potassium aluminum sulfate in gelatin sizing and this combination lasted until Mortiz Illig’s invention of rosin-alum sizing in 1807. The rosin was added to the pulp and precipitated with the aluminum salt to size the paper internally. Papermakers primarily used this combination until the 1980s when new neutral or alkaline papermaking processes became prominent. The common alkaline sizing agents today are alkylketene dimer (AKD) and alkenylsuccinic anhydride (ASA).

From the history of paper sizing methods, we know that the paper made from 1850 to 1950 was internally sized with rosin and papermaker’s alum (aluminum sulfate) at an acidic pH, usually between a pH of 4 and 5. This low pH was required to allow the aluminumIII cations to form bonds between the rosin and cellulose fibers. The presence of these aluminum ions was found to increase the rate of cellulose degradation, which embrittles the paper during long-term storage.

Most paper research requires some form of aging. The technique of accelerated aging to observe the deterioration of paper through heating was perhaps introduced in 1899. This technique was developed and further refined during the 1920s through several tests in the United States and Sweden. An artificial aging method exposing samples for 72 hours at 100°C was considered equivalent to 18–25 years of natural aging. In the 1950s, researchers noted that relative humidity had a strong effect on the chemical reactions causing paper degradation. They also determined that the reactions that cause degradation have differing activation energies. These observations prompted several researchers to advocate using the Arrhenius equation in accelerated aging studies and a relative humidity equivalent to long-term natural aging.

In recent years, some researchers have reported a relationship between the embrittlement of paper and various sizing methods using a pure cellulose paper, normally Whatman filter paper. It is hard to find any articles in the conservation science literature, however, that report the changes in mechanical, chemical, and optical properties of paper that was sized internally with rosin and alum.

As part of the Heritage Science for Conservation project at The Sheridan Libraries, Johns Hopkins University, funded by the Andrew W. Mellon Foundation, special papers were made under TAPPI standard conditions using cotton rag fiber that was sized with rosin and alum. Subsequently, these TAPPI handsheets were subjected to accelerated aging and tested using a variety of instruments common in the paper industry. Further research will involve deacidifying those handsheets,

again aging the paper, and testing those sheets in a similar manner. The aging conditions selected include variations of time, temperature, and relative humidity. The results of this research will be published at a later date.

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INTRODUCTION

Paper conservators are very particular about their pastemaking recipes, each arguing that their method of cooking paste is the most effective. There are a myriad of variables in preparation. Some choose to pre-soak their starch, others debate the methods of sieving, working and kneading the paste after it is cooked. Perhaps the most controversial question is about the merits of cooking paste with a cook and stir, a double boiler, or using a microwave oven. Storage methods for paste, whether in the refrigerator, in a syringe, or under water, are equally contested. This project is made up of a number of small experimental vignettes, each exploring a facet of the use and preparation of wheat starch paste in book and paper conservation.

The Andrew W. Mellon Heritage Science for Conservation (HSC) research project at The Sheridan Libraries of Johns Hopkins University has not only enhanced dialogue between conservators and conservation scientists, but enabled conservators to explore various conservation questions using analytical and diagnostic equipment. A number of secondary research projects were developed alongside the primary research of the HSC post-doctoral fellows. This particular research project began by exploring the Zeiss Axio Imager M1m compound microscope, employing reflected light (bright field and dark field) and fluorescence microscopy, in order to further elucidate some of the methods and materials used by conservators in the preparation of wheat starch paste.

Wheat Starch Granular Structure

The wheat endosperm has a cellular structure. Each cell is filled with starch granules, surrounded by proteins, minerals, coloring matter and enzymes, contained in thin cellulose walls (Olkku and Rha 1978). On a molecular level, starch consists of amylose (linear chains of \(\alpha\)-D-glycopyranose units joined by 1–4 linkages), and amyllopectin (a non-random 1–6 branching of the 1–4 linked \(\alpha\)-D-glycopyranose units, having one of the highest molecular weights of naturally occurring polymers) (Singh et al. 2003). Purified wheat starch used for preparing conservation adhesives has approximately a 25%(w/w) amylose content (Van Steene and Masschelein-Kleiner 1980). This equates to several million amyllopectin molecules per granule, and a much larger number of the smaller amylose molecules (Chaplin 2010). Amylopectin is oriented radially within the starch granules, with concentric amorphous and crystalline regions, in such a way that as the granule radius increases, so does the number of polymer branches to fill the radius (Chaplin 2010). The crystalline regions are clusters of double helices formed by hydrogen bonding between outer strands of the amyllopectin; these crystalline regions cause starch granules, when viewed under crossed polarization filters, to exhibit their characteristic anisotropic cross pattern. Amylose strands in the granules also form hydrogen-bonded double helices, but these do not result in high enough order to exhibit birefringence (Tester and Morrison 1990).

The average diameter of wheat starch granules ranges from 2–40µm; it is the larger granules, from 15–40µm (Belard et al. 2009), some say 30–40µm (Van Steene and Masschelein-Kleiner 1980), that are used in the preparation of starch paste for conservation activities.

Theory of Paste Cooking

The theoretical background for this research was found largely in the arena of food science, where there has been, and continues to be, a great deal of investigation into the properties and cooking of various starches. In granule form, starch is insoluble in water, briefly forming a suspension before settling out completely (Van Steene and Masschelein-Kleiner 1980). When the suspension is heated, however, the granules will slowly and reversibly take up water, until they reach the temperature of the onset of gelatinization. Gelatinization is, by the narrowest definition, the thermal disruption of crystalline structure within the starch granules marked by the loss of birefringence (Tester and Morrison 1990). More broadly,
the term gelatinization is used to include the swelling of the granules and the leaching of soluble amylose components out of the intact granules. Alternately, the term pasting is used to refer to the change in viscosity just before, during and after strict gelatinization (Zeng et al. 1997).

Gelatinization can be broken down into numerous small steps. First, wheat starch granules swell tangentially. This swelling, under the right temperatures and concentrations, can expand the starch granules up to 30 times their original size without disintegration (Singh et al. 2003). Initially a reversible hydration in the weakly bound and amorphous regions of amylpectin, the swelling continues irreversibly in the crystalline amylpectin regions, as well as in the strands of amylose. In these crystalline regions, the hydrogen bonds between molecular components of starch are replaced by hydrogen bonds with water and the hydroxyl groups along the starch polymer chains (Singh et al. 2003). In the case of amylose, hydration takes the polymer chains from a state of suspension into solution; this transition results in the increased translucency observed during paste cooking. This solubilized amylose is found both within the still intact starch granules, and also exuded outside the starch grains.

The viscosity of paste has been shown experimentally to reach a maximum after granule swelling ceases. This indicates that it is the release of exudates from granules, rather than simply the swelling of the granules, that is responsible for viscosity. In SEM images of flash frozen cooking starch, the exudates can be seen entangling with themselves and with the intact granules (Miller 1973). Above the point of maximum viscosity, as cooking proceeds, all cohesive forces within the granules are lost, the granules fragment, and the viscosity of the paste decreases (Christianson et al. 1981).

Swelling of the starch granules begins at 45–55°C, with a loss of birefringence in the range of 50–55°C. By 65–67°C, the paste is almost completely gelatinized (Belard et al. 2009). Increases in viscosity and tack continue linearly up to 85°C, above which the granules begin to disintegrate completely, with a corresponding drop in tack above 92°C (Tester and Morrison 1990). Stirring is necessary during paste preparation to evenly distribute heat and ensure complete and even gelatinization. Hot starch paste is a mixture of granules, granule fragments, and colloidally- and molecularly-dispersed starch molecules (Olkku and Rha 1978).

Upon cooling, the properties of starch are governed by a process called retrogradation, which is the reassociation of starch molecules into an ordered structure. Hydrogen bonding between the molecular chains is restored. Amylose molecules align to form aggregates, with the association of 40–70 glucose units in each (Singh et al. 2003). The recrystallization of amylpectin also occurs, but to a much lesser degree than in the original native starch grains. This reordering is associated with an increase in viscosity. The resulting gel has a three-dimensional structure held together by the now aggregated amylose chains that were leached out of the starch grains during gelatinization. In gels with highly swollen, intact granules, there is a high proportion of water still held in the granules. This system requires only a small fraction of leached amylose to form a continuous network. If the granules were not sufficiently swollen, or were swollen to the point of granule fragmentation, a much higher proportion of amylose would be required to hold the gel network together (Olkku and Rha 1978). Hence it is possible to both under or overcook starch paste: insufficient or incomplete gelatinization leads to insufficient exudate to fully gel and tack, whereas rupturing all of the granules will result in a paste of low cohesiveness.

According to one study, day-old starch is already about 50% retrograded, while three-day-old paste is about 90% retrograded (Miller and Root 1991). The effects of retrogradation on adhesion are not well understood, but while studying furunori (aged, highly retrograded starch, known to be less tacky than fresh starch; employed in the mounting of scrolls), researchers have found no significant decrease in adhesiveness of highly retrograded paste (Daniels 1988).

Aside from the clear changes made by sieving and kneading on a macroscopic level, on a microscopic level, it is possible that these actions are rupturing additional starch granules. Swollen starch granules are susceptible to shear disintegration, as well as mechanical and thermal breakdown (Olkku and Rha 1978). Some level of fragmentation may result in the release of additional exudate.

**EXPERIMENTAL**

The project consists of a number of small experiments, each examining a facet of how adhesives, primarily wheat starch paste, are prepared, used and stored in the context of book and paper conservation. Each small experiment is couched in terms of a question, followed by a short account of the theoretical background behind the question, the experimental design, the photomicrograph image results, and finally, any conclusions or follow-up research resulting from the experimentation.

**Experiment #1: Adhesive Films Coating Paper Fibers**

Question—How do different adhesive films dry on a “real life” surface, such as paper?

Background—Book and paper conservators use a number of different adhesives, consolidants and sizing agents, each with a different set of working properties. As an introduction to what is visible under the microscope, a number of these adhesives were coated onto paper supports to observe their film-forming characteristics, while examining the interaction of adhesive and substrate.
Experimental—Twelve adhesives, consolidants and sizing agents (1: Control (no coating), 2: Wheat starch paste (double boiler), 3: Wheat starch paste (microwave), 4: 2% Methyl cellulose A4M, 5: 2% Methyl cellulose A15C, 6: Jade 403 PVA, 7: Lascaux 360HV acrylic, 8: Lascaux 498HV acrylic, 9: 2% Klucel G in ethanol, 10: Cellugel (hydroxypropylcellulose in isopropanol), 11: 2% Gelatin USP and 12: Gum Arabic (Winsor & Newton)) were brushed onto the surface of two papers: one Western paper (Rives Lightweight Buff, 115gsm, 100% cotton rag) and one Japanese paper (Ikeda #29, 22gsm, 100% Kozo). The appearance of the control was compared to the various adhesives, consolidants and sizing agents with reflected light brightfield illumination under 200X magnification.

Conclusions and Future Experimentation—The image results can be seen in figures 1a and 1b. The thermoplastic adhesives (PVA and the Lascaux acrylics) form a film coating the entire surface of the paper fibers, unlike the other coatings, which settle into the interstices. The sizing agents and consolidants (the cellulose ethers, gelatin and gum Arabic) seem to bridge between adjacent paper fibers. Wheat starch paste falls somewhere between these two characteristics, forming more of a film over the paper fibers than the cellulose ethers, but also seeming to penetrate between the individual fibers more than the thermoplastic adhesives.

**Experiment #2: Mixed Adhesive Films**

**Question**—Do wheat starch paste, methyl cellulose and polyvinyl acetate (PVA) form compatible films when mixed?

**Background**—Paper conservators often mix various adhesives together to get a blend that tweaks desired working properties. For instance, methyl cellulose and wheat starch paste are mixed for an adhesive with “more slip.” Particularly in book conservation, wheat starch paste or methyl cellulose adhesives are mixed alone, or in combination, with Jade 403 PVA to acquire longer working times, while maintaining the flexible character of the PVA film. By examining these mixed adhesives microscopically, it is possible to see if these various components will form homogeneous films, providing insight into whether these adhesives are truly miscible.

Experimental—Pure films of fresh double boiler wheat starch paste (WSP), 2% A4M methyl cellulose (MC) and full strength Jade 403 (PVA) were cast on microscope slides, by laying two “guide tracks” of double sided tape down onto microscope slides and using a razor blade resting on the tape to cast films with a smooth surface and even thickness. This film casting technique was also employed for the films cast in the experiments #3–6. Mixed films of 1:1 WSP:MC, 1:1 MC:PVA, 1:1 PVA:WSP and 1:1:1 WSP:MC:PVA were also cast on microscope slides. Photomicrographs were recorded under bright field illumination at 200X magnification.

Conclusions and Future Experimentation—The image results can be seen in figure 2. Wheat starch paste forms a significantly more dimensional film than either of the smooth PVA and very smooth MC films. 1:1 mixtures of wheat starch with either of the other two adhesives, or a 1:1:1 mixture of all three adhesives, result in uniform films, with character similar to that of a wheat starch paste film. The 1:1 mixture of PVA and MC form a film with a strange reticulation pattern, perhaps indicating that the two adhesives are not fully miscible. It would be very interesting to follow this observational research with research testing the flexibility, durability, reversibility and adhesive strength of these pure and mixed films.

**Experiment #3: Paste Swell**

**Question**—Does soaking dried starch prior to cooking visibly swell (hydrate) the granules?

**Background**—The food science literature and even some conservation articles seem to indicate once starch granules are dried, they do not rehydrate until heated. Most authors state that uncooked starch in water will always simply settle out (Van Steene and Masschelein-Kleiner 1980; Light 1980). Several studies indicate that starch swelling really only occurs at the onset of gelatinization T=45-55°C (Tester and Morrison 1990). This may be due to the method of dry starch manufacture. One method of industrially drying starch in involves taking raw starch (after extraction from wheat flour) from a moisture content of 42.3% down to 6.4% by exposure to hot air at a temperature of 60–70°C. Under such conditions, the surfaces of the starch grains are altered, meaning that they do not absorb water as easily as starch that remains in the wet state (Belard et al. 2009). Nonetheless, the additional step of soaking prior to cooking is frequently referenced in paste preparation methods as a means to swell the starch granules. It is possible that the practice of soaking starch prior to cooking was adopted from Japanese paste preparation methods where the intent not to swell the starch grains, but rather to decant the soaking water to remove unnecessary impurities (Belard et al. 2009).

Experimental—The pre-soak time recommended in paste preparation recipes ranges from not at all, to 20 minutes, to several days. This experiment compromised by soaking precipitated wheat starch granules (Zin Shofigi) in deionized water (1:4 or 20% v/v) for 1 hour at room temperature. The excess water was then decanted, and the soaked
Fig. 1a. Coatings on Rives Lightweight Buff, 115gsm, 100% cotton rag fiber paper, viewed with 200X magnification under reflected light bright field illumination

Fig. 1b. Coatings on Ikeda #29, 22gsm, 100% kozo fiber paper, viewed with 200X magnification under reflected light bright field illumination
granules were mounted on a microscope slide. The granules were observed under bright field reflected light illumination at 200X magnification. Photomicrographs were taken while they dried, and the images of the soaked starch compared to dry starch to assess visible change.

Conclusions and Future Experimentation—The image results can be seen in figure 3. The diameter of the paste granules does not appear to change during soaking at room temperature. While this does not rule out the possibility of some hydration at a molecular level, it does imply that significant pre-swelling of starch granules in excess water at room temperature does not occur.

Experiment #4: Microwave vs. Double Boiler

Question—Is there a significant difference in the granularity and film-forming characteristics of paste prepared by microwave and double boiler cooking methods?

Background—This is a question of expediency versus more traditional preparation methods. On a macroscopic
level, the consistency of paste prepared in a microwave is observably different than that prepared by the slower cook-and-stir or double boiler cooking methods. Looking to the food science literature, an explanation can be found in the fact that starch gelatinization occurs in a relatively narrow range of temperatures. In slower, stirred cooking methods, the granules are likely to swell uniformly. In a microwave there is more likely to be a broad range of temperatures in different locations (“hot spots”) and therefore a varying degree of granular swelling (Light 1990). Paste, in what is considered its most adhesive format (i.e. at the point just after peak viscosity is reached), consists of a mixture of swollen granules, granule fragments, exudate from swollen granules, and uncooked granules (Miller et al. 1973; Singh et al. 2003). Undercooked paste will exhibit slightly swollen granules that are still highly intact. In overcooked paste, the majority of granules will have ruptured, with a high degree of fragmentation. Cooking time, temperature and mechanical shear all affect the degree of paste swelling. If the temperature is too low throughout the entire cooking period, starch will not swell sufficiently, even over an extended cooking period. If the paste is cooked for too long or at too high a temperature, the starch will break down completely.

In a previous study of paste, Miller and Root (1991) note that microbial growth is greater on microwave paste, attributing this to the fact that the water that was used in paste preparation was not disinfected by microwave cooking. They also examined microwave paste under crossed polarization, and found incomplete gelatinization, as exhibited by remaining birefringence (Miller and Root 1991).

Experimental—

- Microwave Paste—15mL of Zin Shofu wheat starch in 60mL deionized water was combined in a 150mL Pyrex beaker, which was first sterilized by immersion in boiling water. The starch suspension was placed in the microwave (Magic Chef MCD 766W, 2450MHz) at full power for 30 seconds before stirring with a glass stir rod. Cooking continued first for 15 seconds, followed by 10 second increments, where the paste was alternately microwaved and stirred. At each stirring point the temperature was recorded in degrees Celsius using a mercury thermometer and a small sample cast onto a microscope slide in the method described in Experiment #2. The total cooking time was 75 seconds, with a peak temperature of 82°C. Cooking was judged complete when the paste became translucent, with a smooth texture.

- Double Boiler Paste—15mL of Zin Shofu wheat starch in 60mL deionized water was combined in a sterilized 150mL Pyrex beaker and set into a sauce pan of hot water on a hotplate element. The water in the saucepan was brought to a simmering boil around the continuously stirred beaker. A mercury thermometer monitored the temperature of the paste mixture. Samples were cast at regular intervals on microscope slides at temperatures similar to those recorded in the microwave paste, until the paste took on a creamy, translucent texture, just after peak viscosity was reached. Cooking proceeded for a total of 14 minutes, with a peak temperature of 85°C.

- Working the Paste—Both pastes were cooled to room temperature before an additional film of each was cast (direct cast) followed by films which had been sieved through plastic mesh three times. The final films were sieved paste which had been kneaded with the addition of a small amount of deionized water to a very smooth, thick, creamy texture using a synthetic bristle paint brush against a glass surface. Photomicrographs of each of the cast films were recorded at 100X magnification, under bright field reflected light.

Conclusions and Future Experimentation—The image results can be seen in figures 4a and 4b. Similar temperatures are reached by both cooking methods. Greater granularity does remain in microwave paste, but both films, when sieved and kneaded, are quite uniform. Future experimentation should involve testing the adhesive tack of the different preparation methods. A Fourier transform infrared spectroscopy (FTIR) study of starch paste gels shows that changes in the spectra are visible throughout the gelatinization and retrogradation processes (Wilson et al. 1988). FTIR could also be used in a future study to monitor various paste preparation methods throughout cooking.

Experiment #5: Paste Storage

Question—How does the storage method affect the structure of cast films of paste over time?

Background—There is great diversity represented in the conservation literature regarding the storage recommendations for paste. The question of storage is a balance of maintaining working properties of paste, while also trying to keep microbial growth at bay. Older recipes often recommend the addition of fungicides (Mucci 1975; Baker 1984), but these cause concern both for the health of the conservator and for the potential long-term effects on artifacts. Other recipes focus on means of sterilizing storage containers by boiling or UV irradiation. Some seek to exclude air, by storing under water or in a syringe, in order to limit the introduction of mold spores. Many recipes recommend refrigeration as the only way to keep...
All of the storage containers were sterilized in boiling water prior to use. Paste samples were cast onto microscope slides in three ways: direct cast (straight out of the storage container), sieved (worked three times through a fine plastic mesh strainer), and kneaded (after sieving, a few drops of deionized water were worked into the paste by kneading with a brush to a smooth, creamy consistency). The samples were cast on the first day (from fresh room temperature paste), as well as after the 4th, 7th, 12th, 15th and 21st day of storage. The resulting films were observed under bright field reflected light illumination at 200X magnification.

Conclusions and Future Experimentation—After seven days of storage (see figure 5a) each of the five pastes could be worked (sieved, kneaded) to the point where they exhibited virtually identical film-forming properties. After kneading, they also all resembled the initial freshly prepared paste. Observations of the pastes after this point are summarized in table 1.

Experimental—A batch of double boiler paste was prepared according to the method described in Experiment #4. The paste was cooled to room temperature, and then the batch was divided into the following five storage arrangements:

1. Refrigerator, in a Pyrex beaker sealed with Parafilm.
2. Refrigerator, covered in deionized water in a Pyrex beaker sealed with Parafilm.
3. Dark location at room temp. (inside an opaque container), in a Parafilm-sealed Pyrex beaker.
4. Covered in deionized water, dark location at room temp. in a Parafilm-sealed Pyrex beaker.
5. Luer-lok syringe, loaded from the back end of the syringe, and excluding all air through the syringe tip.

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5. Luer-lok syringe, loaded from the back end of the syringe, and excluding all air through the syringe tip.
Fig. 5a. Fresh paste compared to the same batch of paste after seven days of storage using five storage methods. Stored paste was cast directly onto microscope slides (top row), sieved through plastic mesh (middle row) & kneaded with distilled water and a paint brush (bottom row). Bright field, reflected light illumination with 200X magnification.

Fig. 5b. The same batch of paste as seen in figure 5a, after 21 days of storage. Bright field, reflected light illumination with 200X magnification. Paste D was no longer capable of being sieved or kneaded.

<table>
<thead>
<tr>
<th>Paste</th>
<th>Day 12</th>
<th>Day 15</th>
<th>Day 21 (see figure 5b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paste A (refrigerator)</td>
<td>Good tack, gelled, casts a nice film.</td>
<td>Good tack, casts a good film when worked, gelatinous in direct cast.</td>
<td>Good tack, casts a good film when worked, gelatinous in direct cast.</td>
</tr>
<tr>
<td>Paste B (refrigerator, under water)</td>
<td>Slightly watery, mealy, doesn't cast a cohesive film until it is worked.</td>
<td>A little granular/watery, good tack, works (sieves/kneads) well.</td>
<td>A little granular/watery, good tack, works (sieves/kneads) well.</td>
</tr>
<tr>
<td>Paste C (room temperature, dark)</td>
<td>Smooth, good tack.</td>
<td>Visible mold (yellow), with mycelia throughout. Still kneads and sieves well, good remaining tack.</td>
<td>More visible mold, granules less defined than previous.</td>
</tr>
<tr>
<td>Paste E (syringe)</td>
<td>Thick, but sieves and kneads well, good tack.</td>
<td>Thick, but sieves and kneads well, good tack.</td>
<td>Thick, still works well, but with slight odor; mold was evident under magnification.</td>
</tr>
</tbody>
</table>

Table 1. Observed properties of aged paste, as stored by five separate methods.
mycelia were observed without the simultaneous presence of visible mold, with the exception of the syringe paste on day 21. The smell of aged paste cannot necessarily be attributed to mold, as odorous paste did not necessarily contain mycelia; bacterial growth is another likely cause. The presence of mold did seem to disrupt the structural integrity of intact granules in the paste films (see figure 5b, column C, which exhibits less granularity than the other pastes).

In future experimentation, it would be useful to explore how the adhesive tack of the paste films correlates to these visual observations.

**Experiment #6: Observation of Mold**

**Question**—After removing visible mold growth from a batch of paste, is the remaining paste still viable?

**Background**—When there is only one repair to make at the end of the week, and your batch of paste is just the smallest bit moldy; it may be tempting to reach around the visibly moldy paste for the “fresh” paste underneath. However, based on previous studies (Miller and Root 1991), it is likely that mold has contaminated the entire batch of paste.

**Experimental**—Naturally aged paste was monitored daily until the first observable signs of mold. A sample was taken from a portion of this paste that was exhibiting no visible mold, and mounted on a microscope slide. This paste was observed at 200X magnification under bright field and dark field illumination, as well as by fluorescence microscopy (emission filter: LP 470nm, excitation filter: BP 395–440nm, beam splitter: FT 460nm).

**Image Results**—See figure 6

**Conclusions and Future Experimentation**—Microscopic examination of a batch of visibly moldy paste clearly demonstrates that even portions of this paste without mold visible to the naked eye have mycelia distributed throughout. Daily examination of the five different storage methods (see experiment #5), however, revealed no such mycelia until they were also accompanied by visible mold somewhere on the batch. Even a batch of paste that began to smell bad didn’t necessarily show any microscopic mycelia, indicating that bacterial growth, rather than mold, may be responsible for the odor. Paste with mold mycelia also seemed to exhibit fewer intact granules than the same paste earlier in its aging properties, supporting the theory that mold may affect the adhesive nature of paste.

**REFERENCES**


Belard, R., H. Hisashi and J. Perry (2009) "Furunori (aged wheat starch paste): challenges of production in a non-tradi-


properties of starches from different botanical sources,”
Tester, R.F and W.R. Morrison (1990) “Swelling and Gelatin-
ization of Cereal Starches. I. Effects of Amylopectin,
“Modified Starch for Conservation Purposes,” Studies in
Conservation 25(2) 64–70.
transform infrared spectroscopy for the study of food bio-
“Sources of Variation for Starch Gelatinization, Pasting,
and Gelation Properties of Wheat,” Carbohydrates 74(1):
63–71.

NOTE

1. For full color images see http://www.library.jhu.edu/departments/
preservation/hcs/. The research presented in this paper was originally
exhibited as a poster at AIC 2010 in Milwaukee.

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INTRODUCTION

This research examined the effects of Bookkeeper on the rate of mold growth, the rate of water absorption, the discoloration of papers, and the drying of wet books. Northwestern University Library has been a client of the Bookkeeper non-aqueous deacidification product since 1994. Northwestern still turns to Bookkeeper as a non-aqueous deacidifying agent, but since 2008, the Preservation Department has conducted a variety of experiments on the secondary uses and side effects of Bookkeeper treatment. These small scale experiments have led to the observation of a number of intriguing phenomena and a few concrete results.

Bookkeeper is a product composed of a non-toxic inert liquid (perfluoroalkane), magnesium oxide particulates, and a surfactant (a polyfluoropolyether derivative). It was developed as a non-aqueous deacidifying agent to slow the rate of paper degradation and has been proven to be quite effective in achieving that goal.

MOLD GROWTH

The use of Bookkeeper appears to reduce the rate of mold growth on paper. This may be due to the overwhelming amount of magnesium interfering with optimal function of the mold’s digestive enzymes, an increase in pH, which slows enzymatic activity, or other forces. The type of paper and the Bookkeeper application method seem to be significant variables.

During the early 1990s the Library of Congress specified “Blue Books,” each composed of a variety of well defined papers for use in testing the Bookkeeper system’s efficacy. Five papers from the Blue Books were selected for testing: Alkaline Sized, Alum Rosin Sized, Clear Spring Offset, Newsprint, and Whatman #1.

Papers were removed from a Blue Book and exposed to ambient mold spores. Some leaves were treated with Bookkeeper in a spray application and allowed to dry. Papers were placed inside of individual plastic bags with moisture to encourage mold growth. Mold grew on both treated and untreated samples, however for 3 of the 5 paper types, significantly less mold grew on samples treated with Bookkeeper. This growth pattern occurred consistently within treatment groups (figs. 1-5).

ABSORBENCY

Bookkeeper treated materials seem to absorb humidity and liquid water quicker and to a greater extent than untreated papers. Bookkeeper treated materials have been noted to have an increased wettability in the past. Despite increased absorbency, the rate of mold growth is still lower.

Absorption of Humidity

Newsprint paper samples (some sprayed with Bookkeeper) were humidified and weight changes were recorded. Papers treated with Bookkeeper appeared to absorb more water faster than untreated samples (fig. 6).

Dispersal of Liquid Water

Mohawk 60# paper had a grid pattern printed onto it using an Epson laser printer. Some papers were sprayed with Bookkeeper and allowed to dry for several days. Individual drops of water were placed on the center of the grid and observed. Water droplets placed on papers treated with Bookkeeper absorbed into the paper faster, dispersed further and left more cockling and tidelines than on untreated papers (fig. 7).

DISCOLORATION

Some of the most obvious findings relate to generally increased tidelines in many papers and overall discoloration of lignin containing papers that have been treated using Bookkeeper.
Fig. 1. Alkaline sized paper, image taken at day 19. Untreated sample on left has dramatically more visible mold than Bookkeeper treated sample on right, with similar results for all papers of this type. Both samples have distinct tidelines.

Fig. 2. Alum rosin sized paper, image taken at day 19. Similar quantities of mold growth were seen on untreated sample on left and Bookkeeper treated sample on right. Growth on untreated samples of this paper type was slightly greater in quantity and much more colorful. Tidelines are slightly more pronounced on Bookkeeper treated samples.

Fig. 3. Clear Spring offset paper, image taken at day 40. Similar mold growth was observed on Bookkeeper treated and untreated papers of this paper type. In this image, Bookkeeper treated sample is on the left and untreated sample on the right. Tidelines more distinct on Bookkeeper treated samples.

Fig. 4. Newsprint paper, image taken at day 25. Significantly more mold growth was observed on untreated samples, seen here on the left. Mold is easily visible as small black dots at left edge on untreated sample but is barely visible as an indistinct haze on Bookkeeper treated sample, seen on the right. Note distinct tideline and significant overall discoloration of Bookkeeper treated sample.

Fig. 5. Whatman #1 paper, image taken at day 45. Untreated samples, seen here on the left, had slight mold growth visible at 25 days. Treated samples, on the right, did not have visible mold growth after 45 days. Tidelines are diffused, but more colorful on treated samples.

Fig. 6. Newsprint paper samples were humidified for two hours and weighed at 15-minute intervals. In a smaller comparison, two samples were humidified overnight with the sample treated with Bookkeeper ultimately gaining over 8% more weight than the untreated sample.
Increased Tidelines

In various experiments, introduced tidelines were more pronounced on papers treated with Bookkeeper. Tidelines were immediately evident on lignin containing papers, but were evident on other papers as well. Conservators have theorized that this may be a result of localized washing, which is a risk any non-aqueous deacidification system would present to future treatments (fig. 8).

Overall Discoloration of Lignin Containing Papers

In this study, treated and untreated newsprint paper was humidified for various amounts of time. Bookkeeper treated materials darkened slightly when in a passive humidity chamber for 2 hours. Longer humidification times, simulating a disaster situation, resulted in greater discoloration. Overall discoloration was not observed in non-lignin containing papers and extensive testing has shown that Bookkeeper does prolong the useful life of newsprint (fig. 9).

Drying of Wet Books

Preliminary experimentation suggests that Bookkeeper could be part of a system for drying wet books. Wet books were submerged under a bath of Bookkeeper with sachets of the desiccant calcium chloride. It appeared as though some water from the book was transferred through the Bookkeeper to the desiccant. Books that had been under the Bookkeeper bath longer and/or had more sachet changes emerged appearing to have lost more water weight and sachets appeared to have gained roughly the same weight. This was difficult to determine, as both books and sachets emerging from the bath were wet with the very heavy Bookkeeper fluid. Although the numerous variations of this experiment consistently suggested a slight aid in drying, the chemistry is unclear and it does not appear that current methods would produce a practical method of drying. Future research could include experimentation with added surfactants to speed the process (fig. 10).
CONCLUSIONS

- Bookkeeper seems to deter mold growth on some papers. Less mold grew on some papers, despite increased absorption of liquid water and humidity by Bookkeeper treated materials.
- Bookkeeper treated materials should be approached with additional caution when performing wet treatments, such as mending and humidification. Wetting times may be shorter and discoloration of lignin containing papers is likely to occur.
- While elevated humidity related to water disasters may be less likely to cause mold for Bookkeeper treated materials, discoloration of lignin containing papers may occur.
- Some aid in drying of wet books using Bookkeeper may be possible, but further research is needed.

ONGOING RESEARCH AND SUGGESTIONS FOR FURTHER RESEARCH

- Mold remediation—An experiment is underway to determine the efficacy of Bookkeeper at deterring additional growth of established mold. Creating adequate controls for this experiment has been problematic due to the difficulty in visually estimating mold growth, and variables introduced by the Bookkeeper spray process (drying of the sample).
- Comparison of spray vs. vat application on mold deterrence—Preliminary experimentation has suggested that both spray and vat applications of Bookkeeper appear to deter mold growth, but that the spray application of Bookkeeper appears to deter slightly more mold than the vat application. Because both the spray and vat application methods deposit significant amounts of magnesium oxide, we speculate that, if this phenomena is proven to repeatedly occur, it may be because the vat application distributes mold spores within the vat, exposing the inside of the book to spores that had been on the outside and inoculating one book with spores from adjacent books in that treatment batch. The spray application does not distribute mold spores.
- Mold or debris removal—The vat application of Bookkeeper may allow for removal of mold bodies, soot, or other loose debris from pages through the mild abrasion of the sub-micron sized magnesium oxide particles moving through the liquid. Ideally, this would gently “surface clean” the entire book, while deterring future mold growth and, of course, deacidifying it.

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REFERENCES

Mass Deacidification Reports Issued by the Library of Congress. http://cool.conservation-us.org/byorg/lc/massdeac/ Website includes several reports written by conservators and chemists regarding efficacy and side effects of the Bookkeeper product.


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The Impact of Training and Institutional Context on Book Conservation Practices

ABSTRACT

A web-based survey of book conservation treatment practices in research libraries was conducted in 2007. Survey results were summarized in a 2010 report that documented standard practice, moderate-use, and low-use book conservation treatments for special collections and general collections in research libraries in the United States. Similarities and differences between special and general collections practices were highlighted.

In an effort to better understand the differences in practices observed in the first report, the authors revisit the data to identify whether, and how, the demographic characteristics of book conservation practitioners are correlated with particular treatment practices. Noting the trend suggested in the literature toward both hybrid facilities—those dedicated to both special and general collections—as well as hybrid practitioners, the authors were especially curious whether such facilities and practitioners might approach treatment differently. The data collected in 2007 were analyzed to identify whether key demographic variables—such as practitioner training, type of collections served by a practitioner, size of library, type of library, and type of conservation facility—were correlated with specific treatment practices. In this report, specific trends associated with the demographic variables are identified and explored. Areas of further research suggested by the results of the study are identified.

INTRODUCTION

This paper is the second of two reports emanating from a study of book conservation practices in research libraries. The study—which centered on a 2007 survey of conservation practitioners that gathered information about the types of book conservation treatments practiced in research libraries, along with detail about the survey respondents’ training and institutional contexts—had three research goals: 1) to document standard practices in research library book conservation, 2) to identify similarities and differences between special and general collections practices, and 3) to determine whether demographic characteristics of conservation practitioners are associated with particular treatment practices.

Addressing the first two goals, the first report identified standard practices for book conservation in research libraries, and highlighted similarities and differences between practices applied to special collections and those used for general collections (Baker and Dube 2010). The report established and defined a list of common book conservation treatments for special and general collections, and provided data on the use of such treatments, documenting standard practice, moderate-use, and low-use book treatments and techniques for special and general collections at the beginning of the twenty-first century. While significant similarities and differences were identified between practices applied to special collections and those applied to general collections, the authors concluded that, overall, “treatment practices for special and general collections are more similar than different” (Baker and Dube 2010, 28).

At the same time, the data revealed significant variance in practice across conservation facilities, which led the authors to conclude that “an overwhelmingly uniform application of techniques across research library conservation units does not exist” (Baker and Dube 2010, 28–29). Curiosity about this observation fueled further analysis of the data, which dovetailed with the third goal of the research.

This second report addresses the third research goal—to determine whether demographic characteristics of respondents are associated with particular treatment practices—and in doing so aims to shed light on the relative lack of uniformity of practices observed in the first report. The survey data are analyzed to identify whether relationships exist between the respondents’ demographic characteristics and their reported book conservation treatment practices. The demographic variables studied include level of practitioner training, type(s) of collections served by a practitioner, size of library, type of library, and type of conservation facility.
LITERATURE REVIEW

In a review of the literature pertaining to the evolution of book conservation practices in research libraries, the authors’ 2007 report documents a trend toward greater collaboration among conservation practitioners and increasingly similar special and general collections treatment approaches, ultimately concluding that conservation has “showed signs of moving beyond separate approaches to treatment (i.e., special versus general collections) toward a more nuanced methodology” (Baker and Dube 2010, 23). Among those describing and promoting more integrated approaches to damaged collection review and treatment are Kellar (1990), Frost (1999–2000), and Pilette (2006). Kellar describes the conservator’s role as “[transformed] from the restoration expert for antiquarian books to the Collections Conservator of the modern research library” (1990, 8). In an assessment of the evolution of conservator’s roles, Baker’s 2004 survey of U.S. conservators found that positions for “hybrid” conservators—those responsible for both general and special collections treatment—have increased steadily (Baker 2004). Frost advocates a holistic treatment model that physically integrates special and general collections treatment facilities, incorporating “a middle zone of conservation practice. . . [in which] the ‘exception’ category now appears key to a seamless, integrated book repair service” (1999–2000, 2). Similarly, Pilette’s “continuum of care” approach to preservation and conservation suggests that a range of selection criteria, beyond the special versus general collections dichotomy, should be incorporated into decision-making processes (2006). The United States is not alone in observing a narrowing gap between the treatment of special and general collections; a 2005 study of European book repair practices notes that newly developed treatments “came to bridge the gap between special collections item-based conservation, and circulating collections batch-based conservation” (Campagnolo 2005, 330).

Given such observations and evidence, the authors were particularly interested—through this analysis of the demographic characteristics of the survey respondents and their treatment practices—to discover whether hybrid practitioners and hybrid facilities shared a unique approach to treatment.

SURVEY METHOD

In August and September of 2007 a survey was conducted of practitioners of book conservation and repair in research libraries. The anonymous, six-page, web-based survey gathered information about the respondents, their institutions, and their book conservation treatment practices. Key elements of the survey methodology are provided here; additional details may be found in the first report (Baker and Dube, 2010). The survey instrument is provided as Appendix A.

The survey instrument defined the survey audience as “the individual(s) with primary responsibility for book conservation and/or repair,” qualifying that “institutions with multiple conservation/repair units may respond once for the entire institution or individually for each unit.” Responses from multiple facilities at a single institution were therefore permitted, while multiple responses from a single facility were not. The survey gathered basic demographic information about the respondents and their institutions, including their job titles, training, type(s) of collections served, institution sizes, and the ages and scope of their conservation facilities. Individuals with responsibility for one type of collection—i.e., special collections or general collections—were asked to complete one page of treatment questions, while respondents with responsibility for both special collections and general collections received two pages of questions, one for each type of collection.

The fifty-five treatments included in the survey were selected based on a literature review of special and general collections book treatment practices over the past fifty years, and on feedback from survey pretesters. Questions pertaining to treatment practices for special and general collections were identical, covering fifty-five book treatments in six categories: 1) protective enclosures and book jackets, 2) binding reinforcements, 3) minor paper treatments and textblock repairs, 4) board reattachment methods, 5) other binding repairs and rebinding techniques, and 6) advanced paper treatments performed on bound materials. Where treatment names were not sufficiently self-explanatory, definitions were supplied. Definitions are provided in Appendix B.

Respondents were asked to indicate how frequently each of the fifty-five treatments was performed in their facility by selecting from a set of five treatment response options: 1) standard practice, frequent, 2) standard practice, occasional, 3) anomalous use only, 4) never, and 5) not sure. Definitions for the response options were supplied (fig. 1).

An analysis of the potential errors associated with the survey is provided in the previous report (Baker and Dube 2010, 30–31). In summary, the survey response rate is conservatively estimated to be at least 29 percent. This level of survey participation, while not comprehensive, was determined to be sufficiently representative to enable to data to support conclusions about current book conservation practices in the U.S.

DEMOGRAPHIC CHARACTERISTICS OF SURVEY RESPONDENTS

Seventy-nine respondents from research libraries fully completed the survey; however, because there was insufficient response from outside the United States—just six respondents—all non-U.S. data were eliminated from the results. The following results are therefore limited to research library book conservation practice in the United States.
The seventy-three respondents provided forty-five unique job titles. While such a diverse set of job titles cannot be summarized quantitatively, a few highlights help characterize the survey sample. The word “conservator” appeared in 41% of respondents’ titles, a third of which were, more specifically, “collections conservator[s].” The word “conservation” appeared in 21% of all titles while 29% contained the word “preservation” (figures include 3% overlap of titles containing both terms). “Technician[s]” or “assistant[s]” comprised 16% of respondent titles, while department “head[s]” or “chief[s]” comprised 19% of titles. Finally, the word “librarian” appeared in 16% of respondent titles; however, since most respondents supplied functional titles, the percentage of librarians in the respondent pool may have been significantly higher than 16%.

**Respondents’ Training**

With respect to the respondents’ training, nearly two thirds reported formal training in conservation: 45% served an apprenticeship while 27% earned a graduate conservation degree or certificate (includes 8% overlap of respondents with...
both types of formal training). With respect to informal training, the survey sample divided fairly evenly between those who had attended six or more workshops or other forms of short-term training in the prior ten years and those who had attended five or fewer (fig. 4).

A comparison of the respondents’ formal training with the types of collections served (i.e., special collections and/or general collections) revealed some trends (fig. 5). Nearly all (93%) of the respondents working only with special collections had some form of formal conservation training, with apprentice training predominating: over two-thirds (71%) of those working only with special collections were apprentice-trained, while less than a third (29%) of those working only with special collections had graduate degrees in conservation (includes 7% overlap of respondents with both types of formal training).

The respondents working only with general collections, on the other hand, had relatively little formal training. Over two-thirds (69%) of these respondents did not have formal training; of those with formal training, their training was split evenly between apprenticeships and graduate degrees.

The hybrid practitioners formed a more diverse pool with respect to their training. While one-third reported having no formal training, over two-thirds (67%) had some form of formal training: nearly half (47%) of the hybrid respondents had served an apprenticeship while 30% had earned a graduate degree/certificate in conservation (includes 9% overlap of respondents with both types of formal training).

**Size and Type of Library**

Diverse in terms of the size of their institutions, the survey respondents distributed relatively evenly among large libraries with over five million volumes, mid-size libraries with two to five million volumes, and smaller libraries with fewer than two million volumes (fig. 6). Most respondents (81%) worked for a library that was a member of the Association of Research Libraries (ARL). A minority of respondents (19%) worked for non-ARL libraries in the United States, most (86%) of which were smaller libraries with fewer than two million volumes.

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, increased practitioner specialization was associated with larger libraries: nearly two thirds (64%) of the special collections-only practitioners were from libraries with more than two million volumes.
over five million volumes, while none was from libraries with fewer than two million volumes. In the general collections context, however, the converse 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 midsize mid-size libraries with 2–5 million volumes.

Type of Conservation Facility

Two-thirds of respondents worked in a library with a centralized, or hybrid, conservation facility. Nearly half worked in a facility that was built or renovated since 2000 (fig. 7).

A comparison of the respondents’ facility types and their most recent renovation dates revealed a trend toward centralized facilities; three-quarters of respondents from facilities built or renovated since 2000 described their institution’s facilities as centralized, as compared with 59% for the remaining respondents.

survey results

Data pertaining to treatment practices for special and general collections were compiled and compared, with all treatments classified as either “standard practice,” “moderate use,” or “low use” for special collections and for general collections. A treatment was considered “standard practice” when it was reported as “standard practice, frequent” or “standard practice, occasional” by 50% or more of facilities. Treatments reported as standard practice by 25–49% of facilities were considered “moderate use.” The remaining treatments—“standard practice” at fewer than 25% of facilities—were designated “low use.”

The data were examined for trends in treatment practices across all collected elements of demographic information. To determine whether specific treatment practices correlated with demographic characteristics, the responses of different demographic groups were analyzed and compared. For each treatment, the percentage of respondents from various demographic groups who reported the treatment as standard practice was calculated, for special and general collections, and the figures for various demographic groups were compared. This section details the similarities and differences in practices associated with five demographic variables:

- practitioner training
- type of collections served by the practitioner (whether special collections, general collections, or both)
- type of conservation facility
- size of library
- type of research library (ARL or other)

Practitioner Training

The data indicate that, overall, program- and apprenticeship-trained practitioners were more likely to consider treatments standard practice than were their counterparts without such formal training. This trend was strongest for relatively complex treatments such as leather work, dyeing materials, and solvent treatment. The correlation between formal training and increased adoption of complex treatments was strongest in the special collections context.

Special Collections—In the special collections context, the differences in practices between formally-trained practitioners and those without such training were striking. All but four (93%) of the treatments studied were more commonly reported as standard practice by formally-trained practitioners than by respondents without formal training. For all fifty-five treatments, the average differential—between the percentage of practitioners with formal training and those without such training, all of which were more common to respondents with formal training (fig. 8). The data indicate, therefore, that in the
special collections context, training is a strong indicator of treatment practice. This may not be surprising in that individuals with more comprehensive training may tend to be more comfortable with more complex treatments, as well as more likely to be hired into positions requiring such treatments.

General Collections—In the general collections context, the same trend was observed, but the correlation was only about half as strong. For all fifty-five treatments, the average differential was ten percentage points (as opposed to nineteen percentage points for special collections). Forty-three of the fifty-five treatments (78%) were more common to formally trained practitioners than to those without such training, but just two treatments (hinged-on endsheets and Japanese paper board reattachment) displayed a differential of at least 25 percentage points based on type of training (fig. 9). The data indicate, therefore, that in the general collections context, training is a moderate indicator of treatment practice.

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 did their special collections-only counterparts. Forty-nine of the fifty-five treatments (89%) were more common to special collections-only practitioners than to hybrid practitioners. The average differential for all fifty-five treatments was sixteen percentage points, and nine treatments displayed a differential of at least twenty-five percentage points, all of which were more common to special collections-only practitioners (fig. 10). The data indicate, therefore, that in the special collections context, whether or not a practitioner also works with general collections is a fairly strong indicator of treatment practice, particularly with respect to more complex treatments.

**Type of Practitioner**

The data indicate there are 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, 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 treatments, standard practice than did their counterparts working solely with general collections.
The Impact of Training and Institutional Context on Book Conservation Practices

Dube and Baker

Treatments, standard practice than were their general collections-only counterparts, with an average differential for all fifty-five treatments of thirteen percentage points (as opposed to 16% for special collections). Forty-eight of the treatments, standard practice than were their general collections-only counterparts, with an average differential for all fifty-five treatments of thirteen percentage points (as opposed to 16% for special collections). Forty-eight of the

General Collections—A very similar relationship emerged with respect to general collections treatment. In the general collections context, hybrid practitioners were more likely to consider treatments, especially more complex

Fig. 10. Special collections treatments with significant variance in practice (≥25 percentage points) by type of practitioner

Fig. 11. General collections treatments with significant variance in practice (≥25 percentage points) by type of practitioner

Fig. 12. Special collections treatments with significant variance in practice (≥25 percentage points) by type of facility

Fig. 13. General collections treatments with significant variance in practice (≥25 percentage points) by type of facility
fifty-five general collections treatments (87%) were more common to hybrid practitioners than to general collections-only practitioners, with eight of the fifty-five treatments displaying a significant (Δ ≥25 percentage points) differential, all of which were more common to hybrid practitioners than to general collections-only practitioners (fig. 11). The data indicate, therefore, that in the general collections context, whether or not a practitioner also works with special collections is a moderately strong indicator of treatment practice, particularly with respect to more complex treatments.

Type of Conservation Facility

The treatment practices of respondents from centralized, or hybrid, facilities were compared with those from facilities dedicated solely to special or general collections. Significant overlap between this characteristic (type of facility) and the former just discussed (type of practitioner) was identified: of the forty-three hybrid practitioners responding to the survey, the vast majority (93%) worked in a centralized/hybrid facility. Similarly, of the forty-eight respondents from a hybrid facility, most (83%) reported hybrid responsibilities. The data confirmed this overlap, revealing similar treatment practice trends for facility type as were associated with practitioner type.

In the special collections context, practitioners from special collections-only facilities were slightly more likely to report treatments, especially more complex treatments, as standard practice than were their counterparts from hybrid facilities. Conversely, in the general collections context, practitioners working in hybrid facilities were more likely to report treatments, especially more complex treatments, as standard practice than were their counterparts working in general collections-only facilities. The impact of facility type was strongest in the general collections context. The treatment practices of hybrid facilities are therefore more similar to special collections-only facilities than they are to general collections-only facilities, suggesting that general collections-only facilities may be equipped to support fewer types of treatments than their hybrid counterparts.

Special Collections—The data indicate that practitioners in special collections-only facilities were slightly more likely to consider treatments standard practice than were their counterparts in hybrid facilities: forty of the fifty-five special collections treatments (73%) were more common to special collections-only facilities than to hybrid facilities. This trend was most pronounced for more complex types of treatments, such as dyeing leather, limp vellum/paper case binding, and leather reback. The average differential for all fifty-five treatments was eleven percentage points, with just two treatments having differential of at least twenty-five percentage points, both of which were more common to special collections-only facilities (fig. 12).

General Collections—Type of facility had a moderately strong impact on treatment practices in the general collections context. Fifty of the fifty-five treatments (91%) were more common to hybrid facilities than to general collections-only facilities, and the average differential for all fifty-five treatments was seventeen percentage points (as opposed to eleven percentage points for special collections). Fourteen of the fifty-five treatments displayed a significant (Δ ≥25 percentage points) differential in the general collections context, all of which were more common to hybrid facilities (fig. 13).

The data indicate that, overall, more complex treatments—those requiring more specialized skills, supplies, or equipment—were more common to practitioners from centralized/hybrid facilities than to practitioners from general collections-only facilities. One treatment especially stood out in this respect: polyester sleeve/encapsulation was considered standard practice by 77% of respondents from centralized facilities, while just 27% of respondents from general collections-only facilities reported it as standard practice. Because encapsulation is often performed with specialized welding equipment, this striking difference (Δ 50 percentage points) suggests that facilities dedicated only to general collections may tend to be less well equipped than facilities for special collections treatment.

Size of Library

The data indicate that, overall, larger institutions were more likely to consider treatments standard practice than were smaller libraries. This trend was strongest in the special collections context.

Special Collections—In the special collections context, the data indicate a strong relationship between the size of the collection held by the respondent’s institution and its reported treatment practices. Most (85%) of the fifty-five treatments studied were found to be more common to larger libraries (> three million volumes) than to smaller libraries (< three million volumes). With respect to the percentage of respondents reporting techniques as standard practice, the average differential between larger libraries and smaller libraries for all fifty-five treatments was 18%. Sixteen (29%) of the treatments studied displayed a significant differential (Δ ≥25 percentage points) with respect to the percentage of respondents reporting them as standard practice, all of which were more common to larger libraries (fig. 14).

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. A much weaker majority (65%) of the fifty-five treatments studied were
Fig. 14. Special collections treatments with significant variance in practice (≥ 25 percentage points) by size of library

Fig. 15. General collections treatments with significant variance in practice (≥ 25 percentage points) by size of library

Fig. 16. Special collections treatments with significant variance in practice (≥ 25 percentage points) by type of library

Fig. 17. General collections treatments with significant variance in practice (≥ 25 percentage points) by type of library
found to be more common to larger libraries (> three million volumes) than to smaller libraries (< three million volumes). With respect to the percentage of respondents reporting techniques as standard practice, the average differential between larger libraries and smaller libraries for all fifty-five treatments was 10% (as opposed to 18% for special collections), with just five (9%) of the treatments displaying a significant differential (Δ≥25 percentage points) with respect to the percentage of respondents reporting it as standard practice (fig. 15).

Type of Library

The survey data reflect the working practices of U.S. research libraries, comparing ARL and non-ARL libraries. Many top research libraries are members of the Association of Research Libraries (ARL), an “organization of 125 research libraries at comprehensive, research-intensive institutions” (Association of Research Libraries 2010). Another elite research library group is the Independent Research Libraries Association, an organization of nineteen independent, privately supported research libraries (Independent Research Libraries Association 2010). Three additional categories of research libraries are identified in a 2002 Council on Library and Information Resources report on the state of American preservation programs: the University Libraries Group of twenty-three mid-sized university libraries, the Oberlin Group of eighty leading liberal arts colleges, and the twenty major non-ARL land-grant institutions (Kenny and Stam 2002, iv).

The data were examined to compare the types of treatments employed by practitioners working in ARL libraries with those used by practitioners in non-ARL research libraries in the United States. The practices of those working for ARL libraries and those working for non-ARL research libraries were found to be moderately different in both special and general collections contexts.

Special Collections—In the special collections context, the differences in practices between ARL and non-ARL libraries were found to be moderately significant. The average differential for all treatments, based on type of library, was 14%. Just slightly more than half of the fifty-five treatments (62%) were more common to ARL libraries, resulting in a relatively even mixture of treatments more common to ARL libraries and others more common to non-ARL libraries, with no obvious trends within treatment categories. Eleven treatments (20%) displayed a differential of at least 25 percentage points (fig. 16).

General Collections—In the general collections context, a similar relationship was identified as was observed for general collections: the average differential between ARL and non-ARL libraries for all fifty-five treatments was 16% (as compared with 14% for special collections). However, in the general collections context, practitioners from ARL libraries were far more likely to report treatments as standard practice than were their non-ARL counterparts: fifty of the fifty-five treatments (91%) were reported as standard practice by a greater percentage of ARL facilities than non-ARL facilities. Twelve treatments displayed a differential of at least twenty-five percentage points, all of which were more common to ARL libraries (fig. 17).

U.S. VERSUS NON-U.S. TREATMENT PRACTICES

Further study of international treatment practices is needed, as practices in the U.S. may be substantially different from those of other countries. As previously mentioned, while the survey was open to research library book conservation practitioners worldwide, the response rate from non-U.S. facilities was insufficient to support conclusions about non-U.S. practices and how they compare to practices in the U.S. While the data from the six non-U.S. survey respondents were excluded from this analysis, a preliminary assessment prior to the removal of non-U.S. respondent data indicated greater differences between U.S. and non-U.S. practices than among any of the other demographic variables studied. For both special and general collections, non-U.S. practitioners consistently reported more complex treatments—such board reattachments, treatments using leather, and tape removal and other advanced paper treatments—as standard practice at markedly higher rates. More research is needed to discover how treatment practices in the U.S. compare to those of other countries, how institutional contexts differ, and how conservation information is shared internationally.

CONCLUSION

The results of this study indicate that the demographic characteristics of book conservation practitioners and their institutions—including the practitioners’ level of training, the size of library collection, and the type of library—are, to varying degrees, indicators of treatment practices. The data also confirm the authors’ hypothesis that the practices of hybrid facilities and hybrid practitioners differ significantly from the practices of facilities and practitioners dedicated to just one type of collection, with the practices of hybrid practitioners and hybrid facilities occupying a middle ground between those dedicated solely to special collections and those dedicated solely to general collections. Finally, the survey data suggest areas for future research.

Differences between the practices of those with formal training and those without formal training were identified. The level of training of the respondent was found to be a strong indicator of treatment practice in the special collections context, while only slightly so in the general collections context, suggesting that formal training is most critical in the
special collections context. The considerable differences between the special collections treatment practices of formally trained practitioners and those without formal training are relevant to current questions about the future of conservation education in the United States, as the recent closure of the only graduate program focused on book conservation in the United States, at the University of Texas, has made it more difficult to obtain formal credentials in library and archives conservation.

Differences in practice based on the size and type of library were also observed. Library size was found to be a strong indicator treatment practices in the special collections context, while only slightly so in the general collections context. Whether the respondents’ institution was a member of the Association of Research Libraries was a moderate indicator of practice in both the special and general collections contexts.

The survey data support the hypothesis that the practices of hybrid facilities and practitioners bridge the gap between the historically disconnected operations dedicated to special collections conservation and general collections repair, as observed by Frost (1999–2000). The treatments utilized by hybrid practitioners tend to occupy middle ground between their counterparts working with just one type of collections: for general collections, hybrid practitioners apply a larger number of more complex treatments than their counterparts working solely with general collections, while for special collections they regularly utilize fewer of the complex treatments employed by their colleagues working solely with special collections. A similar trend was noted for the practices of hybrid facilities, which the data also confirm have become increasingly more common in U.S. research libraries. These findings suggest that the rise of hybrid conservator positions and hybrid facilities in research libraries in the United States has likely had a significant impact on book conservation treatment practices.

Finally, marked differences in treatment practices were noted between U.S. and non-U.S. libraries, especially for more complex work such as leather and paper treatments, but these results were inconclusive due to the small number of non-U.S. respondents. While not statistically significant, the data suggest the need for another study with greater non-U.S. participation and an internationally standardized terminology to identify gaps in knowledge and practice, and to highlight areas where the need for international information exchange is greatest.

ACKNOWLEDGEMENTS

The authors are grateful to Gary Frost, Alberto Campagnolo, our generous colleagues who pretested the survey, and all those who participated in the survey. The survey was supported in part by a 2007 University of Kansas Library Research Fund award.

REFERENCES


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Appendix A: Survey Instrument

Book Conservation and Repair in Research Libraries

Survey page 1

Thank you for your interest!

Your participation in this 10-20 minute survey will help document current practices and trends in research library book conservation and repair. The survey results will be widely disseminated.

This survey should be completed by the individual(s) with primary responsibility for book conservation and/or repair. Institutions with multiple conservation/repair units may respond once for the entire institution or individually for each unit.

Survey page 2

Survey Disclaimer

Because our institutions are concerned about protecting human subjects participating in research, this information is provided to help you to decide whether you wish to participate in this study.

This study is being conducted to document current book conservation treatment practices in research libraries. Participation in the study entails completion of a questionnaire which should take approximately 10-20 minutes to complete and should cause no more discomfort than you might experience in everyday life. Although participation may not benefit you directly, we believe the information obtained from this study will help the field of conservation better understand its current practices. Your participation is solicited and encouraged, but is strictly voluntary and if you agree to participate you remain free to withdraw at any time without penalty. Your name will not be associated in any way with the research findings; however, given the limitations of internet communications it is possible that by intent or accident someone other than the intended recipient may see your response.

The University of Human Subjects Committee found this research project to be in compliance with all of the requirements and policies in place for protection of human subjects in research. Approval to proceed with the project for a one year period was granted on June 13, 2007. For additional information concerning this study, please feel free to contact us at any time. Completion of the survey indicates your willingness to participate in this research and that you are at least age eighteen.

Sincerely,

Whitney Baker
University of Kansas Libraries
1425 Jayhawk Blvd., Room 135
Lawrence, KS 66045-7544
wbaker@ku.edu (785) 864-3568

Liz Dube
University of Notre Dame Libraries
5 Reyniers Building
Notre Dame, IN 46556-1355
**Please Briefly Describe Yourself and Your Institution**

### Institution size
- Under 2 million volumes
- 2-3 million volumes
- 3-5 million volumes
- Over 5 million volumes

### Institution type
- U.S. research library that is a member of ARL (Association of Research Libraries)
- U.S. Non-ARL research library
- Non-U.S. research Library: Please specify the country in which your library is located:

### Your job title: ______________________________

### Which functions do you manage and/or participate in? (select all that apply)
- General Collections Conservation/Repair
- Special Collections Conservation

### How much of your position is dedicated to managing and/or participating in these activities?
- 75% or more
- 50-74%
- 25-49%
- less than 25%

### Which best describes your institution’s conservation/repair facilities?
- Our sole facility serves the general collections
- Our sole facility serves the special collections
- Our sole facility serves both special and general collections (may contain spaces, equipment and/or staff dedicated solely to special or general collections)
- We have separate/distinct facilities for special and general collections
- Other: ______________________________

### How recently was your in house conservation/repair facility built or last significantly renovated?
- 2000s
- 1990s
- 1980s
- Pre-1980
- N/A

### How did you acquire your conservation knowledge and skills? (select all that apply)
- Conservation apprenticeship
- Graduate degree/certificate in conservation
- Other graduate coursework
- On the job training or experience
- Workshops/training sessions
- Professional association meetings
- Self-study (books, online resources, etc.)
- Other: ______________________________

### How many conservation-related workshops and/or training sessions have you attended in the last ten years?
- 1 – 5
- 6 – 10
- more than 10
Survey pages 4 and 5

[Special/General] Collections Conservation

(While otherwise identical, page four of the survey applied to special collections and page five applied to general collections. For treatments whose names were not self-explanatory, definitions were accessible by scrolling over an “info” link adjacent to a treatment’s name. Fully clicking on the “info” link opened up a new web browser window with additional detail. See Appendix B for treatment definitions.)

Taking into account the past three years, identify which of the techniques listed below are performed in house on your [special/general] collections. Responses are categorized as follows:

- **Standard Practice, frequent** - Part of your laboratory’s established toolbox of techniques, executed routinely or with some regularity (as defined relative to overall production levels).
- **Standard Practice, occasional** - Part of your laboratory’s established toolbox of techniques, executed occasionally or rarely (as defined relative to overall production levels).
- **Anomalous** - Performed rarely and for exceptional reasons. Not considered standard practice.
- **Never** - Never performed in the past three years.
- **Not sure** - Uncertain what this is and/or if it is performed in your facility.

List additional treatment techniques that your institution considers standard practice under "other."

### Protective enclosures

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Standard practice, frequent</th>
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<th>Anomalous use only</th>
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<td>Pocket, envelope, or 3 or 4-flap folder in pamphlet binder</td>
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<td>O</td>
<td>O</td>
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<td>O</td>
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<tr>
<td>3 or 4-flap “tuxedo” box (tongue &amp; slot closure)</td>
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<td>O</td>
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<td>O</td>
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<tr>
<td>3 or 4-flap “phase” box (rivet &amp; string closure)</td>
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<td>Corrugated board box</td>
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<tr>
<td>Fitting books with custom sized boxes purchased from a vendor</td>
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<td>O</td>
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<td>O</td>
<td>O</td>
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<td>Polyester sleeves and/or encapsulation info</td>
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</table>

Other protective enclosures and/or book jackets:

---

### Binding reinforcements

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Appendix A.3.
## Appendix A.4.

### Pamphlet binding, adhesive attachment

<table>
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<th>Practice</th>
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<tr>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
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</tbody>
</table>

### Pamphlet binding, staple through the fold

<table>
<thead>
<tr>
<th>Practice</th>
<th>Frequent</th>
<th>Occasional</th>
<th>Use Only</th>
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</thead>
<tbody>
<tr>
<td>O</td>
<td>O</td>
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<td>O</td>
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</tbody>
</table>

### Pamphlet binding, sew through the fold

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<thead>
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### Paperback stiffening info

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<td>O</td>
<td>O</td>
<td>O</td>
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</tbody>
</table>

### Other binding reinforcements:

#### Minor paper treatments and textblock repairs

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<th>Not Sure</th>
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<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
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</tbody>
</table>

### Creating/inserting photocopy replacement pages

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<td>O</td>
<td>O</td>
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### Mending with “archival” tape (e.g., Filmoplast, Archival Aids)

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<tbody>
<tr>
<td>O</td>
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<td>O</td>
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</table>

### Mending with heat set tissue info

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<tbody>
<tr>
<td>O</td>
<td>O</td>
<td>O</td>
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### Mending with Japanese paper & paste

<table>
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<th>Anomalous Use Only</th>
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<tbody>
<tr>
<td>O</td>
<td>O</td>
<td>O</td>
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### Guarding sections with Japanese paper & paste

<table>
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<tbody>
<tr>
<td>O</td>
<td>O</td>
<td>O</td>
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### Re-sewing several sections

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<tbody>
<tr>
<td>O</td>
<td>O</td>
<td>O</td>
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</table>

### Sewing or re-sewing an entire volume

<table>
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<td>O</td>
<td>O</td>
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</table>

### Barrier spine lining of Japanese paper & paste

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<td>O</td>
<td>O</td>
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</table>

### New tipped-on endsheets

<table>
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<th>Not Sure</th>
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<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
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</table>

### New hinged-on endsheets info

<table>
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### New sewn-through-the-fold endsheets

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### Other minor paper treatments and textblock repairs:

- Joint tacketing (Espinosa) info
- Japanese paper board reattachment (Etherington) info

<table>
<thead>
<tr>
<th>Practice</th>
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### Board reattachment methods

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<tbody>
<tr>
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</table>

Appendix A.4.
### Appendix A.5.

Toning Japanese paper with acrylics for board reattachment or binding repair  
Solvent set tissue board reattachment (Anderson & Puglia) info  
Board slotting (Clarkson) info  
Partial cloth hinge (Brock) info  
New slips info  

Other board reattachment methods:

**Other binding repair and rebinding techniques**

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<th>Method</th>
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<tr>
<td>&quot;Recase&quot; info</td>
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<td>&quot;New case&quot; info</td>
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<td>Lapped case / Bradel binding info</td>
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<td>Leather &quot;reback&quot; info</td>
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</tr>
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<td>Japanese paper &quot;reback&quot; info</td>
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<td>○</td>
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<tr>
<td>Reattaching detached spines with a hollow tube or v-hinge</td>
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<tr>
<td>Lifting endsheets to save original pastedown endsheets</td>
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<tr>
<td>Dyeing cloth with acrylics for binding repairs</td>
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<td>Dyeing leather with leather dye for binding repairs</td>
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Other binding repair and rebinding techniques:
### Advanced paper treatments performed on books/bound volumes

<table>
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<th>Treatment</th>
<th>Standard practice, frequent</th>
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<tr>
<td>Wei T'o deacidification info</td>
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<td>O</td>
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<td>O</td>
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<tr>
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<td>O</td>
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<tr>
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<td>O</td>
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<td>Tape/adhesive/stain removal using other solvents</td>
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<td>O</td>
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<tr>
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<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
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</table>

Other advanced paper treatments:

---

**Survey page 6**

**Follow up**

Would you be willing to participate in a brief follow up survey in a couple of months, if needed?

☐ Yes     ☐ No

If yes, contact information:

Name: __________________________
Email Address: ______________________

---

**Survey page 7**

**Your survey has been submitted.**

**Thank you** for your participation!
Appendix B: Treatment Definitions

The survey provided the following definitions, via pop-up text, for the twenty-five treatments whose names were deemed insufficiently self-explanatory.

<table>
<thead>
<tr>
<th>Treatment name</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyester book jacket</td>
<td>A non-adhesive custom fitted book jacket made of clear polyester film (e.g., Mylar).</td>
</tr>
<tr>
<td>Polyester sleeve/encapsulation</td>
<td>Encapsulating paper in polyester (e.g., Mylar) and/or using prefabricated polyester sleeves (where one or more edges may remain unsealed).</td>
</tr>
<tr>
<td>Paperback stiffening</td>
<td>Adhering a thin board to the inside cover of a paperback binding. The inner hinge may also be reinforced with cloth, paper, or tyvek.</td>
</tr>
<tr>
<td>Heat set tissue mending</td>
<td>A thin, acrylic-coated tissue applied with a heated tool.</td>
</tr>
<tr>
<td>New hinged on endsheets</td>
<td>Endsheets that are attached using a hinge of Japanese paper adhered to the spine.</td>
</tr>
<tr>
<td>Joint tacketing</td>
<td>A board reattachment technique wherein thread is laced through holes piercing the book’s shoulder and through corresponding holes in the boards.</td>
</tr>
<tr>
<td>Japanese paper board reattachment</td>
<td>A board reattachment technique wherein Japanese paper is adhered along the inner and outer joints.</td>
</tr>
<tr>
<td>Solvent set tissue board reattachment</td>
<td>A variant Japanese paper board reattachment technique employing solvent-set tissue impregnated with an isopropanol-activated acrylic adhesive.</td>
</tr>
<tr>
<td>Board slotting</td>
<td>A board reattachment technique using specialized equipment to create an angled slot in the edge of the board for a cloth spine lining hinge.</td>
</tr>
<tr>
<td>Partial cloth hinge</td>
<td>A board reattachment technique that minimizes spine disruption by employing limited sections of cloth spine lining/hinges, typically at the head and tail.</td>
</tr>
<tr>
<td>New slips</td>
<td>Using new thread (and sometimes cords or tapes) to create new board attachment slips at one or more sewing station.</td>
</tr>
<tr>
<td>“Recase”</td>
<td>A rebinding using the original case binding and new endpapers.</td>
</tr>
<tr>
<td>“New case”</td>
<td>A rebinding using a newly constructed case binding (may include retaining parts of the original spine title).</td>
</tr>
<tr>
<td>Lapped case/Bradel binding</td>
<td>A variant case binding in which the boards are attached to each other with cloth or paper, creating a “flexible spine inlay,” prior to covering.</td>
</tr>
<tr>
<td>New limp vellum/paper case binding</td>
<td>A generally non-adhesive limp paper/parchment cover with a texblock typically sewn on supports that are laced into the cover.</td>
</tr>
<tr>
<td>Cloth “reback”</td>
<td>Spine replacement using new cloth.</td>
</tr>
<tr>
<td>Leather “reback”</td>
<td>Spine replacement using new leather.</td>
</tr>
<tr>
<td>Sewn boards binding</td>
<td>An early coptic adaptation in which the boards, typically folios of mat board, are sewn with the texblock. Cloth/paper coverings use minimal adhesive.</td>
</tr>
<tr>
<td>Split board binding</td>
<td>An in-boards binding repair in which new boards are constructed as laminates, with the hinge and sewing supports sandwiched between layers of board.</td>
</tr>
<tr>
<td>Treatment 305</td>
<td>A tight joint binding repair wherein new boards are attached with a cloth spine lining adhered to (and sometimes inset in) the outside of the boards. The covering cloth may be dyed to approximate leather.</td>
</tr>
<tr>
<td>Aqueous washing/alkalization</td>
<td>Removing acidic products by bathing paper in water. Alkaline chemicals may be employed to deposit an alkaline reserve in the paper.</td>
</tr>
<tr>
<td>Bookkeeper deacidification</td>
<td>A commercial product sprayed onto paper to slow acidic degradation processes.</td>
</tr>
<tr>
<td>Wei T’o deacidification</td>
<td>A commercial product sprayed or brushed onto paper to slow acidic degradation processes.</td>
</tr>
</tbody>
</table>
The Book and Paper Group Annual is a non-juried collection of papers pertaining to the conservation and preservation of works of art on paper, paper artifacts, books, and library and archival materials. The Annual compiles postprints (full text papers, summaries, or abstracts) of papers presented at the Book and Paper Group (BPG) specialty group sessions at the AIC annual meeting and independently submitted papers that are of interest to members of the BPG. Papers in the Annual may be of any length from a short technical tip to a full-length article.

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Deadline
The deadline for submissions is July 1. Send submissions to:

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