FOR WALTER HENRY

The Book and Paper Group is delighted to dedicate the 2016 Annual to Walter Henry. Walter has been an active leader in the conservation community, supporting AIC-BPG publications beginning with the BPG Book Conservation Catalog in 1988. In the mid-1990s Walter assumed the role of BPG Publication Committee Webmaster and Chair.

Walter is an Internet pioneer and the founder of Conservation OnLine (CoOL), which is a resource used by conservation professionals around the world. Many a conservation professional has relied on the DistList to stay current with materials, research and most importantly JOBS! Emerging conservators use the list serv to get a lay of the land, while students engage the community with requests for information related to their thesis projects or participation in a survey. The CoOL website hosts the online archive of the BPG Annual and links to innumerable conservation publications. CoOL also hosts the websites of many smaller conservation organizations that would otherwise struggle to maintain a web presence on their own. Thanks to CoOL, the collected knowledge of our profession is available across specialties, generations and the world.

We salute you, Walter, onward!

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The Book and Paper Group Annual

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A Protocol to Conserve Glazed Paper After Water Damage

Following water damage in the Art and Literature Department at the Bibliotheque nationale de France (BnF), the question came of how to handle the wet glazed papers. The company in charge of freezing and drying the damaged documents was reluctant to take care of them because the quantity of water that impregnated each document was very variable. They knew from previous experience that if glazed papers were not totally soaked with water, the sheets would stick together and freeze-drying would have essentially no effect. As a consequence, we had to find a way to separate the sheet of glazed paper stuck together. We investigated the composition of the glazing, and found that most papers were glazed with Styrene-Butadiene latex. One of the solvents of SB latex is Tetrahydrofuran (THF). THF is toxic, but it can be replaced with a mix of ethanol and toluene (50/50 v/v). Tests were carried out on a sample of damaged documents. They gave excellent results on paper sheets which were stuck on their entire surface; however, the results were not as good, as the solvent also seems to have an effect on many of the inks. Following these investigations, we were able to establish an emergency protocol applicable to massive amounts of wet glazed papers. In this presentation, we will report on our results and present the protocol that was established from our experience.

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Presented at the Book and Paper Group Session, AIC's 44rd Annual Meeting, May 13–17, 2016, Montreal, Canada

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Watercolour Pencils: Composition and Conservation Concerns

ABSTRACT

This work examines the composition of a variety of commercially available artists' watercolour pencils (from Derwent, STAEDTLER™, and Reeves®), and the reactions of the pencils to aqueous and solvent immersion, non-contact humidification, and mechanical smudging. Both artificially aged and un-aged samples were tested. Fourier Transform Infrared (FTIR) spectroscopy was used to identify the composition of the pencils, spectrophotometry was used to quantify any colour shift following the experiment, and ImageJ software was used to compare the effects of smudging.

Despite many similarities to traditional watercolour paints in how they are used, the pencils differ greatly from their traditional counterparts in composition. All of the watercolour pencils analysed were found to contain colourants, clays, a polysaccharide binder, and modified polyethylene glycol. The results of the immersion, humidification and smudging tests provide a basis to inform the treatment of works containing watercolour pencils but also illuminate the need for further investigation in this and other related media types emerging on the market.

INTRODUCTION

Within the last century watercolour pencils (WCPs) have become more prevalent as a multidisciplinary artistic medium. Watercolour pencils can be used wet or dry to achieve a multitude of colours, textures, and artistic effects. Little information is available in the art conservation literature regarding their general composition, aging characteristics, or the risks associated with their treatment.

A review of the paper conservation literature finds many references concerned with the care and treatment of works composed with watercolours. Published topics have involved direct studies of specific artists' materials, as well as overviews of individual pigments, and more technical analyses of watercolour aging parameters. Since the early twentieth century, however, watercolours (WC) have been made commercially available to artists in the form of pencils, offering an additional method of application and a new area of study.

WCPs can be used dry, as a typical pencil in terms of drawing or writing, or they can be used wet, either by dipping the pencil lead in water prior to application or by applying water with a brush after dry application to create a wash. Unlike traditional watercolour half-pans or tubes, the WCP leads must be soft enough to deposit media on the surface of a substrate with gentle pressure while also retaining enough strength to withstand the heavy mechanical pressures associated with sharpening, and more vigorous application. WCPs are not regarded as permanent, in the sense that re-wetting the medium may result in additional flow even after the application of a watercolour pencil has been allowed to dry on a paper substrate. The range of working properties that these WCPs are able to achieve comes with a corresponding change in composition, and aging characteristics. This paper seeks to investigate the nature of WCPs and the potential concerns they may pose for the paper conservator.

At this point, the issue of terminology must be addressed. In advertisements and artist material catalogues, watercolour pencils have been described and marketed in a variety of different ways. Generally, they are referred to with one term referencing the medium's interaction with water (i.e. aquarell(e), water-soluble, and water-thinned), and a second term to reference to the form of application (i.e. pencil, crayon, and stick). For the purposes of this study, the term watercolour pencil will be used to describe what can broadly be understood as a soft, coloured, water-soluble "lead" within a wooden case.

HISTORICAL BACKGROUND

The copy pencil is generally considered to be the predecessor of the WCP in terms of working properties. Copy pencils were introduced in the 1870s, and were used in letterpress

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copying and as a more indelible alternative to traditional graphite pencils. The lead of a copy pencil was composed of graphite, clay and a colourant which was usually dye-based. Mordants, such as alumina, as well as binding agents like dextrin, gum tragacanth, albumen, or wax were also added.[1] These pencils would be moistened before being applied to a paper substrate.

The earliest available reference to a product akin to WCPs was provided by an archival specialist at STAEDTLER™. It is a catalogue description for oil-pastel pencils from 1928:

> These […] artist pencils are used with STAEDTLER colouring instrument No. 7720 for a colouring process which combines the advantages of coloured pencils with water-colour paint. By blending the colours with the instrument dipped in water or with a paint brush or with the finger, unknown effects can be achieved. They can be used on plain paper, oiled paper, tracing cloth, etc. and combined with water paints or tempera.[2]

It is possible that similar products manufactured by other artists' suppliers were available at a slightly earlier date, however no such evidence was found at the time of this publication.

One of the few detailed accounts of historical uses of WCPs comes from Margaret Holben Ellis's review of Jackson Pollock's works of art on paper. In his early works, Pollock appears to have used WCPs more as a dry drawing tool. In his later years, Pollock's use of WCPs seems to be more closely aligned with their intended use, "suggesting a fully realized familiarity with them".[3]

Pollock's diverse exploitation of the working properties of WCPs provides a perfect case study of issues that WCPs pose for the conservator. When used dry, the waxy nature of WCPs can be easily confused with other waxy drawing media such as crayons, coloured pencils, or pastels. This makes precise identification of the medium difficult, if not impossible, with visual examination alone.[4] Similarly, when used wet, WCPs could reasonably be misidentified as traditional watercolours or ink. In either case, misidentification of the media could lead the conservator to grossly underestimate the potential solubility concerns associated with WCPs.

Despite the use of WCPs by notable artists in the 1940s/50s, the published knowledge on WCPs remains sparse in the decades following. It is not until the 1990s that artist manuals on the uses and techniques associated with WCPs began emerging in greater numbers.

EXPERIMENTAL

The research for this study was taken up with the hopes of being able to address two main questions: 1) what WCPs are made of and 2) how they will be affected by typical conservation treatments. To address the question of composition, some manufacturers of WCPs were contacted. STAEDTLER™ communicated that:

> The colored leads contain…binding agents based on cellulose, filling agents such as Talcum or Kaolin (natural products), coloring pigments which are according to the EN 71 standard,[5] [and] slip additives such as fat, natural and synthetic waxes and emulsifying agents…[6]

The company's manufacturing method for WCPs is similar to that of standard pencil crayons. It involves mixing the raw materials into a homogeneous substance and pressing the finished mix into cylindrical blocks. These blocks are then passed through a hydraulic press to make a 'rope,' which is then cut to individual 185mm pieces. The flexible leads are put into metal tins and dried for eight hours at temperatures between 60–120°C. After drying, the leads for standard coloured pencils are ready to be glued into the pencil slat. At this point, WCP leads go through an additional working cycle where they are impregnated with a wax that diffuses into the lead and makes them "water-colourable".[7]

Compositional analysis was carried out to see if there were any great differences in composition between different brands of WCPs (STAEDTLER™, Derwent and Reeves®) and within different lines of WCPs produced by the same manufacturer (STAEDTLER™ karat aquarelle and STAEDTLER™ ergosoft).

To investigate the effects of typical conservation treatments, the experimental procedure followed the method outlined by Liz Dube (1998) during her investigation of the solubility parameters of historic copy pencils. Drawn lines of WCPs were exposed to several distinct treatment conditions including humidification, smudging, and immersion in aqueous and solvent baths. In this study, both artificially aged and un-aged samples were submitted to all of the test conditions.

CHEMICAL ANALYSIS

Small samples of the leads were taken directly from the pencils and liquid-liquid separation was used to separate the components. Isolated components of the pencil leads were analysed by mid-IR spectroscopy using a Nicolet Avatar™ 320 Fournier Transform Infrared (FT-IR) spectrometer equipped with a Nicolet SMART™ Golden Gate attenuated total reflectance (ATR) accessory (Thermo Instruments, Canada). The spectra were collected with 32 scans at a 4 cm^{-1} resolution, with background correction. Data was collected and analysed using EZ Omnic® 5.2 software.

SAMPLE PREPARATION

Samples were prepared by drawing horizontal lines with select WCPs by hand onto Winsor & Newton Watercolour Pen and Ink paper (mould made, 140lb. 100% cotton rag, acid free, neutral pH, internal and surface sizing). This

Fig. 1. Example of a WCP test strip with the following colours/ brands:
(1) Derwent Ivory Black 67
(2) Reeves Black
(3) Staedtler karat aquarell Art. Nr. 125-9 Schwarz Black
(4) Staedtler ergosoft Art. Nr. 156-9
(5) Derwent Gunmetal 69
(6) Staedtler karat aquarell Art. Nr. 125-80 Dove grey
(7) Derwent Prussian Blue 35
(8) Reeves Dark Blue
(9) Staedtler karat aquarell Art. Nr. 125-3 Blue
(10) Staedtler ergosoft Art. Nr. 156-3
(11) Derwent Deep Vermillion 14
(12) Reeves Dark Vermillion
(13) Staedtler karat aquarell Art. Nr. 125-2 Red
(14) Staedtler ergosoft Art. Nr. 156-2

Sample Pairing	Test Conditions
1	Control (no treatment)
2	Aqueous immersion for 5 minutes
3	Solvent immersion (ethanol) for 5 minutes
4	Solvent immersion (acetone) for 5 minutes
5	Solvent immersion (toluene) for 5 minutes
6	Humidification at 100% RH for 60 minutes (non-contact)
7	Smudging: a paper pastel smudge stick was quickly passed once over the entire sample from top to bottom with even manual pressure

Table 1. Test Conditions of Sample Pairings

paper was cut into fourteen 1" strips, each containing a line of each of the WCP types/colours selected for this experiment (fig. 1).

Half of these strips were stored in the dark while the other half were subjected to artificial thermal aging for 96 hours at 95°C and 50% relative humidity (RH) using a Despatch LEA 1-69 aging oven. These aging parameters were selected to be consistent with those described by Vincent Daniels (1993).

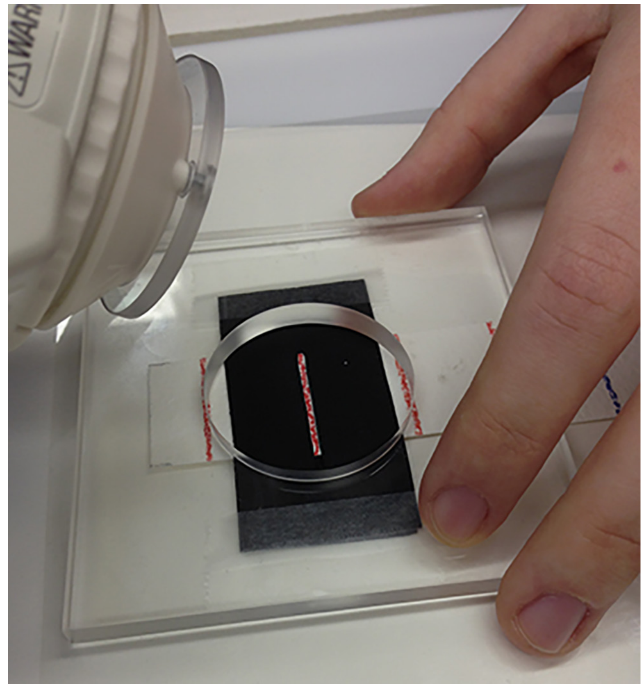

Fig. 2. Spectrophotometer

Daniels found that aging traditional watercolour samples at 100°C and 50% RH for 96 hours rendered them water-insoluble. Here the aging parameters were emulated as closely as possible to see if the same effect would be observed in WCPs.

Once all samples were fully prepared, a pairing of one aged and one un-aged sample was subjected to a variety of tests. The test conditions are described in Table 1.

After testing, samples subjected to solvent immersions were allowed to evaporate in a fume hood and samples treated aqueously were allowed to dry at ambient laboratory conditions for 24 hours prior to analysis. After drying, the effects of each method were observed under magnification and analysed.

SPECTROPHOTOMETRY

Colour changes in the media, before and after immersion and humidity testing, were determined with a Minolta ChromaMeter (CR-700d). The Chroma Meter was calibrated before the collection of each data set. The smallest aperture (5mm) of the spectrophotometer was selected however this aperture was still greater than the thickness of the lines produced by the pencil (~2mm). Given this discrepancy, any measured colour change would be dominated by the degree of bleeding into the surrounding paper, not by the change in the colour of the line itself.

To eliminate this source of error, all the samples were analyzed using a template made from matte black cardstock laminated with Marvelseal™ with a measured 2mm slit in the centre. This slit was aligned with the WCP line to prevent any transmission of extra light and to prevent smudging of the samples (fig. 2). This set-up was found to produce a highly linear offset in the L*, a*, and b* components of the colour measurement that could be easily be compensated for to determine the CIELAB coordinates of the watercolour line alone. Three locations on each sample line were measured and average values for L*, a* and b* were determined. Using the CIELAB 2000 system, the average ΔE^{*00} values were calculated.

COMPUTATIONAL IMAGE ANALYSIS

To be able to compare the aged and un-aged sample sets in the smudge test, photomicrographs were taken of each smudged line. The photomicrographs were imported into ImageJ, an open-source software originally developed by Rasband for the American National Institutes of Health for computational image analysis. Using this software, the images were automatically translated into 8-bit greyscale in order to produce histograms. These histograms were imported into Excel in order to make qualitative comparisons.

RESULTS AND DISCUSSION

COMPOSITIONAL ANALYSIS

The overall composition was fairly consistent between each of the samples analyzed (fig. 3). All of the WCP leads were found to contain the same four materials: clay, a water-soluble wax, a polysaccharide binder, and colourants. The colourants used by each brand were not identified by pigment index numbers. Throughout the course of analysis it became apparent that dyes were also used in conjunction with pigments for some pencils. While all of the WCP leads examined

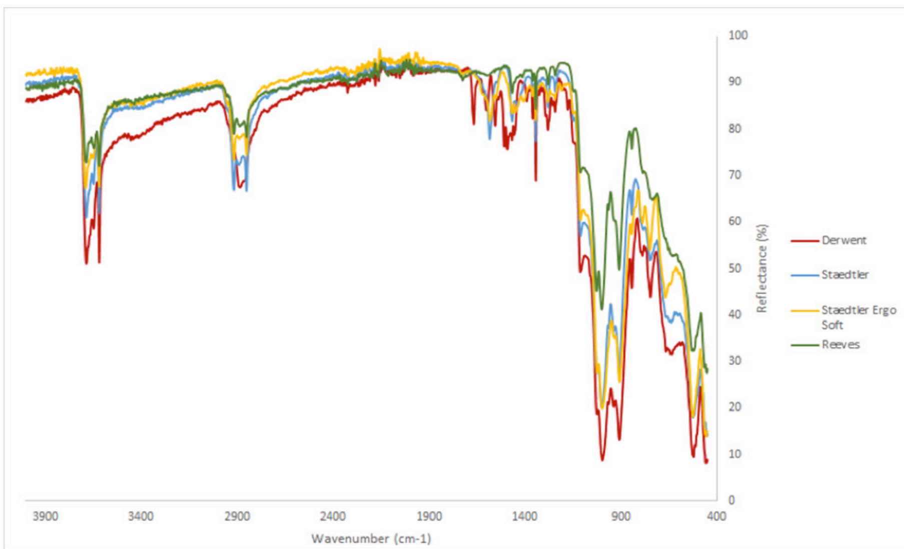

Fig. 3. Mid IR Spectra of white WCPs by brand.

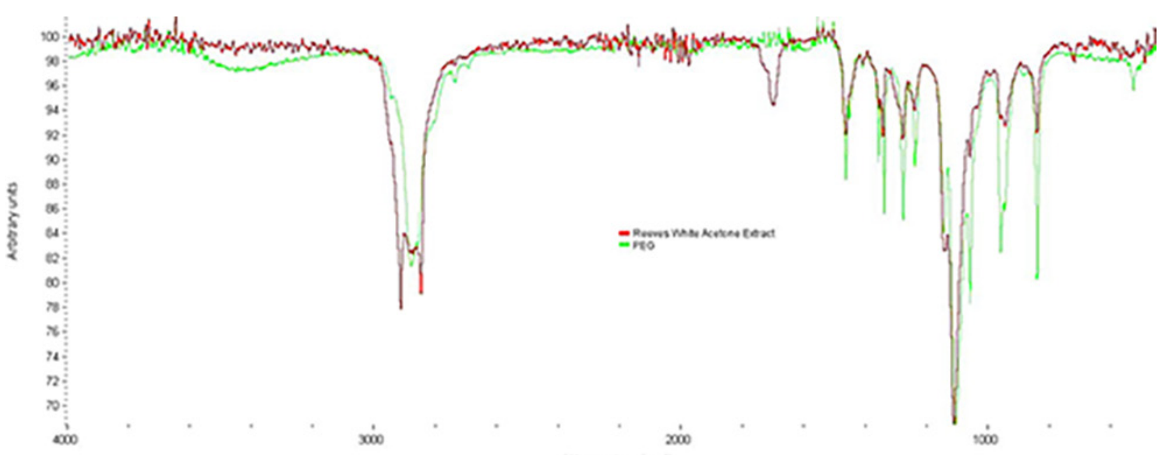

Fig. 4. FT-IR spectrum of isolated wax component in Reeves white WCP which was extracted through liquid-liquid separation between distilled water and acetone in the acetone phase along with a reference spectrum of polyethylene glycol (PEG).

contained polysaccharide binders, the binder in each sample was functionally different. Some spectra suggested the presence of agar, while others appeared more similar to a cellulose gum. While traditional watercolour cakes usually contain gum arabic, this did not seem to be the primary binder in any of the WCP leads tested.

The waxy component in the WCP samples was found to be a polyethylene glycol (fig. 4). The peaks at 2925 cm^{-1} and 1360 cm^{-1} both indicate the common presence of methyl groups, suggesting that the wax component—or at least part of it—is likely a methoxypolyethylene glycol, or mPEG. mPEG is a water-soluble, linear polymer and is commercially available from Dow Chemicals under the trade name Carbowax™. When the methyl stretching modes, are considered along with the carboxylic functionality around 1700 cm^{-1} and a notable lack of hydroxyl bending around 3200 cm^{-1}, it seems likely that the waxy component is actually a mixture of mPEG, CarboxylPEG and Carboxyl-methyl PEG.

AQUEOUS AND SOLVENT IMMERSION

As expected with water-active materials, the immersion bath in distilled water resulted in an immediately obvious visible change of the unaged samples (fig. 5). However, the aged WCP samples in this experiment also experienced significant bleeding. This is contrary to what might be expected if one is assuming similarity between traditional watercolours and WCPs when emulating Daniels' aging conditions. This discrepancy can be partially explained by the compositional analysis previously discussed.

Daniels (1993) identified the reason for traditional watercolours being rendered water-insoluble after aging was due to the irreversible dehydration of the gum arabic binder. Compositional analysis of WCP leads revealed that, while a polysaccharide binder existed in each of the WCP leads, gum arabic was not among them. This poses the question of whether or not these other binding agents undergo the same mechanism for achieving water-insolubility. If so, it could be concluded that the polysaccharide binder(s) present in the WCP leads either did not consistently undergo this same process of irreversible dehydration to the critical point where it renders the media water-insoluble—either because the aging conditions were not sufficient or because the presence of other materials in the leads inhibited this reaction – or the binder(s) did undergo dehydration to the critical point of insolubility but were not present in a high enough concentration to fully protect the colourants in the media. Further research is required to fully understand these initial results.

As for the solvent immersions, most of the WCP samples were not significantly altered by ethanol, acetone or toluene except for the red samples. All of the red samples experienced colour change, making them an interesting case study. Figure 6 shows the cumulative colour change of the sample media and paper after being submerged in an aqueous or solvent bath. The colour shift in the paper is fairly substantial which is significant given that the opacity of watercolour pencil media varies with dilution.

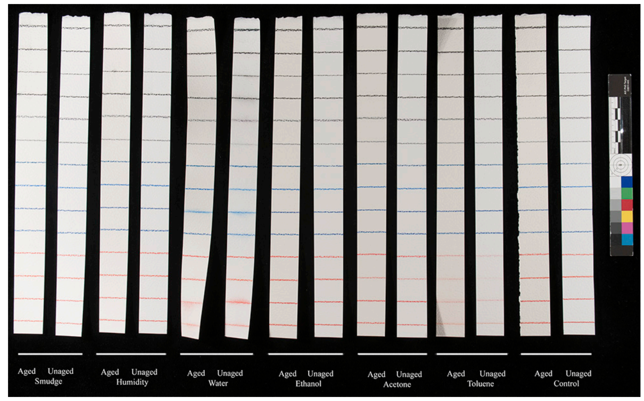

Fig. 5. Comparison of samples before and after aqueous / solvent immersion.

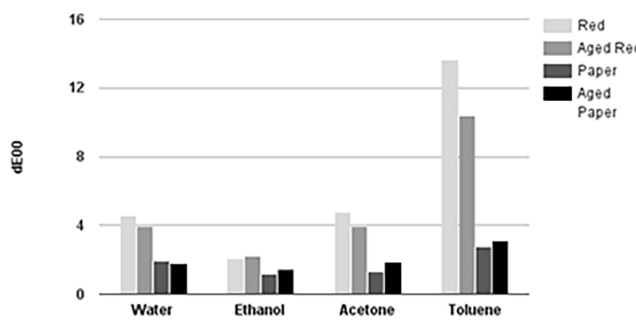

Fig. 6. Bar graph showing cumulative colour change of the unaged and aged red samples (for all product brands/lines) as well as the colour change of the paper substrate.

Most of the colour shift in the paper pertained to the L* coordinates (see Appendix). This suggested that the paper is darkening after submersion in each of the baths. This could be due to the solubilisation or displacement of additives in the paper.

Focussing on the change in a* and b* values is subsequently of greater interest. For the relatively non-polar solvents, toluene and acetone, the results for the red WCP media show that artificial aging had no statistically significant effect on colour change within the a* and b* coordinates (fig. 7). The change in colour may be attributed to high sensitivity of the dye-based colourants, which likely remain constant before and after aging. This is further confirmed by the negative a* values which indicate a shift away from red and therefore, a loss of colourant.

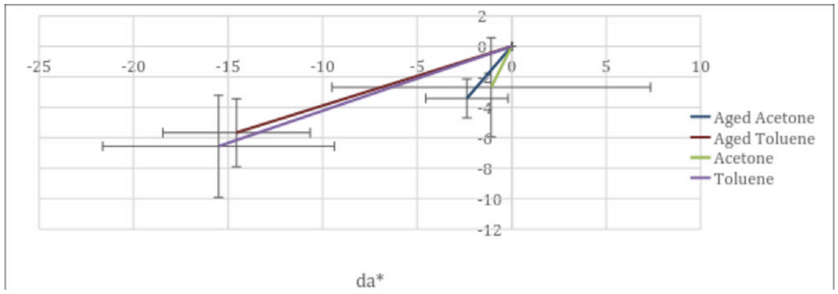

Fig. 7. Graph of change in a* (-green, +red) and b* (-blue, +yellow) values before and after submersion in acetone and toluene for aged and unaged red samples.

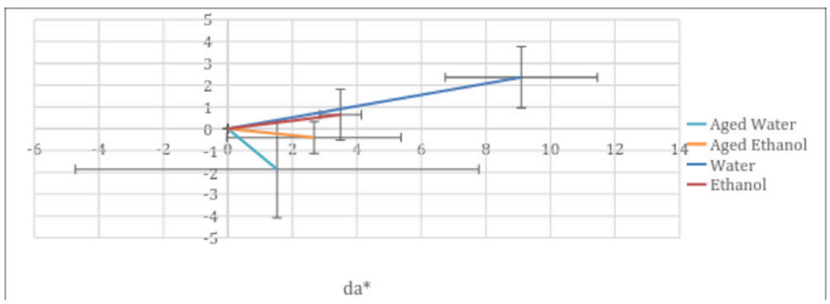

Fig. 8. Graph of change in a* (-green, +red) and b* (-blue, +yellow) values before and after submersion in water and ethanol for aged and unaged red samples.

It should be noted also that while all of the red samples were affected by toluene, only one was affected by acetone. This explains why the averaged magnitude of change is lower with the acetone samples but the standard deviation is higher.

As for immersion in relatively polar solvents, ethanol and water, artificial aging caused a statistically significant change in colour in the red samples (fig. 8). However, the colour shift between aged and un-aged samples immersed in water was visibly and statistically more noticeable than that of ethanol.

The overall change in b* is most significant in the case of the water and ethanol. The change in b* is positive for un-aged samples and negative for aged samples in both water and ethanol. This means that un-aged samples became more yellow and aged became less yellow.

This result may, once again, have to do with the influence of the colour change of the paper. Washing aged papers is most often done to try to remove acidic by-products in the paper, thus making the paper less yellow. By contrast, un-aged papers are likely to have alkaline buffers and other additives removed by an aqueous or ethanol bath, making them less bright.

If this theory is correct, the change in b could initially be understood as a source of error however, as previously touched upon, the opacity of WCP media varies with dilution, therefore, if these results speak more to the change in the colour of the paper they may also simultaneously speak to an increasing lack of opacity which could be interpreted as solubilisation—or partial solubilisation—of the media in question.

However, somewhat contradictory to the last supposition is that all samples immersed in ethanol and water experience a positive shift in a* values which is a shift towards red. This could be the result of partial solubilisation of the binder, resulting in a more consistent film on the surface of the paper and more saturation of the colourants however, at this time; we cannot concretely confirm or deny this interpretation of the data.

NON-CONTACT HUMIDIFICATION

Humidification was not found to produce any observable effect on any of the WCP media tested. Given that humidification is often employed to aid in flattening, it is worth stressing the fact that humidification was carried out in a chamber and drying was not constricted and did not involve any pressing afterwards.

SMUDGING

Mechanical smudging marred all the WCP media examined, both un-aged and artificially aged. Examining the value histograms of each photomicrograph, the peaks due to the colourant of each WCP line were more skewed to higher colour values in the un-aged samples than the aged samples (fig. 9). The colourants are therefore more thinly spread across a larger surface area of the paper in the un-aged samples, indicating a higher degree of smudging. When aged,

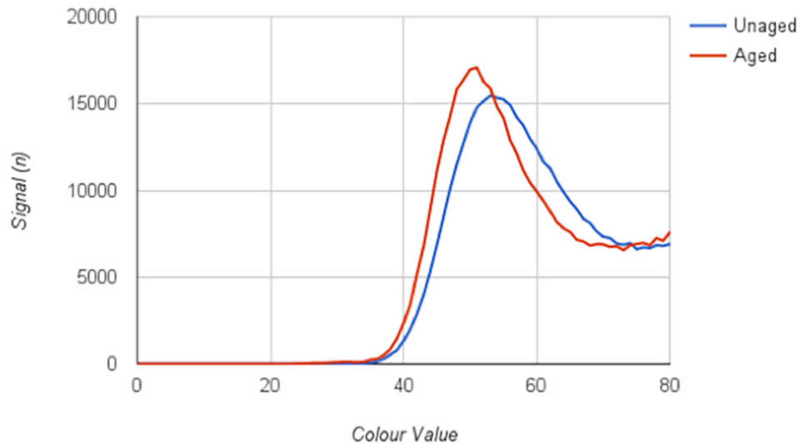

Fig. 9. Colourant peak in smudge histogram of Staedtler Ergosoft 156-2 Red WCP unaged and aged samples. This example is representative of the same general pattern observed in all colours and brands.

the degree of mechanical damage to the media is significantly lower. From this it can be understood that damage to WCP media will be progressively less likely to occur as a work ages, possibly due to the crosslinking of the media to the substrate or from the migration of the soft modified PEG components away from the surface.

CONCLUSIONS

The overall composition of the WCPs was found to be fairly consistent among the brands tested. Each contained the same four major components: clay, a modified PEG, a polysaccharide binder and the colourants. To be more specific and more quantitative, a more precise method of analysis such as gas chromatography with mass spectrometry (GC-MS) would be required; however this is beyond the scope of this project.

The aim of the accelerated thermal aging was to determine whether or not the WCPs would become insoluble in water over time just as traditional watercolours have been shown to do. In this experiment, the WCP media was not rendered fully water-insoluble however the possibility that WCPs can become increasingly resistant to moisture in time, cannot be fully disregarded either; further study of the potential mechanisms for rendering WCP media water-insoluble and it's relation to thermal aging parameters is required.

Further investigation is also required to determine the types of PEG used in the pencils and their aging characteristics. Conservation literature pertaining to the use and stability of polyethers so far is largely focussed on the use of PEG as a consolidant for archaeological wood. Notable concerns include rapid oxidation due to chain scissioning, which is accelerated by light, as well as acidic degradation, which occurs in the presence of metals.[8] These concerns may carry over to their use in WCPs. Photo-oxidation of PEG could have detrimental effects on the stability of WCP media, as could acidic degradation catalyzed by the presence of metal ions in wash water, metal inclusions in paper, and metallic pigments in the pencils themselves.

In the solvent testing, ethanol was found to cause the least amount of colour shift in the 14 un-aged and aged samples tested and visibly caused the least amount of bleeding. Acetone and toluene both had less-than-desirable effects on the dye-based components in some of the pencil samples, however, did not appear to cause detrimental effects on any of the other colours in our experiment.

Non-contact humidification proved to be harmless to the samples tested, however both aged and un-aged samples proved to be very susceptible to damage by abrasion. In light of these discoveries, it is recommended that humidification only be carried out in a non-contact enclosure like a humidification dome as opposed to a Gore-Tex® sandwich and that flattening be carried out with dutiful consideration of the softness or the media. In terms of storage, drawings with dryly-applied WCPs should be treated similar to that of other waxy media, insomuch that any direct contact with the surface is very likely to result in abrasion, smudging and subsequent distortion of the image.

WCPs offer the amateur and artist an exciting new avenue for creative expression, which correspondingly, creates new avenues of research for the conservator and conservation scientist. The considerations expressed here are not limited to works of art carried out in WCPs; they also extend to conservators seeking a medium for toning and inpainting. Issues of solubility and lightfastness have yet to be fully understood however it is hoped that this research has provoked curiosity, which may inspire further inquiry into this and other related products that are emerging on the market.

In recent years, Winsor & Newton have introduced lines of watercolour sticks and watercolour markers. Derwent has released their Artbar range of watercolour bars as well as their Inktense range of dye-based pencils and bars, and Caran d'Ache has introduced their Neocolor® range of water-soluble crayons. Clearly watercolour drafting is an artistic medium that is gaining prominence, and therefore, one deserving of the conservator's attention.

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NOTES

1. Dube: 1988, 2
2. pers. comm. Staedtler, 2015
3. Ellis: 2005, 129
4. Ellis: 2005, 129
5. EN-71 is a European Union Standard specifying safety requirements for toys
6. pers. comm. Staedtler, 2015
7. pers. comm. Staedtler, 2015
8. Horie: 2010, 191-192

APPENDIX

See chart below.

Treatment (compared to Un-aged Control L*a*b*)		Average dL* (0 -100 Lightness)	Average da* (+red, -green)	Average db* (+yellow, -blue)	dE2000
Water Un-aged	**Paper**	-3.11	-0.38	-0.41	1.94
	Combined SD	1.14	0.33	0.54	
	Red 1	3.14	7.39	1.18	4.11
	Combined SD	0.48	1.09	0.47	
	Red 2	-4.06	15.56	3.35	7.31
	Combined SD	1.14	2.05	0.72	
	Red 3	0.61	4.33	1.50	1.89
	Combined SD	1.64	1.08	0.46	
	Red 4	-3.97	9.10	3.39	5.09
	Combined SD	1.57	0.84	0.51	
EtOH Un-aged	**Paper**	-1.68	0.51	0.09	1.21
	Combined SD	0.92	0.03	0.25	
	Red 1	-1.66	3.18	1.14	2.00
	Combined SD	0.44	1.19	0.45	
	Red 2	-3.19	6.15	1.76	3.77
	Combined SD	0.98	1.46	0.60	
	Red 3	0.08	1.16	-0.73	0.86
	Combined SD	1.57	1.15	0.47	
	Red 4	0.26	3.48	0.41	1.77
	Combined SD	1.62	0.95	0.40	
Acetone Un-aged	**Paper**	-0.73	0.93	-0.03	1.35
	Combined SD	0.42	0.11	0.08	
	Red 1	2.23	1.57	-1.01	2.00
	Combined SD	1.25	1.34	0.56	
	Red 2	-2.76	6.20	0.63	3.63
	Combined SD	1.24	0.97	0.29	
	Red 3	9.88	-14.65	-7.65	10.90
	Combined SD	1.90	0.66	0.21	
	Red 4	0.20	2.56	-2.74	2.60
	Combined SD	2.08	1.04	0.41	
Toluene Un-aged	**Paper**	-2.74	1.61	0.19	2.78
	Combined SD	1.02	0.37	0.27	
	Red 1	10.99	-11.80	-1.87	10.75
	Combined SD	0.83	1.10	0.43	
	Red 2	10.69	-10.95	-6.12	10.58
	Combined SD	1.05	1.02	0.31	
	Red 3	16.97	-25.33	-10.65	20.73
	Combined SD	2.18	0.44	0.26	
	Red 4	11.46	-13.94	-7.59	12.64

Treatment (compared to Aged Control L*a*b*)		Average dL* (0 -100 Lightness)	Average da* (+red, -green)	Average db* (+yellow, -blue)	dE2000
Water Aged	**Paper**	-0.26	-0.64	-1.95	1.82
	Combined SD	0.27	0.18	0.55	
	Red 1	6.15	0.66	-1.87	4.55
	Combined SD	1.21	2.17	0.74	
	Red 2	4.02	-3.50	-4.02	3.93
	Combined SD	0.89	3.57	1.42	
	Red 3	-1.60	0.35	-2.02	1.83
	Combined SD	0.67	1.53	0.52	
	Red 4	-5.23	8.61	0.45	5.59
	Combined SD	0.99	1.56	0.46	
EtOH Aged	**Paper**	-0.49	-0.01	-1.85	1.45
	Combined SD	0.90	0.11	0.32	
	Red 1	-3.23	3.65	0.21	2.98
	Combined SD	1.28	1.19	0.39	
	Red 2	-1.27	0.50	-0.91	1.18
	Combined SD	0.89	1.65	0.40	
	Red 3	-2.05	2.39	-0.58	2.02
	Combined SD	0.55	0.78	0.17	
	Red 4	-2.00	4.14	-0.34	2.65
	Combined SD	1.04	0.96	0.17	
Acetone Aged	**Paper**	-1.56	0.56	-1.89	1.84
	Combined SD	0.41	0.07	0.26	
	Red 1	1.86	-2.79	-2.66	2.33
	Combined SD	0.63	0.95	0.25	
	Red 2	-0.14	0.17	-2.14	1.44
	Combined SD	0.55	1.47	0.40	
	Red 3	1.86	1.86	1.86	7.35
	Combined SD	0.70	0.79	0.14	
	Red 4	1.86	1.86	1.86	4.70
	Combined SD	1.14	1.53	0.21	
Toluene Aged	**Paper**	-2.67	1.84	-1.13	3.13
	Combined SD	0.52	0.52	0.31	
	Red 1	7.20	-12.87	-2.12	9.36
	Combined SD	1.64	0.84	0.31	
	Red 2	8.23	-15.84	-6.78	10.69
	Combined SD	1.78	1.10	0.27	
	Red 3	10.29	-19.38	-7.67	13.63
	Combined SD	2.53	1.24	0.14	
	Red 4	6.82	-10.11	-6.08	7.91
	Combined SD	1.14	0.99	0.16	

Each L*a*b* change was calculated individually with all three data sets.
Average dL*a*b* calculated by averaging the three data sets from individual calculation and the resulting standard deviation is also reported.
dE2000 values were calculated by first averaging the three data sets of coordinates for each of the treated and control samples, aged and un-aged.

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SAIRA HAQQI

The Rationale for Rebinding at the Pierpont Morgan Library in the Early 20th-Century: A Study of Bindings by Marguerite Duprez Lahey

INTRODUCTION

Books in the Western world have historically been rare luxury items; for hundreds of years, they were mostly available to the wealthy or to those in religious communities. With the advent of the printing press in the fifteenth century, their status began to change, and by the end of the nineteenth century, they were no longer exclusive to a small segment of society. Graphic design historian Ellen Mazur Thomson, citing the work of German sociologist Georg Simmel, notes that this caused a signal change in the relationship between people and objects: "Endlessly changing fashion and its relationship to class now made the acquisition of objects and their display an occasion of some tension."[1] At the start of the twentieth century, the previous century began to be seen as "drab and anti-intellectual, anti-artistic," and there was a shift away from industrialization and mechanization.[2]

Until this point, hand bookbinding in America had been largely the province of immigrant craftsmen. With the growth first of Aestheticism, and then the Arts and Crafts movement, there was a sudden interest in hand-crafted goods, including books. In 1895, the bibliophiles of the Grolier Club began organizing the Club Bindery, going so far as to bring French master binders to New York to run it and, in the process, to improve the quality of American bookbinding.[3] There was a sudden outbreak of exhibitions devoted to the craft, beginning with a display of bookbindings at Scribner's, the publishing house, in 1895 and followed by shows sponsored by the Grolier Club, the Society of Craftsmen, and Houghton Mifflin, among others. In 1906, the Guild of Book Workers was organized to establish and maintain "a feeling of kinship and mutual interest among the workers in several book crafts."[4]

With such attention being given to the craft, bookbinding became a socially acceptable form of artistic expression for the upper classes, and it was not long before the immigrant craftsmen mentioned above were joined by home-grown products. This was particularly the case in New York.[5] Even at this early stage, fine binding was a craft with a "strong feminine influence."[6] This was at least in part due to financial considerations. A 1905 article ruefully notes that while bookbinding is a fascinating and creative process, "Whether fine binding as a vocation or studio practice—outside of the regular binderies—can be made sufficiently remunerative to warrant those who have a taste for the art giving their whole time to it, is another question."[7] Meanwhile, as late as 1954, Lawrence Thompson characterized American binders as "(1) individuals with other sources of income, (2) binders attached to great special libraries such as the Folger, and (3) binders in shops maintained by Donnelley and Doubleday," and acknowledged that "The predominance of women in the field of hand binding is readily explained by the fact that all but a few depend on their families, not on their craft, for their bed and board."[8]

Many of the women who took up bookbinding were profoundly influenced by the Arts and Crafts movement in England, and Art Nouveau in France. T. J. Cobden-Sanderson, a friend of William Morris and one of the luminaries of the Arts and Crafts movement, not only exhibited his bindings at Columbia University but also accepted several American women as pupils.[9] Many of these women continued their studies in Paris and returned to the United States to take on their own pupils.

A BRIEF BIOGRAPHY

It was into a world on the cusp of a new appreciation of hand craftsmanship that Marguerite Josephine Duprez Lahey was born on January 22, 1880, in Brooklyn, New York. Her parents were Isaiah Antony Lahey, a lace importer from Ireland, and Margaret (Maggie) Ayton Duncan, a New Yorker of Scottish origin. She was the youngest of four siblings.[10] Her family was wealthy; when her father passed away in 1913, he left an estate of $84,200.68, which translates to roughly $2 million in today's currency.[11] Duprez Lahey was very much a product of a privileged background: she spoke several languages (in

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1905, an article described her as speaking "French, German and English and … studying Italian"), played the mandolin and the violin, rode horseback, and knew how to swim—accomplishments that defined her as a lady of leisure.[12]

Duprez Lahey's background was key to her pursuit of bookbinding. In one interview, Duprez Lahey acknowledged, "I did not have to depend upon its [i.e. bookbinding's] rewards for my living, which was important; fine book binding offers an uncertain future because it appeals to a very limited circle of people with the means to indulge their fondness for books."[13] Duprez Lahey was wealthy enough to devote years of her life to taking classes and learning from others—both at home and abroad—and her familial relations were such that she was encouraged to do so.

Much like another dynamic young woman at the Morgan Library, Belle da Costa Greene, Marguerite Duprez Lahey seems to have actively tried to change the narrative of her life in order to enhance her importance and interest. One newspaper article, for instance, describes her as being "of Huguenot and Virginian descent"—unlikely, given the identity of her parents.[14] Another newspaper made much of the fact that her sister-in-law was the niece of the governor-general of Poland, as well as being the daughter of a Russian general.[15]

The exact details of her life and her introduction to bookbinding are likewise unclear. According to one newspaper account, Duprez Lahey suffered from ill health as a teenager, to the point that she had to leave school at the age of sixteen. Two years later, she read a newspaper article on bookbinding as an art suitable for women and was immediately intrigued. As one newspaper article put it, "Here was something in which she could indulge in the joy of work without injuring her health."[16] Another newspaper account claims that "As a girl she was taken to Paris by her father and there she discovered the art of bookbinding. She studied for a while at Adelphi College, but left before graduation to study binding."[17]

Regardless of the exact circumstances of her initial introduction to bookbinding, it seems clear that she began taking classes at The School of Bookbinding for Women conducted by the Schleuning & Adams bindery in Manhattan.[18] After two years of study with Alfred Schleuning, Duprez Lahey traveled to Paris, where it was generally assumed that there was a higher level of skill insofar as finishing techniques for books were concerned.[19] Here, she had a harder time finding teachers—they were reluctant to take female pupils and "only agreed when she showed them what she could do."[20] However, she was persistent, and her determination paid off. She studied tooling with Marius Michel, Jules Domont, Emile Mercier, and Antoine Joly; learned edge gilding from Chapiers and Koch; and studied design with Coulomb and Henri Noulhoc, who also taught famed Art Deco bookbinder Rose Adler.[21] She continued to return to Paris to work with these masters every year for the rest of her life. It is to be noted, however, that she does not appear to have undergone a formal apprenticeship with any of these master craftsmen; rather, she trained with each of them briefly.

By 1905, Duprez Lahey was already the subject of a glowing profile in the *Utica Sunday Tribune*, which quotes Alfred Schleuning as saying, "I know of no man or woman in America who can do such excellent work in bookbinding as Miss Lahey."[22] It is not surprising that she eventually came to the notice of J. Pierpont Morgan, although the exact means of this introduction is unclear. Some articles suggest that she was friends with Belle da Costa Greene; others, that the financier saw a book she had rebound and was favorably impressed. However the introduction took place, Marguerite Duprez Lahey began rebinding books for Morgan in 1908, when she received her first commission in a luxe edition of Frédéric Masson's *Napoléon et les femmes*.[23]

Duprez Lahey continued to work for the Morgan until her death on October 22, 1958. During her long association with the Library, she experienced the death of J. Pierpont Morgan in 1913, the transfer of the Library by the second J. P. Morgan to a board of trustees in 1924, and the retirement of Belle da Costa Greene, the library's first librarian and director, in 1948. Over the course of her life, Duprez Lahey herself went from being a contract bookbinder to becoming the Morgan's sole in-house binder, moving her studio into the building at 29 East 36th Street in 1941.[24] Her stature within the institution was such that she even gave bookbinding classes to Frances Morgan, the great collector's granddaughter.[25] Outside the Morgan, she was equally famous: by the time of her death, she was widely acknowledged as "America's greatest binder."[26]

CHARACTERISTICS OF DUPREZ LAHEY BINDINGS

An examination of Duprez Lahey's work at the Morgan quickly reveals a distinctive aesthetic style. Most of her bindings have a leather component, being, if not a full leather binding, at least half or quarter leather. The leather is usually left fairly thick except at the edges where it is turned in over the boards. The majority of her bindings do not have much cover ornamentation, although almost all have title information tooled (usually gold tooled, but occasionally blind tooled) on the spine. Some books, presumably due to their perceived importance, received elaborate covers with extensive tooling, such as a fifteenth century book of hours (PML 591), which has an elaborate gold tooled design evoking the aesthetic of Art Deco (Figure 1). These seem to have been much more to her taste—this is the aesthetic of the books she made outside of her work at the Morgan as well, as seen in the blank books left to the library by her estate. It is also the style of the books with which she chose to be depicted in the photographs surviving in her scrapbook. Many of the books appear to be tight-backs with raised bands, possibly sewn on raised cords. All have endbands, mostly sewn in the French manner with two cores and a front bead.

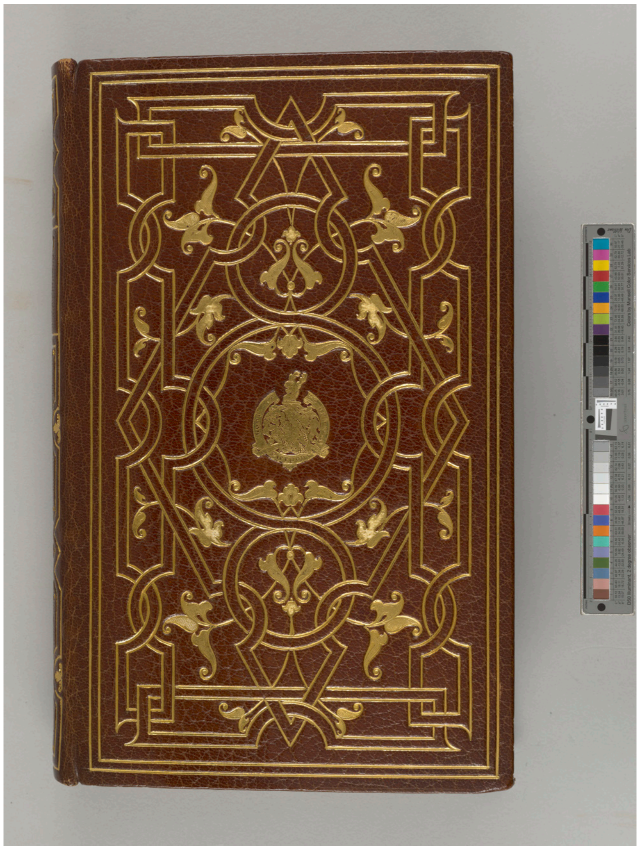

Fig. 1. Marguerite Duprez Lahey and Catholic Church, *Book of Hours*, record 110865, text ca. 1507, binding dated 1925, full leather binding with gold tooling, front cover. Morgan Library & Museum, New York, NY, USA.

All of these characteristics are representative of the time in which Duprez Lahey was practicing. Leather covers, for instance, reflect the understanding of library preservation practices at the time. The Librarian of Congress, Ainsworth R. Spofford, wrote as early as 1876 that "The combined experience of librarians establishes the fact that leather binding only can be depended on for any use but the most ephemeral."[27] Leather was widely acknowledged to be the most durable binding material. However, there was a simultaneous awareness of the detrimental impact of contemporary leather manufacturing practices: "Leather, more than any other material entering into bookbinding, needs careful watching . . . leather should be subjected to the severest test, since much of it is spoiled for the purpose for which it is made by the ingredients used in its preparation."[28] It is not, therefore, surprising that Duprez Lahey not only used leather extensively, especially to cover 'weak' areas such as the spine and the joints of the book, but also took great care over the origins of the leather, claiming that there was "no leather like French levant *moroquin du Cap* . . . [the] skin of a goat, indigenous to Cape Good Hope. The grain is large and firm. It is tanned and dyed in France."[29]

Tight-back bindings today are somewhat more carefully considered than in Duprez Lahey's time, since they can (as many of Duprez Lahey's books demonstrate) have a tendency not to open well, particularly when the textblocks are comprised of parchment pages. This was acknowledged at the time: one patriotic British observer comments that "In 'forwarding', whatever may be the opinion of the layman, every expert knows that the English and American binders are more forthright than the French, whose books are apt to be weak in the binding and so stiff in the back (to enable them to bear the overdose of gilding) that they open with difficulty and in time break."[30] At the same time, however, tight-back books were considered more durable, particularly when they used thick leather, as Duprez Lahey did. Douglas Cockerell, the noted English binder, declared in his seminal *Bookbinding and the Care of Books* that:

> The polished calf and imitation crushed morocco must go, and in its place a rougher, thicker leather must be employed. The full-gilt backs must go, the coloured lettering panel must go, the hollow backs must go, but in the place of these we may have the books sewn on tapes with the ends securely fastened into split boards, and the thick leather attached directly to the backs of the sections.[31]

It is possible that this concern about durability prompted at least some of Duprez Lahey's binding decisions. After all, Pierpont Morgan's purported aim was to create a library that would be an educational resource—his will stated that his collections should be made "permanently available for the instruction and pleasure of the American people."[32] A library that was primarily designed to serve scholars and researchers required books that were strong—and Duprez Lahey's books were as strong as she could make them, even if they did not open well.

DECORATIVE SCHEMES

Duprez Lahey's extensive use of leather allowed her to decorate the covers and spine of the book in either blind or gold tooling. Her fondness for gold tooling in particular is apparent in the mention she makes of it in almost every interview. Duprez Lahey was pardonably proud of her skill in tooling, and took care to underline the difficulty involved: "That book there . . . required just 374 hours to tool the cover alone. I was glad when it was done: it was like a load rolling off my hands. It was big and heavy and the constant pull on it exhausted me."[33] Her emphasis on tooling reflects her French training; as one British observer commented, "When it comes to decoration the French may be ahead of the Anglo-Saxon," going on to say, rather scornfully, "France regards the bound book as a work of art—on the outside . . . to the tooler a book is something to look at rather than to use."[34]

This said, Duprez Lahey's focus on tooling was representative of the tastes of the era. Cover decoration was the subject of great interest towards the end of the nineteenth century, and several of Duprez Lahey's teachers were intensely involved in this debate.[35] Marius Michel, for instance, insisted that a book's cover needed to reflect its contents.[36] At the same time, he was also a staunch advocate of the use of floral decorative forms, as opposed to direct illustration of the book's contents. He advocated a thoughtful and subtle use of all aspects of a book's binding, down to its color. As Ellen Mazur Thomson describes:

> For Balzac's *Eugénie Grandet*, Marius Michel thought that intense, vibrant colours were out of place. Instead, he suggested using brown leather and simple incized lines, with little or no gilding. On the other hand, Victor Hugo's *Orientales* called for strong blues, intense oranges, pure green inlays and gold gilding to evoke this poet's vision.[37]

Duprez Lahey seems to have absorbed at least some of this teaching; Marius Michel's fondness for floral forms is echoed in many of Duprez Lahey's designs, and Lawrence Thompson notes that "her understanding of the texts of the books she has bound is often brought out in minute but telling details."[38] Not all of her decorative schemes, however, are easy to understand. Binders' references to the book's contents could be extremely personal and subtle. T. J. Cobden-Sanderson, for instance, once admitted that a line from Tennyson's *Tithonus*, 'grassy barroes of the happier dead,' inspired his decoration of the cover of *In Memorium* with bands of gold-tooled daisies.[39]

This said, some of Duprez Lahey's cover designs can be understood as a commentary on the book's contents. Possibly the simplest of these is a guest book she created for a yacht, which incorporated a design of a yacht on the cover, made with leather onlays (PML 50093—Figure 2). Most of Duprez Lahey's cover designs, however, are more sophisticated. For example, MS M.334, a 7th century French manuscript copy of *St. Augustin's Epistolam Joannis Ad Parthos Tractatus Decem*, is bound in brown leather with French-style endbands of what appears to be plain, undyed linen thread. The only ornamentation is some gold tooling in the form of fish at the fore-edge. The fish are designed to mimic clasps (Figure 3). This decorative conceit evokes the idea of early Christianity through the iconography of a fish, while also reminding us of one type of early binding that may have been in use over the course of the manuscript's life: the wooden boards binding compressed at the fore-edges with clasps. At the same time, the lack of colored endbands and the use of natural colored leather suggest monastic simplicity appropriate to the works of St. Augustine.

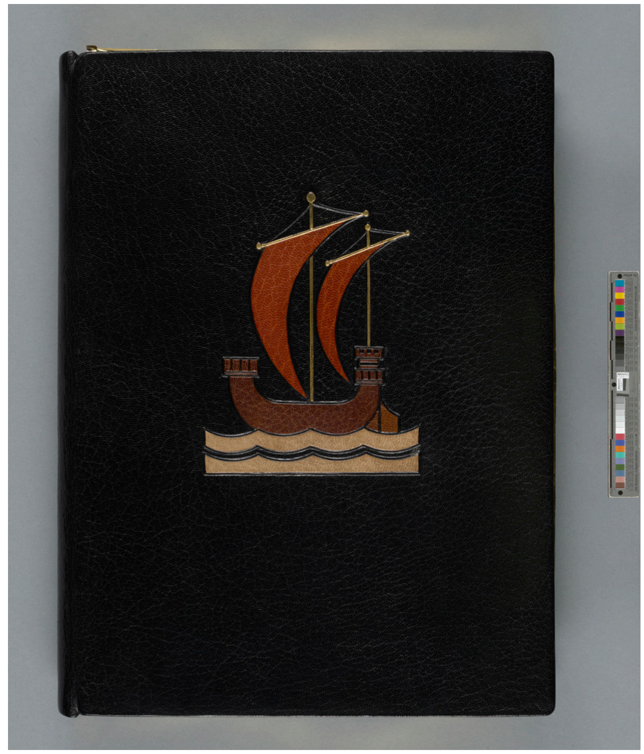

Fig. 2. Marguerite Duprez Lahey, *Guest book for a yacht, no lettering*, record 122686, n.d., full leather binding with gold tooling and leather onlay. Morgan Library & Museum, New York, NY, USA.

Fig. 3. Marguerite Duprez Lahey and St. Augustine, *In Epistolam Joannis ad Parthos tractatus decem*, record 77209, text dated 669, binding 20th century, full leather binding with gold tooling, front cover. Morgan Library & Museum, New York, NY, USA.

Fig. 4. Marguerite Duprez Lahey and William M. Laffan, *Catalogue of the Morgan Collection of Chinese Porcelains*, record 77706, 1904-1911, full leather binding with gold tooling, doublure and front opening. Morgan Library & Museum, New York, NY, USA.

Fig. 5. Marguerite Duprez Lahey and Catholic Church, *Book of Hours*, record 121468, text ca. 1415, binding 1951, full leather binding with gold tooling, front cover. Morgan Library & Museum, New York, NY, USA.

The volumes Morgan published on his collection of porcelain, *Chinese Porcelains* (PML 77706 and 77707) were both bound in a simple full-leather binding of "Chinese yellow," with the Morgan crest gold tooled on the covers.[40] The boards open to reveal elaborate leather doublures[41] composed of several panels of differently colored leather, and gold-tooled symbols of "the emperors of the Ming Dynasty, the period in which the greatest Chinese vases were produced" (Figure 4).[42] Duprez Lahey must have had these tools custom-made only for this book, taking the symbols themselves off the bases of the porcelain objects themselves.[43] The center panel of the doublures comprises a geometrical gold-tooled pattern that gives a sense of three-dimensionality to the surface. This is enhanced by the fly-leaf, which itself is formed of yellow moiré fabric adhered to paper. The patterning evokes the three-dimensionality of the Chinese porcelain, while the Chinese symbols and the colors used create a sense of exoticism.

However, why did some books receive bindings that seem so appropriate while other books did not? One 15th century French Book of Hours, MS M. 743, was rebound in green leather tooled with rows of gold polka-dots (Figure 5). Even assuming that the circular pattern was a reference to the divine, the binding's modern sensibility is incongruous when paired with the book's contents.

Other questions abound as well. Why were some books rebound in such elaborate bindings when others were not? One assumes that more decorative bindings were allocated to those books that were considered more valuable, but exactly why one book was considered more valuable than another is not always clear. Contrast the above binding with the French Book of Hours mentioned earlier, PML 591 (seen in Figure 1). This book, with text dating a mere century later, has a full leather binding in brown leather with an ornate gold-tooled Art Nouveau design around Pierpont Morgan's seal. The design continues onto the spine, board edges, and even headcaps. The endband is in two colors, probably in silk, and there is a floral gold-tooled band all along the turn-ins.[44] This binding seems more in tune with the book's contents as well as much more decorative. The floral elements, while distinctly Art Nouveau in sensibility, still evoke the natural world, and can therefore be related to the content of the book, while the use of extensive ornamentation evokes a memory of time when books were precious and scarce commodities, and books relating to religion were considered doubly valuable, often decorated with jewels, ivory, and gold.

CONSERVATION CHALLENGES

While Duprez Lahey's bindings fit with contemporary thought and practice in the ways outlined above, there were certain idiosyncrasies. Some of these were faults in finish —while she was undoubtedly skilled at tooling leather, she was not always quite so neat when it came to other aspects of finishing. The headcaps, for instance, in her bindings, tend to be unusually large and flat, coming over the endband at a sharp right angle.[45] A fine binder could also quibble with her squares—the length of board that extends beyond the textblock at the head, tail, and fore-edge of a book—as these tend to be uneven. However, more troubling than these minor flaws are the structural problems with her works. As mentioned above, her fondness for tight-back binding made the books she bound or repaired very difficult to use. Most do not open easily. The case is particularly dire when it comes to medieval manuscripts on parchment. The torqueing of the pages as these are opened can result in ink and paint flaking off, causing damage to the very book the binding is supposed to protect, and making it difficult for scholars to access the material within. This is occasionally exacerbated by her use of stiff cores for her endbands, which result in books that only open well if that core is broken.

Duprez Lahey's bindings can occasionally be difficult to handle, as well. The guest book she designed for a yacht includes a gilt paper 'sleeve' that folds around the textblock, presumably to protect the textblock from dust. This makes the book awkward to handle and maneuver. Similarly, a few of her gold tooled full leather bindings are encased in a leather slipcase chemise, similar in design to a 'dustjacket' and originally paired with a matching slipcase to protect the binding from abrasion. While the chemises do succeed in their protective function, they are somewhat stiff, with the leather at the spine in particular prone to cracking. Taking them off—as one must, to view the decorative covers—requires extreme care.

Like others at the time, Duprez Lahey did not leave much room in the joints for the book to open. This increases stress on the book when it is used, resulting in the joints being more prone to breakage.

Finally, Duprez Lahey's fondness for leather (and on occasion wood) has resulted in the paper facing the leather or wood becoming brittle and discolored due to the acidity of the wood or leather. This is at least partially due to the new methods of leather processing mentioned earlier, which aimed to "expedite the process and at the same time gain an unnatural evenness of color by the application of acids that have proved to be injurious and resulted in an inferior product."[46]

These issues point to one of Duprez Lahey's key areas of weakness—her treatments are inconsistent. Binding styles do not always match the text date and style: as mentioned above, while one medieval manuscript may be in a binding that attempts to pay homage to medieval wooden board bindings, another may find itself in an Art Deco binding of green leather with gold-tooled polka dots. Similarly, Duprez Lahey does not seem to be aware of the links between binding aesthetics, structure, and function. While she may make historical references in decorative elements such as tooling, these rarely go so far as to coincide with the binding structure. Thus, a book that is elaborately tooled to resemble a medieval binding does not necessarily have the corresponding medieval sewing structure, endbands, or wooden boards. These problems are ironic as, in an interview, Duprez Lahey waxed eloquent on "the minutiae of historical accuracy," saying that "only the French people appreciate and hold [these things] in due respect, for there is a disposition, even among the English, to depart from the canons of the past."[47]

Even where Duprez Lahey succeeds in following best practices, she clearly does not understand exactly why they are best practices. For instance, when discussing edge gilding, she discloses a technique for gilding edges without trimming them, saying, "Cutting the leaves would be a mortal sin. You see, all these traditions are sacrosanct; it is not just a mistake, it is a real culpability to make the slightest infraction of one of them."[48] Trimming the edges can remove marginalia and, in the worst cases, fragments of the text. There is a real reason for not cutting the leaves, but Duprez Lahey dismisses the practice as a mere 'tradition.'

Finally, Duprez Lahey seems to have devoted a considerable amount of her time to rebinding books, rather than repairing their existing bindings. Much debate exists even today about the rebinding of books, which continues today, particularly in research libraries where "they strive to provide unimpeded access to scholarly books while maintaining those same volumes in perpetuity."[49] However, rebinding has long been considered undesirable; as early as 1905, author Fletcher Battershall wrote in *Bookbinding for Bibliophiles*, "As a rule, if a contemporary covering is still decently sound upon its back, it is best to let it stay there. One cannot better it."[50] Similarly, Douglas Cockerell castigated the rebinding of valuable books as "at best a necessary evil," while arguing that "Valuable books should either be issued in bindings that are obviously temporary, or else in bindings that are strong enough to be considered permanent."[51]

It is impossible not to wonder about the bindings replaced by Duprez Lahey, which were usually discarded. In some cases, notes as to previous bindings exist in the museum catalog. Discarded bindings included a "French 15th century parchment [binding] with ties" (MS M.334); "ca. 1730 rough blind-tooled calf" binding (MS M.776); and "red velvet" bindings (MS M. 373 and 348). Why these bindings were discarded remains unknown, bringing us to the final problem with Duprez Lahey's working practice: the complete lack of documentation. Duprez Lahey tracked her work primarily with a view to record payments and the service delivered. Thus, her receipts rarely mention even the title of the book, much less any detailed information—one from December 1911, for instance, reads, "For binding 1 volume in full red Levant, ribbed silk flies, style Francois I - $50."[52] There are no treatment records where the book is identified, the rationale for treatment noted, and the actual treatment described. Now required by conservation codes of ethics, "Such features are designed to pin down decision-making by conservators onto a bedrock of empirical evidence, so that, for example, the future can reverse-engineer our present."[53]

In all fairness, these problems are not unusual for the time. In the last century, there has been a tremendous change in values and ethics in what is now called conservation, rather than bookbinding or book repair. In 1946, Pelham Barr, the Library Binding Institute's first director, noted that as librarians were untrained in conservation theory and lacked sufficient knowledge to make conservation decisions, "determinations about which books to retain in their original bookbindings and which to rebind were randomly made."[54] It was only in 1960 that the first graduate program in conservation opened in the United States, and even then the focus was primarily on works of art, as opposed to functional objects such as books. A formal code of ethics for American conservators did not exist until 1967, and it was not until 1994 that the Modern Language Association adopted its "Statement on the Significance of Original Materials," which affirmed the importance of saving as much as possible of the original object.[55] All of Duprez Lahey's 'faults' are entirely consistent with the era in which she flourished.

THE INFLUENCE OF THE PATRON

To what extent are the issues above actually traceable to Duprez Lahey herself? While the technical binding problems such as the uneven squares are ultimately her own responsibility, it is not clear that she was the primary decision maker when it came to the aesthetic and perhaps even structural aspects of the binding. There is, unfortunately, a paucity of data in the Morgan archives as to the specific decision-making process—as mentioned before, Duprez Lahey did not document her treatment or binding process. In the face of this lack of documentation, it seems likely that, were the binding decisions not made solely by Duprez Lahey herself, they were made by Pierpont or Jack Morgan and Belle da Costa Greene and conveyed to Duprez Lahey verbally.

There are indications that Greene and Pierpont Morgan were both closely involved in the decision-making process. Duprez Lahey seems to have been on cordial terms with the former as early as 1912, even mentioning in a letter such trivialities as her search for a Pomeranian ("for I want an English dog").[56] She appears to have consulted with Greene often, updating the librarian when she plans to order tools for Morgan bindings. For her part, Greene appears to have been deeply interested in Duprez Lahey's work, going so far as to approach Anne Morgan, the daughter of the great collector, to ask whether she can arrange an exhibition of the binder's work at the Colony Club, an exclusive club for women founded by Anne Morgan and her friends.[57]

However high Greene's estimation of Duprez Lahey, she did not trust the binder's judgement completely. In a surviving letter to the librarian, Duprez Lahey mentions that she is sending samples of leathers and papers she is planning to use in the rebinding of a particular book to Greene for approval.[58] Greene does not hesitate to declare her dislike of Duprez Lahey's choices:

> I cabled to you on May 17, immediately after receipt of your letter, to say that I do not at all care for the end papers which you sent me, and would prefer plain paper used. I am sure this will be a disappointment to you, and I am very sorry; but Miss Thurston and I both found the effect very much mixed up and not at all appropriate for the volume. If my cable did not reach you too late, I hope you will substitute a plain cream paper or a pale yellow paper, instead of the enclosed which you wish to use.[59]

Another letter from Duprez Lahey asks for clarification regarding the spelling of the name of Geoffrey Tory on the binding for his illuminated book of hours.[60] That this was not considered a trivial matter is indicated in Greene's immediate reply on the matter.

The intense involvement of Greene with the intimate processes of bookbinding accords with Duprez Lahey's comments about her employers in various interviews. On the death of Pierpont Morgan the elder, she is quoted as saying:

> Mr. Morgan had a remarkable knowledge of the minutiae of the artistic features of my craft . . . He also knew its canons, a rare accomplishment that shows sympathy with both historical and literary traditions. Every page of [Geoffrey] Tory's illuminations bore the emblem of the *pot casée*, his sign manual, which is so intimately associated with him. After the death of his little daughter Agnes, the artist added the auger, or toret, as a play upon his own name, and explained that 'the broken pitcher represents our body, a vessel of clay, and fate is the auger which pierces all alike.'
>
> I have woven Geoffrey Tory's name into the cover design of this Book of Hours as Tory always did himself, but Morgan would not let me use the broken-pitcher emblem, for he thought it too personal to the artist to be used upon anything but the work of his own hands.[61]

All of this suggests that Duprez Lahey's work was mediated to a considerable extent by her employer, Pierpont Morgan—and by extension, Greene. This may explain some of the peculiarities of Duprez Lahey's bindings. While not necessarily knowing much about the effect of different binding structures on varying textblocks, Greene and Pierpont Morgan nevertheless had decided opinions about the visual appearance of the books within their library. Belle da Costa Greene, who was trusted by Morgan to the extent that she was the only one except his lawyer to read his will, was also in sole charge of the library, and her mission was clear. In 1909, she wrote to Morgan that her goal was to make his library "*pre-eminent*, especially for incunabula, manuscripts, bindings and the classics."[62] She was, in a sense, ahead of her time: one of her projects, a catalog of the first century of printed books, mystified her lover, art historian Bernard Berenson, who "saw the appeal of preprint books, especially the illuminated manuscripts that contained gorgeous, well-preserved pieces of art within their bindings. But he saw no artistic value in printed books, even the earliest examples."[63]

If Belle da Costa Greene was devoted to her work, her employer was no less dedicated. While he trusted Belle implicitly, he was still involved in the process of acquisition, making a point of "never purchasing an object he or Belle hadn't seen."[64] Although he had begun his collection by buying others' collections en masse, after 1908, the bulk of his purchases consisted of "individual volumes or groups of manuscripts purchased at auction or through dealers," suggesting a level of discrimination. He had a particular love for beautiful objects, and could be single-minded in their pursuit—one anecdote quotes him as follows:

> I was told . . . in London, that the Byron manuscripts were in the possession of a lady, a relative of Byron, in Greece. Libraries in England were after them. I wanted them. I therefore, through the advice of an expert, engaged a man, gave him a letter of credit and told him to go to Greece and live [there] until he had gotten those manuscripts. Every once in a while, during several years, a volume would come which the relative had been willing to sell, until the whole was complete.[65]

His son Jack was no less committed: he was "an ardent bibliophile" who continued to add to his father's rare book collection until his death in 1943.[66]

However interested the Morgans and Greene were in books, they still were not aware of all the intricacies relating to a book's binding structure. As an anonymous observer notes in an article in *Lotus Magazine*, "The layman is not apt to distinguish between 'forwarding' and 'tooling.' He forgets that a book is a book, to be opened and read, and not simply to be looked at."[67] This was a common failing at the time—Mirjam Foot, the noted book historian, quotes antiquarian bookseller Ernest Philip Goldschmidt (1887-1954) as saying that late nineteenth century bibliophiles were "too exclusively preoccupied with the artistic charm of their chosen objects, . . . too beglamoured with the reputed ownership of lovely queens and royal mistresses."[68] That this was a problem at the Morgan can be seen not just in Duprez Lahey's bindings, but also in a 1952 article by Morgan curator George K. Boyce which discusses the Morgan binding collection in terms of "jeweled and richly ornamented covers of heavy gold and silver," "ivory plaques . . . contemporary oaken boards . . . stamped and gilded pink doeskin . . . [and] several fine specimens of these Gothic book coverings, the *cuir-ciselé*, blind-stamped, and panel-stamped techniques which preceded the introduction of gold tooling."[69] The bindings of books were only considered of interest when they were elaborately decorative—more humble bindings that are now valued for the insights they offer into the lifestyle of less exalted members of the populace were not considered worth mentioning.

It is not unreasonable to assume that this widespread perspective may have influenced binding decisions at the Morgan. It is perhaps this attitude that Duprez Lahey referred to when, in an interview, she commented that knowledge of book history was extremely important to binders in America due to American collectors' desire for books bound in 'historic' styles:

> You must know the centuries when blind-tooling was the rule, and the centuries when gold was first used . . . You must know these things particularly for Americans . . . because Americans always want Fifteenth and Sixteenth Century bindings, even on new books. They do not realize that modern bindings are just as beautiful and infinitely more appropriate than ancient bindings. You can't get a French bookbinder to make an ancient binding today, and you can scarcely get an American book fancier to order anything else.[70]

Still, the Morgan as an institution was better informed than others. Belle da Costa Greene knew most if not all of the book historians and bibliophiles of the time, including Sydney Cockerell (who "had 'an awful crush' on her") and Goldschmidt himself.[71] Duprez Lahey herself included a clipping on the Cockerells' binding of the Codex Siniaticus in her scrapbook.[72] The problem was one of a general widespread lack of information (and to a certain extent, interest) throughout the field in the relationship between binding structure and function, between aesthetics and use.

This points to another factor influencing the Morgan's bindings—their purpose was not necessarily only to make the books they covered functional, or even durable. With increased mechanization, the use of cheaper wood pulp paper, and vastly increased access to libraries, books were becoming more and more readily available. Thanks to increased literacy, more people were able to take advantage of them as well. As Kevin Dettmar puts it:

> Not only, then, can the average man or woman in the street now read; he or she can gain entrance to free public libraries, as well. Together, these two developments lead to an increasing fetishization of the private, home library, for those who can afford to establish one: a place where cultural and symbolic capital are guarded by economic capital, and heavy oak doors.[73]

Increased access paradoxically led to the fetishization of the physical book. If anyone can access the contents, status needs to be based on something else, and in this case, that object became the book's binding. Books became a source of status. The new focus on decorative bindings led to the use of books in interior decoration, to the extent that an anonymous author writing in Fraser's Magazine in 1859 referred to "furniture books" which served as "a kind of culturally ostentatious furniture."[74] A look at gentlemen's libraries of the period reveals the meaning of the anonymous commenter's remark—their bookcases were all lined with the same solid leatherbound tomes, each with raised bands and gold-tooled titling. This was not a new phenomenon—the Roman philosopher and dramatist Seneca (4 BCE–CE 65) condemned the focus on lavish bindings in his own time: "Our idle book-hunters . . . know about nothing but titles and bindings: their chests of cedar and ivory, and the book-cases that fill the bath-room, are nothing but fashionable furniture and have nothing to do with learning."[75]

If books were beginning to become fetishized, the Morgans collected the rarest, most fetishized books of all, and it was likely important that they be sufficiently ornamental. The fact that so many books were rebound—and sometimes rebound in elaborate covers—suggests that there was some small desire to impress the value and beauty of the books upon the outside world.

CONCLUSION

It seems clear that Duprez Lahey's books reflect the tastes of the time, as arbitrated by the binder herself and her employers. While her work may not meet with the standards of conservation today, it did conform to the best practices of the day; and in many cases, the problems she faced are still the focus of debate today. As Michèle Cloonan asks:

> ". . . should conservators be guided primarily by the aesthetic or by the practical? Is historical accuracy regarding the date of the item being rebound or repaired more important than the immediate consideration of the use and handling the item will receive?"[76]

Duprez Lahey approached her work with imagination and creativity, while working within the limits of her own and her employer's aesthetic tastes. While she did change the nature of the books themselves in doing so, one could argue that the books have already lost much of their original context.[77] A manuscript that was once part of a monastic library has lost an intrinsic part of its history when it reaches a Fifth Avenue mansion. In addition, many books acquired by the Morgan had already been rebound at least once before their acquisition, including some of the books rebound by Duprez Lahey. They were already in bindings that were not original to the text, in which case, why should it matter if those later bindings were lost? After all, some of the eighteenth century bindings they sported would have been viewed by Duprez Lahey as lacking value and beauty—much as some view nineteenth- and early-twentieth-century bindings today.

Duprez Lahey may have caused damage to some of the books she rebound—a few have been rebound in recent years due to conservation concerns. However, this is not an unusual occurrence in the field of conservation and does not, by itself, condemn her as an incompetent worker. As Jonathan Ashley-Smith wryly notes, "It is not wrong to deliberately damage objects, we do it all the time through display or conservation treatment."[78] If it is acceptable to *deliberately* damage objects, how unacceptable can it be to damage an object through lack of knowledge?

Some of Duprez Lahey's bindings are now considered to have artistic value in their own right. They are held specifically in the bindings collection, and were exhibited during the binder's life. This accords with the fact that, by Cloonan's measure, Duprez Lahey would be deemed more a bookbinder than a conservator:

> Aesthetics affect the decisions made not only by bookbinders but by conservators as well. However, some restraints are imposed on the conservator, who must be sensitive to the dictates of the artifact and its probable use. The bookbinder, on the other hand, may be able to give free rein to creative expression.[79]

Whether the bookbinder has a right to this creative expression is a discussion that continues to this day. In 2003, the "Tomorrow's Past" exhibition at the Antiquarian Booksellers Association book fair in London showcased antiquarian books in modern conservation bindings.[80] Its popularity led to the exhibition becoming an annual event, continuing until 2011.

When considering Duprez Lahey's work, one uncovers more questions than answers. How should we view her role? How should her bindings be categorized? How did she approach the decision-making process? What was the rationale behind the selection of books for treatment, and for the selection of binding styles for those books?

Whatever our view of her work today, she was one of the most celebrated female bookbinders—if not one of the most celebrated bookbinders—of her time. At the Morgan, her work was highly valued, with Belle da Costa Greene describing her as doing "the very best bookbinding in America,"[81] and in 1914, famed American book designer William Dana Orcutt mentioned Duprez Lahey as one of three binders whose work was highly prized by contemporary collectors.[82]

Duprez Lahey herself was aware of her consequence, keeping a detailed scrapbook containing numerous press-clippings and glowing letters of thanks from clients, which she later bequeathed to the Morgan. Her pride in her work was reflected in each binding, no matter how minimal: she

Fig. 6. Marguerite Duprez Lahey and William M. Laffan, *Catalogue of the Morgan Collection of Chinese Porcelains*, record 77706, 1904-1911, full leather binding with gold tooling, doublure and front opening. Morgan Library & Museum, New York, NY, USA.

stamped each book with her initials at the bottom of the turn ins on the inside front cover (Figure 6). Where the book has been covered in leather, her name has been tooled, sometimes in gold, and where the book does not incorporate leather, it may be stamped in ink. It seems appropriate that all of the books she handled are forever marked with her name.

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NOTES

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2. Lawrence S. Thompson, "Hand Bookbinding in the United States Since the Civil War," *Libri* 5, no. 2 (1954): 103.
3. Ibid., 102. Ellen Mazur Thomson, "Aesthetic Issues in Book Cover Design 1880-1910," *Journal of Design History* 23, no. 3 (2010): 229.
4. Ibid., 98.
5. Ibid.
6. Ibid.
7. Meyer, Ernest E. "The Art Industries of America: VI. The Binding of Books." *Brush and Pencil* 16, no. 2 (Aug., 1905): 35-36.
8. Lawrence S. Thompson, "Hand Bookbinding in the United States Since the Civil War," *Libri* 5, no. 2 (1954): 115-116.
9. Ibid, 103.
10. Data gathered from census records on Ancestry.com.
11. "Wills and Appraisals," *The Sun*, July 11, 1915. Currency calculated using http://www.usinflationcalculator.com/
12. Lillian Gray, "Women Art Bookbinders," 1905 clipping from *Utica Sunday Tribune*, in Marguerite Duprez Lahey Scrapbook, 1905-1958, record 122684, Morgan Library & Museum, New York, New York.
13. "Bookbinding is an Art as well as a Craft and a Difficult One to Follow, Says This Woman Expert," clipping from *New York Evening Sun*, December 20, 1916, in Marguerite Duprez Lahey Scrapbook, 1905-1958, record 122684, Morgan Library & Museum, New York, New York.
14. Lida Rose McCabe, "Purveyor to His Majesty the Bibliophile," undated clipping from unidentified newspaper, in Marguerite Duprez Lahey Scrapbook, 1905-1958, record 122684, Morgan Library & Museum, New York, New York.
15. "A Maker of Beautiful Books," undated clipping from *Town and Country*, in Marguerite Duprez Lahey Scrapbook, 1905-1958, record 122684, Morgan Library & Museum, New York, New York.
16. Lillian Gray, "Women Art Bookbinders," 1905 clipping from *Utica Sunday Tribune*, in Marguerite Duprez Lahey Scrapbook, 1905-1958, record 122684, Morgan Library & Museum, New York, New York.
17. "Miss Lahey Dies; Noted Bookbinder," clipping from *New York Herald Tribune*, October 22, 1958, in Marguerite Duprez Lahey Scrapbook, 1905-1958, record 122684, Morgan Library & Museum, New York, New York.
18. It may be significant that Ralph Randolph Adams himself enjoyed the patronage of J. P. Morgan and his nephew Junius S. Morgan, as well as other early twentieth century collectors. – Lawrence S. Thompson, "Hand Bookbinding in the United States Since the Civil War," *Libri* 5, no. 2 (1954): 107.
19. "Some Notes on Book-Binding," *The Lotus Magazine* 3, no. 2 (Nov. 1911): 57.
20. "Boro Woman Is World's Best Bookbinder, Skilled in Preserving Priceless Tomes," clipping from *The Brooklyn Daily Times*, January 29, 1932, in Marguerite Duprez Lahey Scrapbook, 1905-1958, record 122684, Morgan Library & Museum, New York, New York.
21. Several undated clippings from several newspapers, in Marguerite Duprez Lahey Scrapbook, 1905-1958, record 122684, Morgan Library & Museum, New York, New York.
22. Lillian Gray, "Women Art Bookbinders," undated clipping from *Utica Sunday Tribune* (Utica, NY), in Marguerite Duprez Lahey Scrapbook, 1905-1958, record 122684, Morgan Library & Museum, New York, New York.
23. Lida Rose McCabe, "Purveyor to His Majesty the Bibliophile," undated clipping from unidentified newspaper, in Marguerite Duprez Lahey Scrapbook, 1905-1958, record 122684, Morgan Library & Museum, New York, New York.

24. "Miss Lahey Dies; Noted Bookbinder," *New York Herald Tribune*, October 22, 1958, in Marguerite Duprez Lahey Scrapbook, 1905-1958, record 122684, Morgan Library & Museum, New York, New York.
25. Untitled clipping from *British and Colonial Printer & Stationer*, March 16, 1916, in Marguerite Duprez Lahey Scrapbook, 1905-1958, record 122684, Morgan Library & Museum, New York, New York.
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29. Lida Rose McCabe, "Luxuriant Art in leather," *The International Studio* 63 (December 1 1917): XLVIII.
30. "Some Notes on Book-Binding," *The Lotus Magazine* 3, no. 2 (Nov. 1911): 57.
31. Douglas Cockerell, *Bookbinding and the Care of Books*, 1901, Project Gutenberg, 2008, http://www.gutenberg.org/files/26672/26672-h/26672-h.htm.
32. Jean Strouse, "The Collector J. Pierpont Morgan," American Council of Learned Societies Occasional Paper 48, http://archives.acls.org/op/op48-4.htm#strouse.
33. "Bookbinding is an Art as well as a Craft and a Difficult One to Follow, Says This Woman Expert," clipping from *New York Evening Sun*, December 20, 1916, in Marguerite Duprez Lahey Scrapbook, 1905-1958, record 122684, Morgan Library & Museum, New York, New York.
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35. Ellen Mazur Thomson, "Aesthetic Issues in Book Cover Design 1880-1910," *Journal of Design History* 23, no. 3 (2010): 229-245.
36. Ibid., 231.
37. Ibid., 237. Italics in original.
38. Lawrence S. Thompson, "Hand Bookbinding in the United States Since the Civil War," *Libri* 5, no. 2 (1954): 109.
39. Holbrook Jackson, *Anatomy of Bibliomania* (New York: Farrar, Straus and Company, 1950), 397.
40. Lida Rose McCabe, "Purveyor to His Majesty the Bibliophile," undated clipping from unidentified newspaper, in Marguerite Duprez Lahey Scrapbook, 1905-1958, record 122684, Morgan Library & Museum, New York, New York.
41. A doublure is "An ornamental inside lining of a book cover, which takes the place of the regular pastedown and fly leaf. It is usually of leather or (watered) silk, generally with a leather hinge and is often very elaborately decorated. of leather." – Matt Roberts and Don Etherington, *Bookbinding and the Conservation of Books: A Dictionary of Descriptive Terminology,* http://cool.conservation-us.org/don/dt/dt1074.html.
42. Lida Rose McCabe, "Purveyor to His Majesty the Bibliophile," undated clipping from unidentified newspaper, in Marguerite Duprez Lahey Scrapbook, 1905-1958, record 122684, Morgan Library & Museum, New York, New York.
43. Lee Ambrozy, email message to author, March 29, 2015.
44. A turn in is "The extra length and width of the covering material of a book overlapping the head, tail, and fore edge of the cover, and turned over the edges of the board and glued to the inside surface. In leather binding, the leather is usually pared around these edges so as to make it thinner on the inside of the boards." – Matt Roberts and Don Etherington, *Bookbinding and the Conservation of Books: A Dictionary of Descriptive Terminology,* http://cool.conservation-us.org/don/dt/dt3860.html.
45. A headcap is "The leather covering at the head and tail of the spine of a book, formed by turning the leather on the spine over the head and tail and shaping it." – Ibid., http://cool.conservation-us.org/don/dt/dt1725.html.
46. Harold W. Tribolet and Kenneth W. Soderland, "Binding Practice as Related to the Preservation of Books," *The Library Quarterly* 40, no. 1 (Jan. 1970): 133.
47. "Bound Morgan's Rarest Volumes," undated clipping from *Town & Country*, in Marguerite Duprez Lahey Scrapbook, 1905-1958, record 122684, Morgan Library & Museum, New York, New York.
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51. Douglas Cockerell, *Bookbinding and the Care of Books*, 1901, Project Gutenberg, 2008, http://www.gutenberg.org/files/26672/26672-h/26672-h.htm.
52. Bill from Marguerite Duprez Lahey to J. P. Morgan, record 152186, Morgan Collections Correspondence, 1887-1948 (ARC 1310); Morgan Library, New York, New York. The catalog title is Correspondence: between Belle Greene, MDL, and Ann Morgan.
53. Jonathan Kemp, "Practical Ethics," *V&A Conservation Journal* 56 (Autumn 2008): 14.
54. Randy Silverman, "Can't Judge a Book Without its Binding," *Libraries & the Cultural Record* 42, no. 3 (2007): 295.
55. Ibid., 303.
56. Letter from Marguerite Duprez Lahey to Belle da Costa Greene, August 4, 1912; record 152186, Morgan Collections Correspondence, 1887-1948 (ARC 1310); Morgan Library, New York, New York. The catalog title is Correspondence: between Belle Greene, MDL, and Ann Morgan.
57. Letter from Belle da Costa Greene to Anne Morgan, March 3, 1911. record 152186, Morgan Collections Correspondence, 1887-1948 (ARC 1310); Morgan Library, New York, New York. The catalog title is Correspondence: between Belle Greene, MDL, and Ann Morgan.
58. This appears to have been her standard practice – there are multiple letters in her scrapbook referring to patrons selecting leather from samples she had sent them.

59. Letter from Belle da Costa Greene to Marguerite Duprez Lahey, May 22, 1912; in Marguerite Duprez Lahey Scrapbook, 1905-1958, record 122684, Morgan Library & Museum, New York, New York. The Miss Thurston referred to here is Ada Thurston, Belle Greene's assistant.
60. Letter from Marguerite Duprez Lahey to Belle da Costa Greene, August 15, 2911, record 152186, Morgan Collections Correspondence, 1887-1948 (ARC 1310); Morgan Library, New York, New York. The catalog title is Correspondence: between Belle Greene, MDL, and Ann Morgan.
61. "Bound Morgan's Rarest Volumes," undated clipping from unidentified newspaper, in Marguerite Duprez Lahey Scrapbook, 1905-1958, PML 51421, Morgan Library & Museum, New York, New York. Emphasis in the original.
62. Heidi Ardizzone, *An Illuminated Life* (New York: W. W. Norton & Company, 2007), 79.
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64. Louis Auchincloss, *J. P. Morgan: The Financier as Collector* (New York: Harry N. Abrams, Inc., 1990), 53.
65. Francis Henry Taylor, *Pierpont Morgan as Collector and Patron, 1837-1913* (New York: Pierpont Morgan Library, 1957), 28.
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Targeted Cleaning of Works on Paper: Rigid Polysaccharide Gels and Conductivity in Aqueous Solutions

ABSTRACT

A review of paper conservation literature from the past decade reveals a fundamental shift in the conservator's approach to treatment, an approach that calls for less manipulation, greater control, and targeted cleaning. This two-part paper reviews the use of rigid polysaccharide gels and conductivity-adjusted aqueous solutions as relatively new tools that afford conservators greater control and the ability to tailor treatment.

The first part of this paper provides an overview of rigid gel systems in local and overall cleaning of works on paper, focusing on agarose and gellan gum, two naturally occurring polysaccharides. Both form colorless, rigid gels that may be cut to shape, qualities that make them appealing to paper conservators for a variety of treatment applications: aqueous and solvent-based poulticing to reduce adhesives, stain and tideline reduction, and overall bathing. Dependent upon the specific polymer, these gels may be prepared with deionized water or aqueous solutions, which utilize chelators and other buffers to adjust pH and conductivity. Following a discussion of the advantages of gel treatment and rationale for selecting a gel, the properties of agarose and gellan gum as well as factors that impact their performance will be addressed. These factors—casting thickness, concentration, and additives among others—may be modified to optimize treatment. Several examples are illustrated.

The second part of the paper aims to clarify both the theory and chemistry of conductivity in the context of paper conservation practice. Via combined chemical and physical effects acting on the microscopic and molecular level (for example: diffusion and osmotic effects), a salt in aqueous solution may be exploited to mitigate or to encourage the movement of soluble ions—not only through the fiber web, but also through the walls of individual paper fibers and fibrils. This research addresses the effects of one such electrolyte, aqueous ammonium acetate (a volatile, neutral salt), on discolored paper substrates. The effects of conductivity-adjusted solutions are distinctly advantageous for moisture-sensitive papers and can improve the performance of local wet treatments when using swabs, poultices, and rigid polysaccharide gels.

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INTRODUCTION

Over the past two decades, a movement towards object-tailored conservation treatment has emerged, reflecting a desire for greater control at both the physical and the chemical level. This evolution began with the work of Richard Wolbers, who promoted the use of modified aqueous solutions to chemically target treatment, and the use of gels for greater specificity in application (Wolbers 2000). These concepts were disseminated in Wolbers' courses at the University of Delaware and in workshops and seminars throughout the world. The Modular Cleaning Program, developed by Chris Stavroudis, translated this concept of chemical targeting into an accessible tool, which employs engineered cleaning solutions through pH- and conductivity-adjustment, as well as by the addition of surfactants and chelators. Traditionally, these methods have been used more frequently in the fields of paintings and objects conservation. This paper will delve into their application to paper conservation.

The first half of this paper reviews two rigid polysaccharide gels that have gained popularity among paper conservators—agarose and gellan gum—outlining the properties of each and the ways in which they may be optimized for greater control in a variety of paper conservation treatments. The second half of this paper reviews the principles of conductivity. It will describe the modification of aqueous solutions using conductivity to enhance cleaning and, at the same time, minimize change to paper objects during treatment.

RIGID POLYSACCHARIDE GELS

GEL POLYMERS AND PROPERTIES

Agarose and gellan gum are both naturally occurring polysaccharides (figs. 1 and 2). Agarose is derived from the cell wall

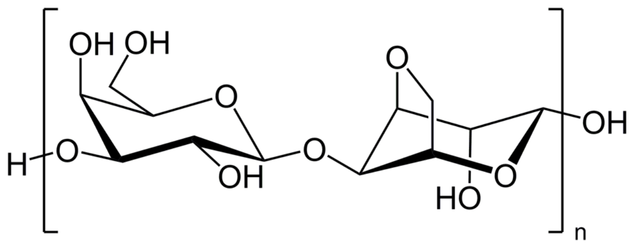


Fig. 1. Agarose monomer, https://commons.wikimedia.org/wiki/Category:Agarose#/media/File:Agarose_polymere.png

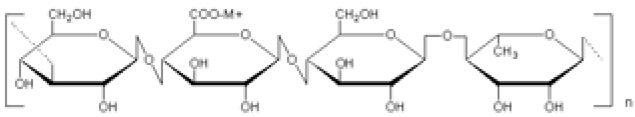


Fig. 2. Gellan gum monomer, https://commons.wikimedia.org/wiki/File:Gellan_gum_structure.png

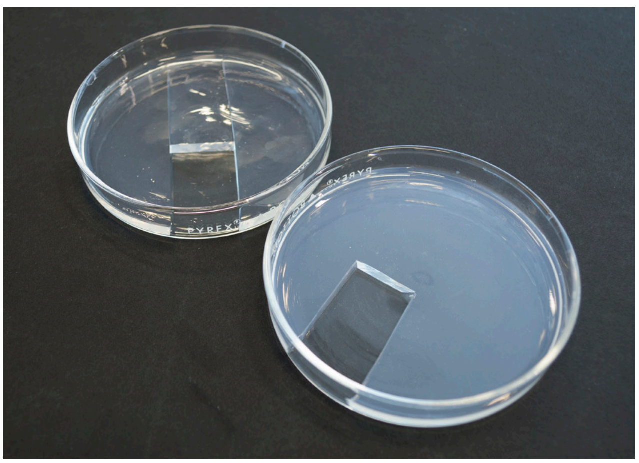


Fig. 3. Gellan gum (left) and agarose (right) prepared at 2% (w/v).

of *Gelidium* and *Gracilaria*, species of red algea, or *Sphaerococcus euchema,* seaweed (Armisén 2000). Along with agaropectin, it is one component of agar-agar. Gellan gum is the product of *Sphingomonas elodea*, a bacterium found on lily pads, and is available in two forms: low-acyl and high-acyl (CP Kelco 2007). When prepared, low-acyl is typically more brittle. This is the type more commonly used in paper conservation.

While agarose is electronically neutral, gellan gum is anionic with negatively charged carboxyl groups, which are available to complex with cations (Sworn 2000 and Mao et al 2001). Agarose and gellan gum are available in powder form and are prepared by dispersing dry polymer in pure water—or modified aqueous solution—and heating until clear and boiling. At this point, the polymers are fully hydrated. Upon cooling, both gels will be colorless, however gellan will remain clear while agarose will become slightly turbid (fig. 3). Some additives, such as volatile salts and enzymes, must be incorporated once the gel has cooled somewhat to prevent evaporation and denaturation, respectively.

As the polymer dispersions cool, both agarose and gellan gum form helical structures. These helical structures proceed to form aggregates, which define a porous network (Armisén 2000 and Valli and Miskiel 2001). These aggregates form in agarose by hydrogen bonding. In the case of gellan gum, hydrogen bonding also occurs, but the gel network is more robust when prepared with an aqueous solution that contains cations that crosslink at the negatively charged carboxyl groups. Both gels are thermo-reversible and can sustain numerous heating-cooling cycles, transitioning between liquid solution and solid gel (CP Kelco 2007).

ADVANTAGES OF GEL TREATMENT

A review of paper conservation literature of the past ten years reveals steadily increased interest in both agarose and gellan gum, for targeted cleaning. This surge in interest among paper conservators is understandable given the numerous advantages afforded by treatment with rigid polysaccharide gels:

- Precise application and restricted lateral flow to confine cleaning
- Increased dwell time, allowing reagents and solutions to work longer in a discrete area
- No mechanical action as with a brush, swab, or spatula
- Colorless and clear, allowing the conservator to monitor the course of treatment
- Unlike viscous gels, they can be removed immediately should a sudden, undesirable change occur

MODIFYING GELS FOR PAPER CONSERVATION

With an understanding of how agarose and gellan gum can be modified to achieve a specific result, conservators may tailor gels to suit the needs of a specific treatment. The primary methods for modifying gels include:

- Altering concentration
- Altering casting thickness
- Increasing contact with light pressure
- Changing the aqueous solutions used to prepare the gels
- Adding organic solvents

Rigid polysaccharide gels are typically prepared at concentrations ranging from 1% to 10% depending upon application. Gel polymer concentration and pore size are inversely related. As concentration of the gel increases, pore size decreases (Tukivene 2007).[1] This results in a gel with relatively greater capillary action, that is, a gel that pulls solutions and solubilized materials into its network more vigorously. Figure 4a and b illustrate the increased capillary action of higher-concentration gels. Moving from left to right, the gels increase

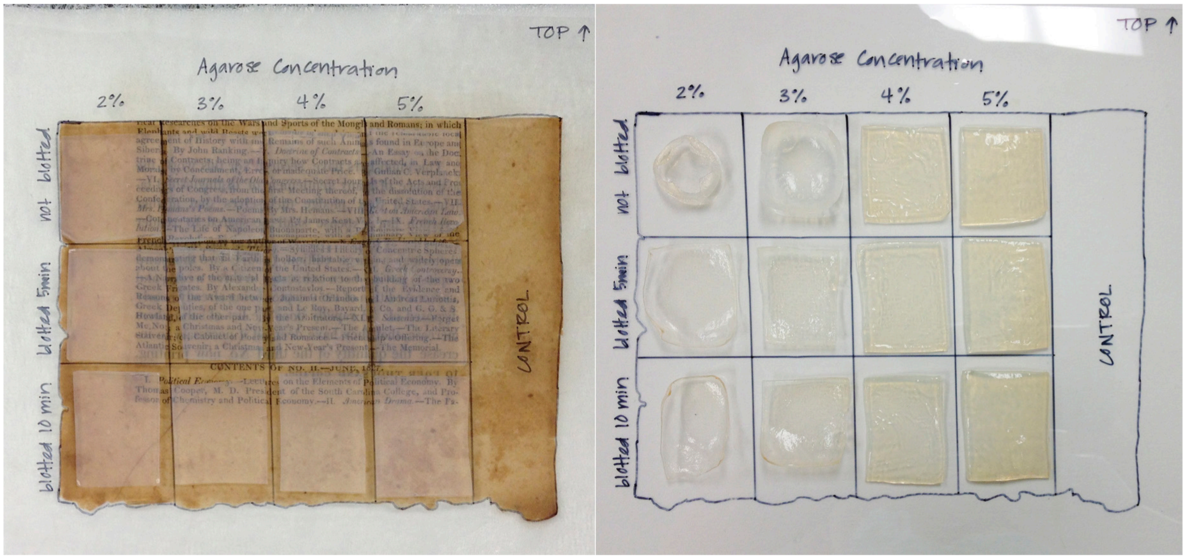


Fig. 4.

LEFT TO RIGHT

a. Gels of increasingly higher concentration, from 2% to 5%, placed on an antique book page.

b. Gels removed from the page and discolored with solubilized degradation products.

in concentration from 2% to 5% (w/v). Once removed from the sheet of paper, it is clear that the 4% and 5% gels with smaller pores are more discolored and have extracted a greater amount of solubilized degradation products than the 2% and 3% gels with larger pores.

In addition to concentration and pore size, casting thickness can be managed to control diffusion of solvent into paper objects. Thinner gels may be preferred to control tideline formation when working on paper objects that cannot be made wet overall. In other instances, thicker gels may be used to provide a larger reservoir of water, as when washing a print overall.

To target cleaning on a chemical level, gels may be prepared with modified aqueous solutions, that is, water that has been treated before addition of the dry polymer. The most common methods for modifying aqueous solutions are pH and conductivity adjustment and the addition of chelators, enzymes, or reducing agents.

Finally, aqueous gels may be converted into solvent gels by soaking pieces of agarose or gellan gum in a solvent or solvent mixture for approximately 24 hours. During this period, water and solvent exchange and the gels become more rigid. It is advisable, therefore, to cut the gels into useful shapes for treatment prior soaking. Given the chemical structure of polysaccharide gels—full of hydroxyl and carboxylic acid groups—this preparation works best with polar solvents like acetone and alcohols rather than non-polar ones.

Modifications as described above make it possible to use polysaccharide gels for a wide variety of paper conservation treatments, including but not limited to:

- Backing and attachment removal
- Aqueous and solvent-based adhesive reduction
- Local stain reduction
- Overall bathing of paper objects
- Measuring surface pH and conductivity of paper

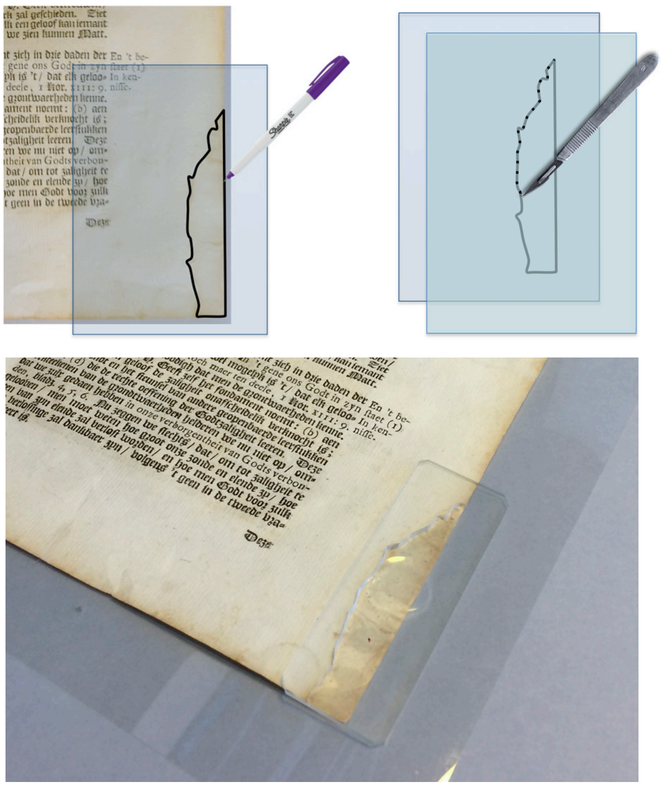
CASE STUDY 1: LOCAL STAIN REDUCTION

Thinly cast, higher concentration agarose or gellan gum may be used to reduce stains or tidelines in a paper object that cannot be wet overall such as a drawing with sensitive media or a page in a bound volume. The following example illustrates this procedure (figs. 5a-c and 6).

To begin, a template of the area to be treated was created using Mylar® and a permanent marker. Gel cast onto another sheet of Mylar® was placed on top of the template and a scalpel was used to cut the gel to shape. Using tweezers, the shaped gel was placed directly on the stain and a microscope slide was used to improve contact and to slow evaporation of solvent. Multiple applications of fresh gel were required to achieve the desired result, and the treated area was dried between applications to prevent overwetting and tideline formation.

CASE STUDY 2: OVERALL BATHING

A number of experiments related to gels and paper conservation treatment have been undertaken at the National Gallery of Art in Washington, DC (NGA), including a study that compared traditional blotter washing to bathing on a sheet of gellan gum. In figures 8 and 9, the sheet on the left in each



CLOCKWISE FROM TOP LEFT

Fig. 5a–c. Stepwise preparation and application of shaped gels for local stain reduction.

Fig. 6. Schematic diagram of gel application for local stain reduction.

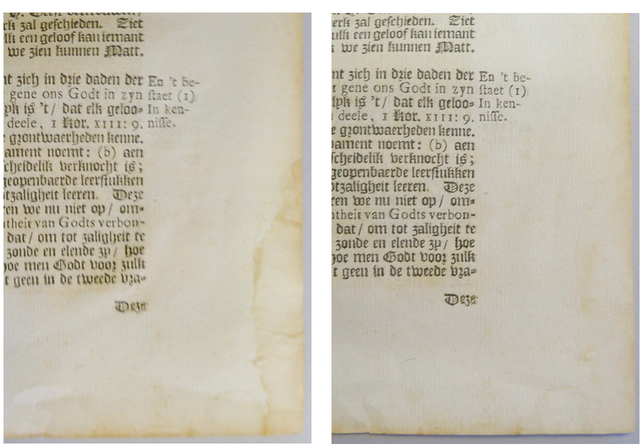


Fig. 7.

LEFT TO RIGHT

a. Lower-right corner of antique book page before local treatment with thinly cast 6% (w/v) agarose gel to reduce tideline.
b. Lower-right corner of antique book page after treatment.

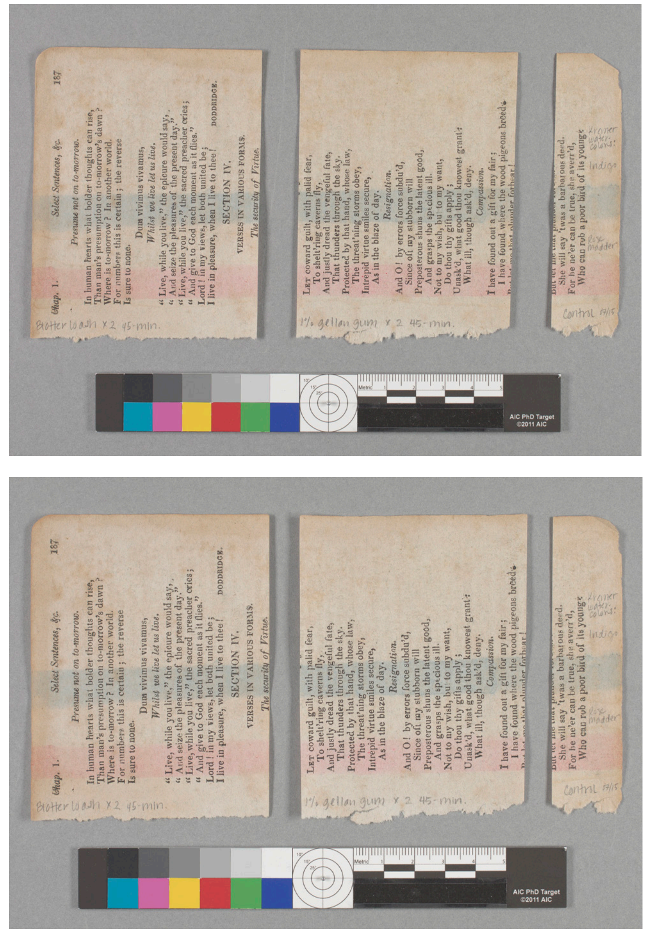


Fig. 8.

TOP TO BOTTOM

a. Antique book page before treatment, comparing blotter washing to gel washing.
b. Antique book page after treatment.

image was blotter washed; the sheet in the middle was washed with 2% (w/v) gellan gum prepared with a dilute aqueous solution of calcium acetate (0.4g/L); and the strip on the right was retained as a control. Both the blotters and gellan sheets were exchanged after 45 minutes and the papers were washed for an additional 45 minutes.

Under normal illumination, improvement to the washed sheets is subtle. Gel washing was more efficient, however, as the sheet washed with gellan appears somewhat brighter (figs. 8a and b). When the samples were viewed under ultraviolet radiation, changes from bathing were more obvious (figs. 9a and b). Both the blotter-washed and gel-washed sheets absorbed more strongly due to the removal of fluorescent, oxidized degradation products. Removal of solubilized degradation products, however, was much more even in the gel-washed sheet versus the blotter-washed sheet. This difference is likely attributed to the gel's ability to conform and

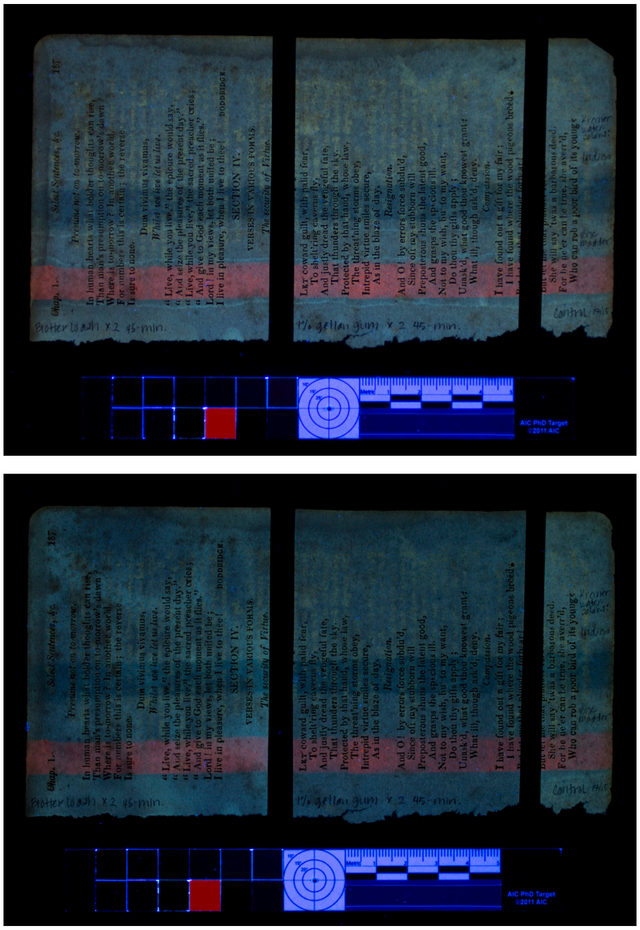


Fig. 9.

TOP TO BOTTOM

a. Antique book page under UV radiation before treatment.

b. Antique book page under UV radiation after treatment. Note the uneven removal of fluorescent degradation products in the blotter-washed sheet (left) versus the gel-washed sheet (center).

make excellent contact with the paper, as noted by others who have published on bathing with gellan gum (Iannuccelli and Sotgiu 2010, Botti et al 2011, and Mayheux 2015).

In light of the positive results of the experimental gel baths, the treatment was scaled up and applied to an object from NGA's permanent collection. Together, the paper conservators treated a chine collé engraving, *Heart of the Andes* by William Forrest (Scottish, 1805 – 1899) after Frederick Church (American, 1826-1900). This print is a laminate paper object that could not be subjected to full aqueous treatment by immersion or float wash for fear of layer separation, but reduction of overall discoloration and strong tidelines throughout was desired. The print's sensitive structure made it an ideal candidate for gel washing for its high degree of control and even cleaning. Gellan gum was prepared as described above and was cast into several heat-resistant, flat-bottomed trays (figs. 10a and b). The resulting sheets of gel were joined to create a sheet of gel large enough to accommodate the print, which measures approximately 20 x 30". A scalpel was used to trim the edges of the cast gel to ensure smooth joins. The gel fused together seamlessly (figs. 11a and b).

Following a period of chamber humidification, the print was transferred to the gellan gum on a sheet of medium-weight *seikishu* Japanese paper. Through spun-polyester web, a smoothing brush was used to ensure contact between the print and gel. During treatment, the print was covered with an inverted Mylar® tray to prevent the surface of the print from drying out. In total, the print was treated with three separate gel washes, each approximately 45 minutes in duration. Periodically, a light mist of slightly alkaline water was applied with a dahlia sprayer to encourage continued movement of water-soluble discoloration into the gel.[2]

The treatment was considered a success. The print's appearance was improved with markedly reduced staining and overall discoloration. Further, no adverse effects, such as

Fig. 10.

LEFT TO RIGHT

a. Preparing gellan gum by dispersing powdered polymer into dilute calcium acetate solution (0.4g/L).

b. Casting fully hydrated dispersion into heat-resistant tray.

Fig. 11.

TOP TO BOTTOM
a. Sheet of gellan gum released from heat-resistant tray.
b. Joining two sheets of trimmed gel.

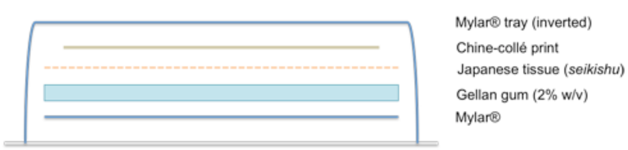


Fig. 12. Schematic diagram of arrangement for overall washing with a sheet of gellan gum.

Water	Conductivity (μS/cm)
Absolute Water (H_20)	0.055
Distilled Water	0.5
Dasani® Bottled Water*	50
Tap water (New York City)*	95
Maximum for Potable Water	1055
Ocean Water (Mid-North Atlantic)	53,000

Table 1. Conductivity of common water sources, in microsiemens/cm. *From laboratory measurements using a Horiba B-771 LAQUAtwin Conductivity meter. Other values from *The pH and Conductivity Handbook*. Stamford, Conn: Omega Engineering, Inc, 1990.

delamination or bubbling of the chine collé, were observed as a result of treatment.

CONDUCTIVITY IN AQUEOUS SOLUTION

The following section addresses the theory and chemistry of conductivity in the context of paper conservation. With an awareness of the properties of electrical conductivity in solution, paper conservators may design aqueous treatments that are more sensitive to the specific needs of objects at hand, achieving stain reduction goals while minimizing swelling of the paper fibers. Many of the concepts surrounding conductivity and ionic strength have been taught in workshops led by Richard Wolbers, Chris Stavroudis, and other paintings conservators.[3] One recent study by Dillon, Lagalante, and Wolbers (2014) addresses specific ionic species and their effects on swelling of acrylic painted surfaces. These concepts have also begun to be published and introduced into wider practice by paper conservators within the last five years (Keynan and Hughes 2013). While conductivity adjusted solutions may be delivered by any familiar method, they are particularly well-suited for local treatment techniques and can be used with swabs, brushes, sponges, loaded into rigid polysaccharide gels, or applied over a suction table.

CONDUCTIVITY

Conductivity, simply put, is that measurement which describes how well a given substance conducts electricity (Atkins, Jones, and Laverman 2016). Electrical charge in aqueous solution flows only in the presence of ions. Therefore, an electrically conductive solution must contain at least one electrolyte, or substance that dissolves into cations and anions. Electrolytes may be acids, bases, or salts—strong or weak, depending on their ability to ionize, or dissociate, in solution.

Conductivity is expressed in the unit siemens (S). Pure water, such as deionized or distilled water, is a poor conductor and yields conductivity values of nearly zero siemens/cm. Table 1 lists conductivity values for familiar types of water. Conductivity is unspecific and merely a broad measurement of ionic content. A conductivity value is a combination of all the ionic species present in a given solution, and typically correlates to the salinity of the water and to total dissolved solids (TDS). In the following section, references to conductivity are primarily used to describe the concentration of salts present in the aqueous solutions used for treating works of art on paper.

Paper conservators already employ numerous salts in their work, although these chemicals are not always recognized specifically as such. Calcium hydroxide, calcium carbonate, and magnesium bicarbonate, to take three examples, are all salts employed in very dilute solutions for the purposes of deacidification (Smith 2011). Sodium borohydride, a salt with high ionic strength, is used in bleaching processes.

Chelators such as disodium ethylenediaminetetraacetic acid (EDTA) and the citrates are frequently used salts as well. Calcium phytate, otherwise known as phytic acid calcium salt, has been employed for several decades to sequester damaging iron ions during treatment of documents bearing iron gall ink (Burgess 1991). Of course, not all salts are equally efficacious, and several salts used for treatment in the early 20th century have been shown to contribute to paper degradation over time (Lienardy and Van Damme 1988; Henniges and Potthast 2009). The safety and efficacy of specific salts, and even specific cations and anions, remains an open venue of inquiry for conservators and conservation scientists alike.

Today, aqueous steps taken during the course of a paper treatment are typically carried out using laboratory-purified water with added ionic species. This is because deionized water is a strong solvent; it has been called "ion-hungry" for its capacity to corrode metals such as copper, and to take up carbon dioxide from the atmosphere. In the late 1970s, Tang and Jones demonstrated that washing paper with deionized or distilled water alone could leach beneficial ions such as calcium and magnesium from the paper matrix, contributing to reduced tensile strength after aging (Tang and Jones 1979).

On the other hand, it is possible that washing with purified water may sometimes be preferable for papers with large amounts of damaging impurities, such as degraded papers with alum-rosin sizing or chemically pulped groundwood papers (Burgess 1986). Results from scientific studies such as those of Burgess, and Tang and Jones, indicate that paper conservators ought to exercise individualized care when tailoring their aqueous treatments. Those ionic species that conservators introduce into wash water, and those already present in paper structure, are significant to long term aging, and will affect tensile strength, optical brightness, and degree of polymerization of cellulose.

When washing paper objects, conservators often condition wash water with an alkaline agent in order to neutralize acids in the paper and to buffer against the post-treatment formation of acids. The most commonly employed alkaline agent is likely calcium hydroxide, which must be used in very low concentrations in order to achieve pH levels appropriate to both paper fibers and media. For example, the conductivity of a dilute solution of pH 8.5 calcium hydroxide intended for washing measures 5 μS/cm and has been diluted over 1720 times (0.013mmol/L) from its saturated state (Smith 2011, 366). Such a dilute salt solution is effective for neutralization and alkalization, but for purposes of neutralization and stain reduction, more concentrated salt solutions may often be preferable. Detailed below will be examples of these alternatives, salt solutions for cleaning that may be adjusted to specific pH and conductivities, ranging from 1,000 μS/cm (0.1 molar concentration) to upwards of 6,000 μS/cm.

In the early 2000s, Bogaard and Whitmore (2001) introduced a theory of applying salt solutions to oxidized papers. In one of their experiments, they investigated the addition of a concentrated solution of neutral pH calcium chloride to wash water. The object of this approach was to speed the rate of diffusion and ion transport into and out of the fibers, with the goal of neutralizing acids in the sheet prior to further aqueous treatment (Bogaard, Morris, and Whitmore 2005). The increased ionic strength (and high conductivity) of the saline water enabled free acids to be drawn out of the fiber interiors more quickly and more thoroughly, leading to improved paper stability after accelerated aging when followed by a rinsing step. Similar findings were presented by Season Tse (2001) of the Canadian Conservation Institute, indicating that deionized water alone cannot wash out significant quantities of acids from cellulosic materials, and that adding a salt enhances the benefits of washing.

MECHANISMS OF TRANSPORT: DIFFUSION, OSMOSIS, AND THE DONNAN EQUILIBRIUM

The chemical principles of diffusion and osmosis ought to guide a paper conservator's choice of conductivity level for treatment. Diffusion is "the most important mechanism in washing paper," according to Vincent Daniels (2011, 294), from the invaluable resource *Paper and Water: A Guide for Conservators*. Diffusion describes a kind of movement of molecules or ions, which is both constant and random. Particles move from areas of high concentration to low concentration in order to establish equilibrium within a system. During washing, acids and associated colored compounds are gradually removed from paper by the mechanism of liquid diffusion.

There are several factors that alter rates of diffusion when washing paper. Temperature, pressure, permeability, and concentration gradient are each frequently manipulated by conservators during washing for just this reason. Of these, concentration gradient bears a great deal of relevance to issues of conductivity. Concentration gradient is commonly manipulated during aqueous treatment by exchanging wash water or wet blotters as they become yellow from the extraction of ionic compounds (Lienardy and van Damme 1990). This introduction of fresh water (with lower conductivity) disrupts the established equilibrium and creates a new concentration gradient. Alternatively, and in certain cases, conservators might choose to use high conductivity water to disrupt the concentration gradient in order to speed up the rate of diffusion and stain reduction during treatment. It is important to keep in mind that paper fibers possess cell walls that act as semi-permeable membranes in aqueous solution, meaning that osmotic forces above and beyond simple diffusion are present when washing paper.

Yet another object might call for a gentler aqueous intervention—the creation of a solution that agrees with the ionic content of the paper at hand, in order to lower the osmotic pressure in the system of fibers and to reduce swelling. When introducing water to paper, the bulk aqueous solution has a tonicity in relationship to the localized water that has penetrated into and swollen the fibers. It is the concentration of ionic species, or conductivity in aqueous solution, that determines tonicity—that is, whether a solution is hyper-, hypo-, or isotonic. Along with pH, conductivity is critical to managing the swelling of paper fibers during treatment. In an uncomplicated biological system, hypertonic solutions will result in cell shrinkage, while hypotonic solutions will cause cellular swelling. An isotonic solution, however, is in equilibrium with the interior contents of the cell wall, creating a stable aqueous environment with no net movement of water. For paper objects vulnerable to swelling, such as highly oxidized papers or papers with calendared surfaces, tailored isotonic aqueous solutions may allow for aqueous treatment with fewer risks of surface alteration.

To achieve isotonicity (or near isotonicity) in solution, the pH and conductivity of a paper support must first be measured and recorded. These measurements may be achieved with handheld pH and conductivity meters, using agarose plugs as the vehicle for ionic content, according to the method demonstrated by Chris Stavroudis in a video published by the Getty Conservation Institute.[4] A weak acid and a weak base should then be combined to create a salt in aqueous solution with precisely calibrated pH and conductivity to match the paper object. The two reactants originally proposed by Chris Stavroudis, Richard Wolbers, and others as part of the Cleaning of Acrylic Painted Surfaces (CAPS) workshop are acetic acid and ammonium hydroxide, a weak acid and a weak base, respectively, that react to form ammonium acetate salt.[5] By adding either excess acid or base, the solution's pH may be adjusted to the value desired by the conservator. Ammonium acetate salt has many attractive qualities for the purpose of paper conservation. It is neutral pH, highly soluble, and decomposes into its volatile components upon evaporation.

Conductivity Adjusted Solution
Acetic Acid + Ammonium Hydroxide →
Ammonium Acetate + Water

By exploiting the effects of conductivity when washing paper, conservators may enjoy greater control over the effects of water on paper. Sometimes it may be desirable to encourage swelling, or to speed up the rate of diffusion for more efficient removal of discoloration products, by creating a hypo- or hypertonic solution. In many other cases, however, it is more important to minimize the extent of physical change, to safeguard sensitive media, and/or to retain paper texture, through use of an isotonic solution.

Additional processes are at work in the application of a moderate conductivity salt solution to a sheet of paper when the goal is to limit swelling and to draw out discoloration. It may seem counter-intuitive to many paper conservators, but the very same solution that limits swelling of paper fibers will also release discoloration efficiently when working in a higher conductivity aqueous environment. In the paper-making industry, studies have shown that electrostatic forces and "Donnan-like" equilibrium effects occur when cellulose fibers are immersed in electrolytic solution (Scallan and Grignon 1979). This may help to explain the mechanism of reduced fiber swelling in moderate to high conductivity solutions. The Donnan effect is similar to osmosis, but with the distinction of trapped or "fixed" charged molecules on one side of a semi-permeable membrane. These charged molecules create an electrical imbalance in the aqueous system and influences the diffusion of smaller and more mobile cations and anions in solution to balance the charge.

Donnan-like equilibrium effects have been shown to occur within the nanopores of cellulose, which are so tiny (not much larger than the diameter of a DNA helix) that they exhibit somewhat unusual behavior in solution (Hidayat, Thygesen, Katja 2013). Acidic compounds, bound to the surfaces of cellulose (mostly carboxylic acid groups), cannot dissociate within the small spaces of the nanopores to the same degree that they can on the exposed surface of the fibers. As a result, the pH within the fiber is quite low. In fact, the measurable pH within the wall of a cellulose fiber is significantly lower than what is measurable by traditional pH measurement techniques (Grignon and Scallan 1980). So whereas a bulk paper might measure pH 6.0 by cold extraction, the pH within the interior of its fibers might be as low as 3.0. Upon discovering this discrepancy, Scallan suggests that paper pH extraction measurements be done in a neutral salt solution (like sodium or potassium chloride) to achieve more accurate readings, as the interior and exterior differences in pH are alleviated as the conductivity of the bulk solution is raised (Scallan 1990). The shift in equilibrium provided by the addition of a salt in the solution effectively releases protons and small acid groups from the interior of the nanopores and subsequently out of the paper matrix. The osmotic effect of the added salt allows small charged ions access into and out of the pores while at the same time limiting swelling of the fiber (Alam et. al. 2012).

ANALYSIS OF AMMONIUM ACETATE SOLUTIONS

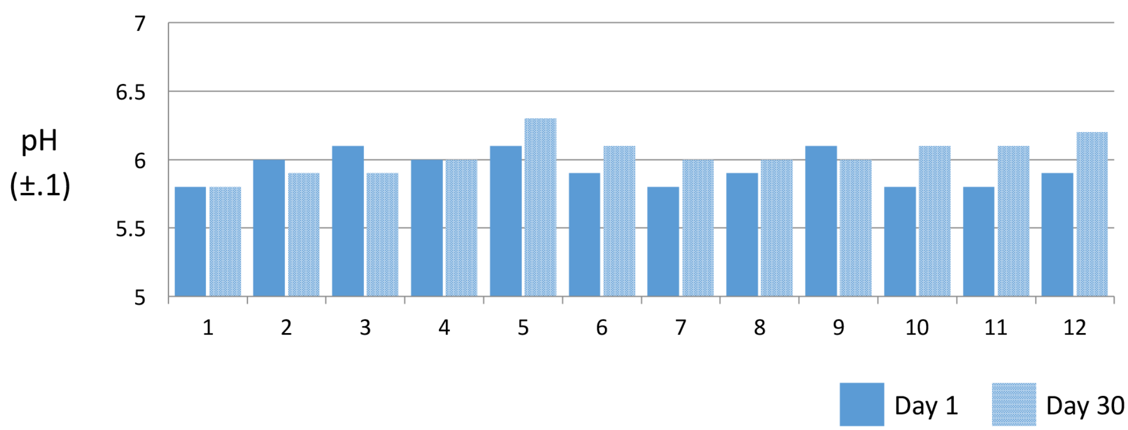
The effects of neutral salts such as ammonium acetate should be investigated more thoroughly to determine their long-term effects on paper aging and on artists' media. Despite the fact that ammonium acetate and its degradation products are volatile, the ammonia and acetic acid volatilize at different rates, with the ammonia evaporating first. Acetic acid remains detectable by its odor in washed paper for up to 5 days after drying, depending on the thickness of the support and the initial concentration of the salt solution. The odor of vinegar is significant at 6,000 microsiemens.[6] Ideally, the use of pH- and conductivity-adjusted solutions will not require a rinsing step, however this may not be possible if the paper retains significant acid functional groups after treatment.

To measure relative amounts of these volatile organic compounds (VOC), Gastec Passive Dositubes were used to measure time-weighted averages (TWA) of acetic acid and ammonium hydroxide off-gassing from the liquid salt solutions into air-tight containers (Table 2). After testing, it was determined that the Gastec tubes were not sensitive enough to detect VOCs from sample papers treated with these solutions, so the solutions themselves were chosen for the measurements. Gaseous acetic acid evaporating from the slightly acidic solution (pH 6.5 at 6,000µS/cm) was found to be less than one half the volume of acetic acid off-gassing measured inside solander boxes according to a study by Dupont and Tétreault (2000). These researchers found that such low levels of acetic acid had no statistically significant effect on the degree of polymerization (DP) of cellulose after artificial aging. However, they measured a slight decrease of pH (0.22 units) after 80 days of exposure to the vapors in an enclosed vessel.

	Ammonia	Acetic Acid
pH 6.5/6,000 µS	1.0 PPM	0.5 PPM
pH 8.5/6,000 µS	16 PPM	Under detection limit

Table 2. VOCs as determined using two types of Gastec Passive Dositubes: Acetic Acid (81D) and Ammonia (3D). Measurements obtained inside an air-tight 1.7-liter polypropylene container.

Therefore, pH tests were performed on samples of Whatman chromatography paper to determine if papers treated with ammonium acetate solutions would prove more or less acidic over time as compared to unwashed controls and to papers washed using alkaline solutions. The Whatman paper was divided and washed in 12 different aqueous solutions to represent a practical range of the pH- and conductivity-adjusted waters in comparison with more traditional washing solutions (Table 3). After washing the papers, the pH of each sample was measured according to the TAPPI T 509 cold extraction method using a Horiba B-713 LAQUAtwin Compact pH meter. Measurements were performed in duplicate and then averaged. The first round of pH measurements was performed 24 hours after washing the samples and allowing them to air-dry—at this time, the samples washed in 6,000 µS/cm ammonium acetate solution



1	Control (unwashed)	7	AW, pH 6.5/18,000 µS
2	Deionized Water (approx. pH 5.5/1 µS)	8	AW, pH 6.5/18,000 µS (rinsed)
3	Deionized Water + $Ca(OH)_2$ (pH 8.5/6 µS)	9	AW, pH 8.5/1,000 µS
4	Deionized Water + NH_4OH at (pH 8.5/9 µS)	10	AW, pH 8.5/6,000 µS
5	Adjusted Water (AW), pH 6.5/1,000 µS	11	AW, pH 8.5/18,000 µS
6	AW, pH 6.5/6,000 µS	12	AW, pH 8.5/18,000 µS (rinsed)

Table 3. pH cold extraction measurements of Whatman Grade 1 cellulose chromatography paper washed in 12 aqueous solutions, measured one day after treatment and 30 days after treatment.

retained a slight vinegar odor. The second round of pH measurements was done 30 days after washing. During the 30-day interval, the washed papers were stored together, uncovered, and loosely stacked in a tray. The measured pH values of all the washed papers, both day-one and day-30, are either equal in pH or more alkaline than the slightly acidic unwashed control samples. This preliminary testing indicates that washing with the ammonium acetate salt may be beneficial to the pH of paper fibers. However, more thorough testing is required to determine how these solutions affect mechanical strength, optical properties, degree of polymerization, as well as pH after longer periods of aging.

CONCLUSION

The advancements to paper conservation treatment discussed here have been afforded by the pioneering work and cross-specialty interests of Richard Wolbers and his many devoted colleagues. In the interest of moving the conservation profession forward—towards increasingly tailored and object-specific treatments—it is critical for practicing conservators to not only become familiar with the scientific principles that underpin these inventions but to continue the search for the most efficacious methods of putting them into practice. Treatments employing rigid polysaccharide gels and/or conductivity adjustment hold much promise for the future of paper conservation treatment; however these techniques are still in their nascent stages and deserve more comprehensive study and development.

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NOTES

1. In Tukivene's article, SEM images of agarose prepared at three different concentrations—2%, 6%, and 16%—illustrate the inverse relationship between polymer concentration and pore size. At higher concentrations, the pore sizes are visibly smaller and the gel networks more compact.

2. Alkaline water was prepared by adjusting deionized water to pH 8 with a saturated solution of calcium hydroxide.

3. Richard Wolbers has been teaching paper-specific workshops since 2007 (personal communication, 2016).

4. This video demonstrates the method as appropriate for acrylic painted surfaces. The method for measuring the surface pH and conductivity of paper is similar, but typically requires a longer dwell time of the agarose plug (up to 10 minutes) to achieve realistic measurements depending on the type of paper and its surface sizing. Surface conductivity measurements reflect the concentration of ionized solutes imbibed by the agarose plug at the test site. Measuring Surface pH and Conductivity Using Water Drop and Agarose Plug Methods. YouTube. The Getty Conservation Institute, Los Angeles, CA. Accessed July 9, 2016. https://youtu.be/bOqZEE7Kb8Y/

5. Further resources, including recipes, may be found on the Getty's webpage for CAPS. Conserving Modern Materials. The Getty Conservation Institute, Los Angeles, CA. Accessed July 9, 2016. http://www.getty.edu/conservation/publications_resources/teaching/conserving_modern.html/

6. The human olfactory system is nearly 35 times more sensitive to the odor of acetic acid than it is to ammonia (Hamilton and Arogo 1999). Thank you to Alan Phenix for this suggestion.

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MATERIALS

Agarose LE (#A1700)
Benchmark Scientific, Inc.
P.O. Box 709
Edison, NJ 08818
(908) 769-5555
http://www.benchmarkscientific.com/Agarose.html

Kelcogel LA Gellan Gum
CP Kelco U.S., Inc.
3100 Cumberland Boulevard, Suite 600
Atlanta, GA 30339
(800) 535-2687
http://cpkelco.com/products/gellan-gum/

Calcium acetate hydrate (#5743-26-0)
Fisher Scientific
300 Industry Drive
Pittsburgh, PA 15275
(877) 885-2081
https://www.fishersci.com/shop/products
/calcium-acetate-acs-mp-biomedicals-100g/icn19382180

Heat-resistant fiberglass trays (#870008)
Molded Fiber Glass Tray Company
6175 Route 6
Linesville, PA 16424
(800) 458-6050
http://www.mfgtray.com

Glacial Acetic Acid (#A38-500)
Fisher Scientific
https://www.fishersci.com/shop/products
/acetic-acid-glacial-certified-acs-fisher-chemical-9/p-20006/

Ammonium Hydroxide (#A669-500)
Fisher Scientific
300 Industry Drive
Pittsburgh, PA 15275
(877) 885-2081
https://www.fishersci.com/shop/products/ammonium
-hydroxide-certified-acs-plus-fisher-chemical-7/p-212671/

Horiba Laqua Pocket Tester, pH (#UX-05754-10)
Cole-Parmer
625 East Bunker
Court Vernon Hills, IL 60061
(800) 323-4340
sales@coleparmer.com
http://www.coleparmer.com/Product/Horiba
_Laqua_Pocket_Tester_pH_Range_2_to_14_pH
/UX-05754-10

Horiba B-171 Twin Conductivity/Salinity Pocket Tester
(#UX-05751-10)
Cole-Parmer
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Court Vernon Hills, IL 60061
(800) 323-4340
sales@coleparmer.com
http://www.coleparmer.com/Product/Horiba_B_171
_Twin_Conductivity_Salinity_Pocket_Tester/UX-05751-10/

Miltex® Biopsy Punch with Plunger, 3.0mm (#15110-30)
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P.O. Box 492477
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http://www.tedpella.com/histo_html/miltex-plunger-punch
.htm/

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A Technical Exploration of a 19th Century Qajar Artists' Album

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In 1960 the Harvard Art Museums acquired a 19th century anonymous Persian album comprised of sketches, designs, finished drawings, manuscript pages, and miscellany. The album had never been closely studied, despite the fact that it is one of the richest resources of its kind known today from the Qajar period. The 57 folios hold 141 varied works on paper, arranged singly and in groups. Many of drawings were apparently used by artists to make objects in different media, such as lacquered pen boxes. This is evidenced by the fact that a significant number of the drawings bear signs of being used as models such as pricking.

This presentation will focus upon the papers in the album. The author was struck by their diversity and by the fact that most of the papers in this Qajar album are European. These papers provide much needed information about the album. They help group works and they provide information on dating, origins and assembler. A second area of interest for this presentation is the varied methods of transfer represented in the album, such as pricking, pouncing, rubbing and a transfer drawing technique. The album's numerous transfer types lead to explorations in the Materials Lab, a purpose-built hands-on space at the Harvard Art Museums where the students practiced pricking, pouncing and related forms of image transfer to better understand what they were looking at and how the drawings might have been used.

The Qajar album will be shown in two years in an exhibition at the Harvard Art Museums. It was, thus, the subject of a graduate seminar last spring that the author helped teach. The seminar was intensively object-based and examined the album from numerous perspectives. The author led two sessions, one on media and one on paper, and sat in on the rest of the course, weighing in on physical characteristics and material issues as needed. This proposal presentation for AIC will focus on what has been learned through careful study of the papers and the various transfer techniques as well as the critical nature of hands-on practice and teaching with real objects.

Presented at the Book and Paper Group Session, AIC's 44rd Annual Meeting, May 13–17, 2016, Montreal, Canada

MYLÈNE LEROUX

Soft Matter: Gel Development for Conservation Treatment Gellan Gum and Nanorestore Gel®

INTRODUCTION

In the field of conservation of cultural heritage, new technologies are developed or adapted to achieve a more gentle, targeted approach to the conservation of artifacts. While gels have been used for decades, recent developments indicate a desire for greater control over the action of the treatment. After reviewing many studies, my interest has focused on two different gels: the Gellan gum and the Nanorestore Gel©. This paper will present the subject of my master thesis "L'utilisation de gel pour le nettoyage d'oeuvre graphique" (*The use of gel for the cleaning of paper artifacts*) at the Paris 1 Panthéon-Sorbonne university.

To begin, we will review the main characteristics we require in gels used for conservation of cultural heritage materials/objects. This will be followed by an examination of how these two gels answer our needs for paper conservation, including details about their properties and their use. Finally we will compare the two gels and see how they complement each other.

WHY USE A GEL?

The word "gel" is commonly used to describe many types of products. In general, we describe "gel" products as having a gel-like appearance, which is thick and sticky. From a chemical point of view, a gel is a polymer, which in small amounts, acts as a thickener liquid. But a gel-like material can be produced from various sources and can have different appearances and characteristics according to the compositions and proportions used.

Gels are used in the food and medical industries. For the conservation of cultural heritage, the gels used are most often an adaptation of these technologies, adjusted to meet the specific needs of the conservator.

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Liquid treatments are used for two main purposes, for the introduction of an element, (introduction of water for the purpose of humidification, or introduction of a chemical for de-acidification treatment) or for the extraction of an element, (acidic degradation products in the paper, yellowing, grime and dirt). A gel can be used as a poultice to achieve both of these objectives.

A poultice can be effective for many reasons when conducting treatments involving liquids. By containing the solvent, we can have a better control over the area treated. We can also have better control over the penetration and diffusion of the solvent into the material, by slowing its absorption. Finally, a poultice can limit the evaporation of the solvent. In doing so, a smaller amount of solvent can be used allowing a longer contact time between the solvent and the object/material. When used with a more toxic solvent, a poultice can lower the risks to a conservator's health.

The use of gel as a poultice material for conservation treatment was popularized in the 1980's. Initial characteristics are transparency, stability and versatility. Using a gel should make conservation treatment simpler and safer both for the artifact and conservator.

Some of the most common gels currently used in conservation are the cellulose ethers (Klucel©, methylcellulose), Carbopol©, Laponite©, and different polysaccharides like agar-agar and gellan gum. The final selection of a single material and the proportions used, are made based on the specific requirements for each treatment, the solvent used and the desired texture.

CHOOSING A GEL

For paper conservation treatment, some gel characteristics are more crucial than others. First of all, the solvent retention ability is very important, considering the high absorptivity of the paper surface. For a poultice to be effective, the affinity of the poultice material with the solvent must be greater than with the surface treated, to control the diffusion of the solvent inside the material.

Secondly, when using a gel, there is the possibility of leaving a residue, which may be limited by an additional rinsing step or by the use of an interleaving layer. These residues can be harmful for the artifact in the medium or long term. A poultice that limits the risk of residue is an appreciable advantage.

For the treatment of paper, we should add a high retention capacity and the absence of residues after treatment to the list of desired gel characteristics. These criteria are the basis for the evaluation of gels used in this paper.

The two gels chosen, gellan gum and Nanorestore Gel©, have both a very high retention ability. They also have a rigid form and a strong internal cohesion which allow their use on paper without leaving residues. These two gels, even though they appear similar, have very different compositions and characteristics. Gellan gum is a physical gel, acting as a thickener for the liquid it is added to. Nanorestore Gel©, on the other hand, is an artificial chemical gel, which acts as a sponge to contain a liquid solvent within its structure.

As previously mentioned, gellan gum is a polysaccharide, which forms a physical gel. In low concentration, it forms a rigid gel that can be cut and handled easily. The retention capacity is higher than other physicals gels. By controlling the proportion of the different components, we can easily modify this aspect. Gellan gum is compatible with aqueous solvents and is capable of being prepared using a small amount of alcohol. It can be used for humidification, removal of adhesives, the washing of paper and for some deacidification or bleaching treatments.

Nanorestore Gel© is a chemical gel, meaning that the chemical bonds between the macromolecules are strong, giving the gel a very high internal cohesion. The gel is very flexible and resistant to tears, to a certain extent. Three formulations of the gel are available, with variable retention abilities, all of which are higher than the gellan gum. The chemical gel performs like a sponge and can retain aqueous solvents, including micro-emulsions and micellar solutions of the Nanorestore© product line, but also can be used with pure organic polar solvents, such as ethanol. The very high retention ability allows for use of the gel in local treatment while limiting the risk of creating a tide-line.

GELLAN GUM

Gellan gum has become increasingly more popular since 2010, following various publications and workshops about the material. The recipe and treatment protocols used are those proposed by conservators S. Iannuccelli and S. Sotgiu in the article *Wet Treatment of Works of Art on Paper with Rigid Gellan Gels*[1]. With little adaptation, these protocols have proven to be quite effective.

Gellan gum is purchased in a powder form and is prepared in a water or water solution, in concentrations ranging from 2% to 5% weight / volume. The mixture is heated in a microwave until achieving complete dissolution of the gellan gum, which is then poured into a container with a flat bottom. When the temperature has decreased and the gel has set, it can be cut to the desired form and manipulated easily.

To wash paper using gellan gum, the smooth side of the gel is applied to the surface of the paper. An interleaving layer of Japanese tissue can be used to facilitate the manipulation of a fragile paper or an item with sensitive media. The paper object and the gel are placed between two sheets of clear polyester, with Plexiglas and a light weight on top to ensure an even contact between the paper and the gel. The transparency of the gel allows the conservator to visually assess the document during the treatment.

In a first stage, the paper will absorb water from the gel. Then, an exchange process will occur, and the solubilized products from the paper will be absorbed by the gel. This process is observable by the yellowing of the gel during treatment. The treatment can last from 20 to 60 minutes, and the treatment can be repeated with a clean gel, until there is no longer a yellow coloration present in the gel.

Gellan gum is also a useful tool for the removal of a lining. The gel poultice ensures a slow and controlled humidification, with the artifact placed face-up on the gel. When the adhesive has softened enough, the recto of the artifact can be placed face down against the gel, which will act as a water reserve during the gradual backing removal process, so the object won't dry out as quickly.

In the aforementioned article, the authors compared the amount of water released by two physical gels, gellan gum and agar. When analyzed, the percentage increase in the weight of the paper samples treated with Gellan gum, was much greater than those treated with Agar, indicating a greater retention ability in Gellan gum, though even after 18 hours of treatment with either of the two gels, the samples showed a much smaller weight increase when compared to samples treated by immersion.

NANORESTORE GEL©

Nanorestore Gel© has been developed by the members of the Nanoforart project, which is a collaboration of specialists from various disciplines and countries. The main objective of the project was the development of nano-materials for the conservation of cultural heritage including nano-structured cleaning fluids. The chemical gel has been developed as a carrier for those products. The resulting publication describes the different products and their use in various areas of conservation[2]. The cleaning liquids and gel are now available commercially from the company, CSGI, located in Italy.

Nanorestore Gel© is available in a pre-made sheet, with an approximate size of 7 x 10 cm or 10 x 15 cm. The gel is conditioned in a sealed bag with purified water and is ready to use. The water content in the pre-made gel can also be replaced by another liquid, such as the cleaning products from Nanorestore©, or by a polar solvent, by immersing the gel for a period of 12 hours. An exchange process occurs between the liquid contents in the gel and the liquid in which the gel is immersed.

Before application of the gel to an object, the two faces of the gel are placed on an absorbent paper to remove the excess solvent. The gel is also visually assessed to make sure there aren't any tears or defects visible such as small tears or air bubbles on the surface of the gel, which may contain additional solvent which could result in an uncontrolled spreading of the solvent during the treatment. Any damaged gel should be discarded.

Once the gel is placed on the surface of the paper, the first stage of the treatment is the humidification of the surface in contact with the gel, followed by an exchange process of the solvent. The solubilized products are then absorbed by the gel. The application can last from a couple of minutes to 30 minutes, and many successive applications can be made.

In another study by Bonelli and Baglioni[3], the three Nanorestore Gel© formulations were compared to Agar and Gellan gum in an examination of the amount of water released by the gels. The results showed that the three chemical gels released approximately half the amount of water compared to Gellan gum.

Nanorestore Gel© was used for the removal of aged adhesive residues from a document at the Bibliothèque et Archives nationales du Québec (BAnQ). The document treated was in 4 four pieces and had previously been repaired with pressure sensitive tapes. The aged rubber based tape had lost its adhesive properties, so the carrier had fallen off and the adhesive components had migrated into the paper, resulting in a strong brown discolouration and a loss in opacity of the paper. Residues on the surface were dry and shiny in appearance. In addition to being visually distracting, the deterioration of the adhesive had made the writing on the document more difficult to read.

The residues on the surface of the paper were first removed mechanically using a scalpel. To reduce the stain in the paper, many options were available, though the sensitivity of the ink and the presence of a wax seal reduced the treatment options. As a result, a localized treatment was required.

Nanorestore Gel© in ethanol proved capable of removing a significant amount of adhesive staining from this document. In this instance, the gel allowed the document to be treated locally, without leaving a residue on the paper or the creation of a tide-line.

After several tests, the more absorbent gel was selected(the Max dry© formulation). The initial duration of the application began at four minutes and was slowly increased to twenty minutes, until no further visible change was observable in the document or in the gel. The first few applications of the gel

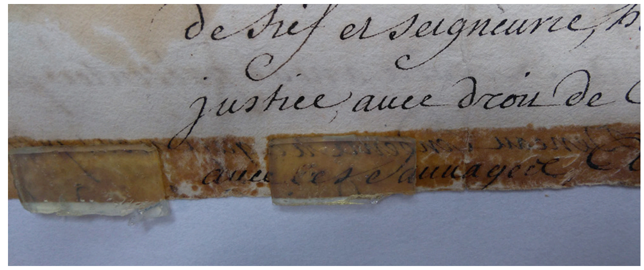

Fig. 1. Pressure sensitive adhesive stain before treatment.

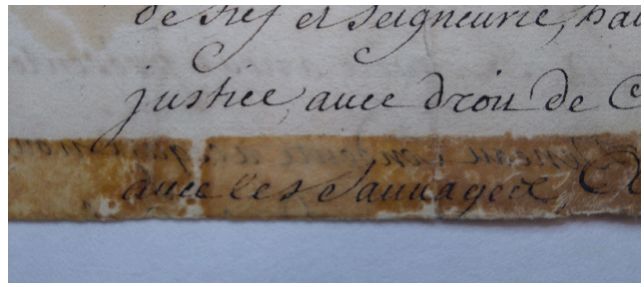

Fig. 2. Pressure sensitive adhesive stain after application of the gel.

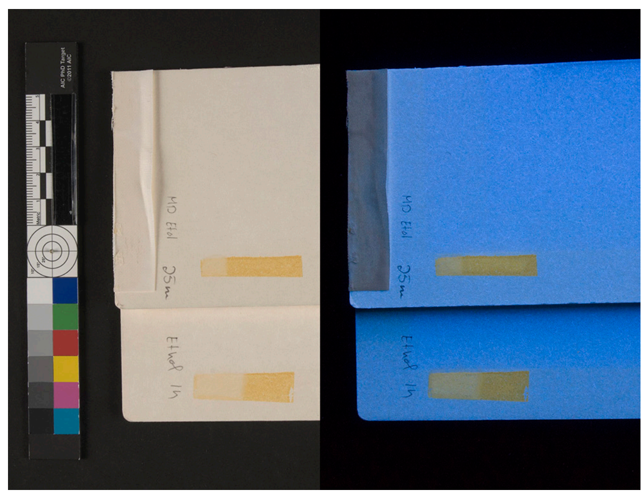

Fig. 3. Adhesive stain on mat-board sample treated with Nanorestore Gel@ in ethanol for 25 minutes and 60 minutes respectively, under natural light and UV light.

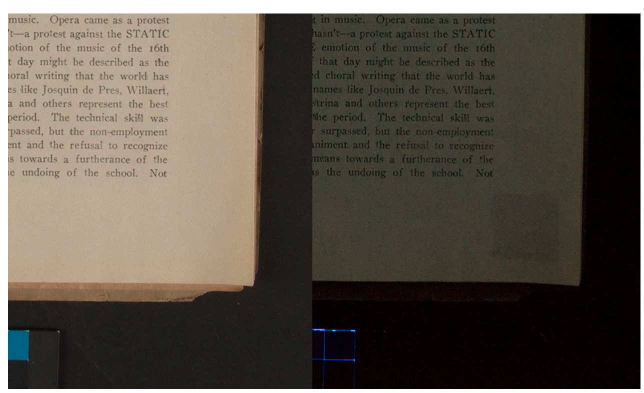

Fig. 4. No tide-line is visible under natural light or UV light after the application of Nanorestore Gel© on a 20th century paper.

Table 1. Comparison of Gellan gum and Nanorestore Gel©

Gel	Solvent compatibility	Retention	Utilization	Accessibility	Reusable	Cost price
Gellan gum	Water	High	Small to large surface	Good	No	Medium
Nanorestore Gel©	Water, polar organic solvents	Very high to excellent	Small surface, local treatment	Difficult	Yes (same solvent)	High

Table 1. Comparison table of the main characteristics of Gellan gum and Nanorestore Gel©.

were made on the recto, followed by applications alternating between the recto and the verso of the document. Between each application, the gel was re-immersed in clean solvent for 12 hours. The gel has the ability to be re-used many times, but with a decrease in absorption capacity. We can see in figure 1 and figure 2 which show the adhesive stains before and after treatment, that the discoloration of the stain is reduced and the opacity of the paper is increased, allowing the document to be read more easily and improved in its general appearance.

The very high absorption ability of the Nanorestore Gel© allows the local treatment of paper without the creation of a tide-line. The sample in figure 3 is a thick mat-board with pressure-sensitive adhesive tape residues. A square of the Nanorestore Gel© in ethanol, has been applied on the surface for 25 minutes and 1 hour respectively. Under natural light and UV light, we can see that the visual impact of the adhesive residues has been reduced. The solubilized products have not spread in the matboard and no tide line is visible.

Nanorestore Gel© also works with water. A square of Nanorestore Gel© loaded with water, was placed onto a 20th century paper for a few minutes, as illustrated in figure 4. While very little change was detected in normal light, the square piece of gel had removed some soluble components from the paper without creating a tide-line. Under UV light, the shape and placement of the gel is easily visible.

ANALYSIS

Table 1 compares some of the principal characteristics of the two gels. First, the Nanorestore Gel© is compatible with aqueous and polar organic solvents, allowing its use on some hydrophobic products. The exceptional retention ability of this gel allows it to be used for localized treatments and reduces the risk of creating a tide-line.

Gellan gum is however, more suitable for the treatment of medium to large surfaces, since the size and shape of the sheet can be produced to specification by the conservator, Nanorestore Gel© is only sold in limited sized sheets. The accessibility of the Nanorestore Gel© is still limited, and current research indicates that it's only available from the producer CSGI, based in Italy. Considering the cost of the gel and the shipping fees, it's a much more expensive option than Gellan Gum.

CONCLUSION

Gels are precious tools for conservation treatments, and are the subject of many current research projects and papers, as demonstrated by an upcoming conference on Gels in Conservation, to be held at the Tate in London in 2017.

We are continuously learning more and more about the properties and advantages of Gellan gum for the conservation of paper artifacts. With a more in-depth comprehension of the gel, methodologies are refined to be more stable and efficient. Nanorestore Gel©, on the other hand, is a new product on the market that still has to demonstrate its potential. Though this gel has been developed specifically for the cleaning of painted surfaces, the results obtained from the treatment of paper samples show a possibility of it being used as a complement to gellan gum treatments.

While compatible with polar solvents, the use of apolar solvents, such as xylene and acetone, is not recommended with the Nanorestore Gel©. Looking toward the future, we hope for the development of a similar gel that will be compatible with a wider range of polar and apolar organic solvents, allowing it to work more efficiently, for example, with aged adhesive stains on paper.

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Treatment of a Terrestrial Cary Globe

Over a two year period ending in 2013, the Canadian Conservation Institute (CCI) treated a pair of globes made in 1835 by John and William Cary who manufactured gloves in London UK in the late 18th and early 19th centuries. The globes were constructed from a papier mâché and plaster, supported internally at both poles by a wooden pillar. Each globe was suspended within a brass meridian ring with the ring mounted in a wooden floor stand with a horizon ring. This presentation focuses on treatment of the terrestrial glove that sustained damage during a fall from a window. Impact upon landing had forced the central pillar of the globe to move, pushing the sphere out at the North Pole and pulling it in at the South Pole. Extensive cracking, with losses of paper and plaster at both poles, had been repaired prior to the mid 1970's with a generous application of polyvinyl acetate adhesive. An area of plaster loss, where the papier mâché foundation was indented, had been filled with thick plaster. Some varnish removal had been attempted with unknown solvents, resulting in loss of color where cleaned and discoloration at each side, below the varnish. Following the mechanical and solvent removal of the discolored varnish (colophony) and old PVA adhesive, the large plaster fill was removed, allowed for the insertion of a small video camera to inspect the central wooden pillar and the interior surface of the globe. It was decided not to remove the paper gores, but to locally reduce staining and discoloration via poulticing. Conservator tested and used Gellan gum as a controlled means of cleaning specific areas.

In order to access and treat the cracks and losses to the plaster sphere, sections of the paper gores were lifted and rolled back. Distortions to the sphere were re-shaped as much as possible at the poles to create space between the sphere and meridian ring so the globe could move freely. Gore fragments were salvaged, treated and re-adhered to the globe. Losses to the paper gores were infilled with toned paper and digitally printed paper, inpainted, and then sized with multiple coats of gelatin. Six varnish resins were tested and the selected varnish of B-72 was applied via sprayer. Finally, reproduction hour dials, made from digital images of those from the celestial globe, were added to the terrestrial globe. The glove was re-assembled with the south point of the meridian ring placed at the North Pole in order to allow the still slightly distorted sphere to fit within it. A brass disc was placed at the base of the recess in the meridian ring that holds the south pivot to keep it as high as possible and create needed space between the glove and the meridian ring.

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Presented at the Book and Paper Group Session, AIC's 44rd Annual Meeting, May 13–17, 2016, Montreal, Canada

CRYSTAL MAITLAND

Learning to Conserve a Kashmiri Birch Bark Manuscript

INTRODUCTION

The AIC/CAC-ACCR Montreal 2016 meeting theme of "Confronting the Unexpected" can be explored not only in the context of disasters and emergencies, but additionally for the unexpected and unusual artifacts that sometimes cross conservators' benches. Such unusual case studies can then provide a lens for considering all of the data compilation, weighing of factors and thought processes that conservators make use of, almost subconsciously, in the decision making surrounding our more usual or "everyday" treatments: the myriad of decisions for both action and inaction that result in a treatment plan and execution.

Conservators are called by our codes of ethics to "practice within the limits of personal competence and education"[1] or are told that a "conservation professional shall recognize his or her limitations."[2] Yet we also acknowledge that each artifact is unique. As such, each treatment and examination is steadily broadening our experience, and thus increasing our limits. The question then becomes: how do we ethically expand our limits when faced with an artifact that asks for a large leap of skills or knowledge? Paper conservators usually have the luxury of really knowing our substrate (paper, primarily composed of cellulose, for which we have a relatively good understanding of degradation mechanisms, as well as historic methods of manufacture). While not the only departure from normative paper substrates, treating a birch bark substrate certainly represents something outside the "limits" of standard a paper conservator.

ENCOUNTERING THE ARTIFACT

The Special Collections of the Sheridan Libraries and Museums of Johns Hopkins University (JHU) in Baltimore, Maryland, houses a Kashmiri birch bark codex consisting of 176 leaves[3] of bark folded into nine signatures or folios (see figure 1.1). While there is evidence of former sewing, the manuscript, as examined in 2008, was unbound. Each signature was housed in archival paper folders (see figure 1.2), stacked in a card-stock four flap enclosure, inside a wooden, cloth, leather, felt and elephant paper Solander box (see figure 1.3). The media employed in the manuscript for text and diagrams is black (likely carbon) ink, which tests as insoluble in water or alcohols. A note in the Solander box stated "Birch bark MSS. From Kashmir in the Indian character called Carada [=Śāradā]. Being a ritual text of the Vedic School of the Kathas." This note dates to early 1990's, left by a researcher who expressed great interest in the contents of the manuscript; the poor condition of the manuscript at that time, however, permitted examination only of the outside of each folio.[4] The Libraries' book conservators performed some tests for treatment at this time, but were uncertain about the best treatment plan. The manuscript was set aside due to other competing priorities.

Having recently hired a paper conservator to join the conservation team, the Conservation lab was asked by the head of Special Collections to reconsider a treatment proposal in 2008. Treatment investigations began, as they often do, with a literature review to inform the writing of a condition report. Results showed that while there are a number of articles on the treatment of birch bark manuscripts (Agrawal, Gupta, and Suryavanshi 1984; Agrawal 2010; Filliozat 1947; Gilberg and Grant 1986; Gilroy 2008; Gupta and Singh 2004; Krueger 2008; Majumdar 2000; Majumdar 1957; Mikolaychuk 2005; Shah 1993; Suryawanshi 1985; Suryawanshi 2006; Suryawanshi 2000), birch bark artifacts of other forms (Anastassiades 2001; Gilberg 1986; Mason 2001), and other similar plant-based artifacts (Wright 2001; Ward et al. 1996; Teygeler and Porck 1995; Nichols 2004; Florian, Kronkright, and Norton 1990; de Poulpiquet 2012), few recommended a treatment plan that fit the JHU manuscript. Most of the manuscript artifacts addressed were treated as single sheet manuscripts or scrolls, where rigid housing could be used to permit a minimal intervention approach to any repair or stabilization of the manuscript leaves. The nested folio structure

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Fig. 1. (1) Folio 1, showing verso of detached leaf and recto of first attached leaf in the signature; (2) Stack of nine folders, housing nine folios of the birch bark manuscript; (3) Solander box housing, showing storage of the nine folios as they entered the lab in 2008.

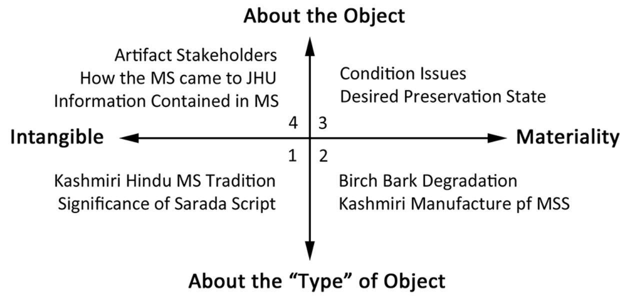

Fig. 2. Appelbaum's (2007) characterization quadrants, as used to collect information relevant to the treatment of the birch bark manuscript.

of the JHU manuscript would not permit this sort of housing. The three dimensional artifacts of the literature rarely had to flex or move after treatment (beyond come expansion in changing relative humidity), whereas the pages of the JHU manuscript needed to be able to turn. The unknown contents and history of the manuscript also proved a troubling concern: any treatment proposal seemed very one-dimensional without knowledge of what the manuscript was, how it had come to be at JHU and what stakeholders there might be in its conservation.

DEVELOPING A TREATMENT PLAN

In the last several decades, as the conservation profession continues to mature, a number of "conservation treatises" have been published that distil not only what we do in the course of treatment, but guide our collective thinking around why we make decisions in the way that we do. Clavir (2002) exhorts us to consider the values of the originators of objects. While her work was aimed particularly at First Nations artifacts, the thinking is also applicable for a Western caretaker of a religious artifact of Hindu origin. Muñoz-Viñas (2005) takes apart classical theories and then reconstructs a contemporary the theory of how we justify performing conservation treatments on cultural heritage materials. His work is useful in determining whether treatment indeed made sense in this case. Finally, Appelbaum (2007) provides a systematic framework in which to build our treatment plans. Indeed, all of the many different types of information used to build both the conservator's knowledge and a working treatment proposal for this birch bark artifact can be placed within the quadrants of Appelbaum's proposed characterization grid (see Figure 2). It is these four categories of information that guided the holistic treatment of this artifact: both the tangible and intangible history of the object, coupled with information on the broad class of Kashmiri birch bark manuscripts and on the minutia of this particular manuscript. It is these four categories of information that give the conservator confidence to treat an unfamiliar material.

BIRCH BARK AS A MANUSCRIPT SUBSTRATE IN KASHMIR

To address the first quadrant of figure 2, combining intangible information about the type of artifact, we seek information regarding the Hindu Kashmiri manuscript tradition. As geography figures largely into the use of birch bark as a manuscript substrate, we must specify that Kashmir will be used in the sense of the historic Kashmir Valley.[5] This is a small, isolated valley approximately 135km long and 32km wide located in the Himalayas, in the northern part of modern-day India.

The religious tenant of Ahisma (non-violence) shared by several Eastern religions means that while livestock was available in the valley (consider the Cashmere wool from fine-haired Himalayan goats), Hindu religious texts were unlikely to be recorded on an animal-based substrate (such as the parchment or vellum found in other manuscript traditions) (Wujastyk 2014). Prior to the introduction of papermaking in a given region, the use of plant-based manuscript substrates is dictated by availability: papyrus along the Nile and along the Mediterranean or palm leaf in the warm regions South East Asia. For the Kashmir valley, with its location in the Pir Pahjal Range of the Inner Himalayas, it is access to abundant amounts of the *Betula utilis*, or Himalayan birch growing at elevations of up to 14,800 feet according to Wikipedia that gave rise to a readily available manuscript substrate (Bühler, 1877).

Geography also plays a role in the writing system employed in the manuscript. Sanskrit, while also used for wide-ranging subjects such as philosophy, poetry, drama, and technical treatises in India and the surrounding area, is also the primary sacred language of Hinduism. The 1990's researcher identified the JHU manuscript as specifically being Sanskrit written in the Śāradā (or Sharada) script. This distinction is necessary because most written Sanskrit is found in the Devanāgarī script. Both Devanāgarī and Sharada are also used to write languages other than Sanskrit. Both writing systems are alphasyllabary and share a common historic root in the Brahmi script, but Sharada is the earlier, more conservative of the two. In a simplistic explanation, the scripts of the rest of the Indian sub-continent continued to morph and change to suit the other languages they were used to write, while the isolation of the Kashmiri Valley maintained the use of the earlier, previously more widespread, Sharada script in writing both Kashmiri and the Sanskrit used in sacred texts (Bhat, N.D.).

The practical ramifications for JHU manuscript are that many readers of Sanskrit will be unable to read this particular manuscript due to its less commonly used script. The close association of the use of Sharada script with a specific geography also permits clear identification of the manuscript as Kashmiri. Present day Sharada use/readership is very rare, with the exception of ceremonial use by the Kashmiri Pandit community. Persecution of this community in Kashmir in the late 1980's and early 1990's, notably including an ethnic cleanse of Hindus and Sikhs in the Valley on January 19, 1990,[6] caused an exodus of this community from Kashmir. This diaspora decreased the already limited transmission of the knowledge of Sharada to future generations. Kaw (2004) notes that today "there are but a handful of elderly Kashmiri Pandits that include few of their most eminent scholars who can read and write in Sharada script". The potential readers of the manuscript are therefore likely decreasing; if the manuscript were to be made available through conservation, this action arguably should happen sooner, rather than later.

MATERIALITY OF BIRCH BARK

Moving to the second quadrant of figure 2, still in the broad class of artifacts, but dealing with the tangible, we find ourselves concerned with the materiality of bark, as well as its degradation. Tree bark is comprised of the non-xylem (non-woody) tissues: the outer-most layers of cells. These layers consists of a number cell types, which broadly include the inner bark (secondary phloem), a living tissue serving primarily a vascular function for the tree in the transportation of nutrients, a middle layer called the cork cambium (phellogen), a consisting of cells capable of division to continually form the other bark layers as the diameter of the tree increases, and finally the outer bark (cork or phellem), a layer of dead tissue that performs primarily protective functions (Chang, 1954, Tsoumis 1991). The protective functions of the outer bark insulate the tree against mechanical damage, penetration of fungi and bacteria, as well as excess moisture evaporation during changes in relative humidity or temperature (Mikolaychuk 2005).

Paper conservators have some familiarity with inner bark in the form of paper making bast fibers: kozo, linen and hemp, for example are inner bark fibers. Inner bark is also used to produce bark cloth, where the fibrous bast is beaten into sheets (Wright, 2001). Birch bark manuscripts and artifacts are however made of the outer bark, specifically the inner layers of the outer bark; the weathered outermost outer bark layer is removed after harvesting.

The outer bark of birch trees in particular has an interesting structure: it forms in a manner similar to the "growth rings" of the xylem with a differentiation between early and late seasonal growth. This differentiation creates the laminar structure of the outer bark, with weak point between early and late growth. This laminate nature permits the relatively easy harvesting of the bark. Coupled with fact that the outer bark is dead tissue, harvesting occurs without killing the tree (Florian et al. 1990); birch bark therefore sees relatively frequent use as a cultural heritage material.

As mentioned above, in a single growth season early and late growth cork cells are differentiable: early thinner-walled early cells light colored and rich in betulin, thicker-walled late cells are darker in color and rich in tannins and suberin (Orsini et al. 2005). Betulin, when extracted, is a white, powdery triterpene that seems to serve an anti-fungal purpose. The extraction of betulin and numerous other triterpene compounds from birch bark has been carefully studied, as they are of much interest to the pharmaceutical industry for its anti-inflammatory and anti-viral possibilities (Abyshev et al. 2007; Chari et al. 1968; Jensen 1949). Salts of salicylic acid have also been reported, theorized to have an anti-insecticide property (Bhargava 1967). Tannins, dark red-brown in color, are antioixidants that are theorized to slow the biodeterioration of bark (Vane, et al. 2006). Suberin is a waxy, non-structural polymer composed of unsaturated fatty acids, which provides the bark with waterproofing properties (Florian et al. 1990). All of these substances have treatment ramifications, as tannins are noted as being water and alcohol soluble, while suberin, waxes and betulin and other triterpenes are soluble in organic solvents such as alcohols, ethers, aromatics and chlorinated solvents (Jensen 1949; Jensen 1971; Florian et al. 1990; Abyshev et al. 2007; Agrawal et al.1984).

The final defining characteristic of birch bark anatomy that is taken as relevant to conservation treatment is the contrast between the bark proper and the dark brown horizontal nodes, or lenticels. These lenticels provide a location for gas exchange and transpiration. The nodes also serve as a weak physical attachment point between the layers of bark, along with the various materials that cement the cells together: gums, pectin, and triterpene resins. Characterized by large intercellular spaces, the lenticels are both physically and chemically very different from the rest of the bark proper. All bark is noted to have lower proportions of cellulose and hemicellulose than wood (Tsoumis 1991), but nodes contain even less of these familiar (to paper conservators) structural substances—as such they are much more brittle. Suryawanshi (2006) finds that birch bark proper contains 12%(w/w) cellulose (of a degree of polymerization between 250-500), while the lenticels showed negligible amounts of cellulose. Lignin levels in the bark were recorded as 18%(w/w) in the bark, with 4%(w/w) in the nodes.

The consequences of this materiality for conservation are that birch bark is remarkably resistant to both fungal and insect damage, due in large part to the properties of betulin. Structurally, however, the laminate does not fair well. Becoming embrittled with time, not only does the adhesion between layers decline as the natural gums and resins desiccate, but the individual layers become less able to flex. Moisture loss and differential response of early and late cells to relative humidity changes encourages curling, and delamination, and the nodes, with less flexibility to begin with, become a fracture point. The final point of note is that if the degree of polymerization of the cellulose found in the bark proper is only 250-500, and if there is only 12%(w/w) cellulose to begin with, a paper conservator cannot rest on their knowledge of how a paper-based cellulosic responds to form a treatment plan for birch bark.

EVIDENCE OF MANUFACTURE

To complete the second quadrant of figure 2, we additionally seek information about how this sort of manuscript was made. Very little information has been recorded about the specific procedures used to harvest and process birch bark in Kashmir for the purposes of manuscript preparation. Most authors cite Al-Biruni's 11th century "History of India", an Arabic written based on his 1017 travels to the region: "They take a piece (of bark) one yard long and as broad as outstretched fingers of the hand […] and prepare it in various ways. They oil and polish it so as to make it hard and smooth and then they write on it."(Agrawal and Bhatia 1981). Agrawal (2010) further describes the technique: "The outer bark after peeling off the tree is discarded and the inner bark, which also peels off easily, is almost paper thin, very supple and flexible. It was first of all dried in the shade; an oil was applied over it and then polished with a smooth and hard stone like agate. It was then cut to the required size and written upon with pen and ink." Authors frequently cite Bühler's late 19th century report to the Royal Asiatic Society, where he describes half a dozen or more leaves as being folded and sewn together, stored between rough leather or two rough wooden boards (Witzel 1994; Kaw 2004; Suryawanshi 2000). In this report, Bühler notes that by the time of his visit, paper had superseded birch bark as the primary manuscript substrate "…and the method of preparing [birch bark] has been lost. It is at present impossible for the Kaśmîrians to produce new birch-bark MSS….As matters now stand, there are no birch-bark MSS. much younger than two hundred years"(Buhler 1877).

Examining the JHU manuscript closely held some further clues regarding manufacture. While no direct visual evidence was found for the oil mentioned by the references above, or particularly for the burnishing techniques described, other conclusions could be drawn. For instance, the folded bark leaves appear to be a mixture of natural laminates (layers that grew together on the tree in the order in which they appear in the manuscript) and artificial laminates (layers that were trimmed separately and have been adhered together with mechanical action and the possible addition of an adhesive). The evidence for the former is found in the matching pattern of lenticels on some adjacent layers (see figure 3), while the evidence for the latter is found in a mismatch of knife trimmed edges, misaligned lenticel patterns, and evidence of pounding-type tooling marks visible in raking light (see figures 4 and 5). Some of the thinner artificial laminates exhibited a wrinkled, reticulated pattern that could indicate some sort of differential shrinking due to application of an aqueous adhesive used in lamination; this is a tentative hypothesis, as no analysis was completed to confirm the presence of an additional adhesive (see figures 4.1 and 5.2).

Further tooling marks show that each folio was folded a full 180 degrees in four places, pounded with some sort of rounded tool, and then unfolded and flattened again. These four folds served to create ruling lines that bracket the text, to guide the scribes in creating straight columns of text of uniform width (see figure 6). These folds also indicate that the bark was once much more supple than it is at present.

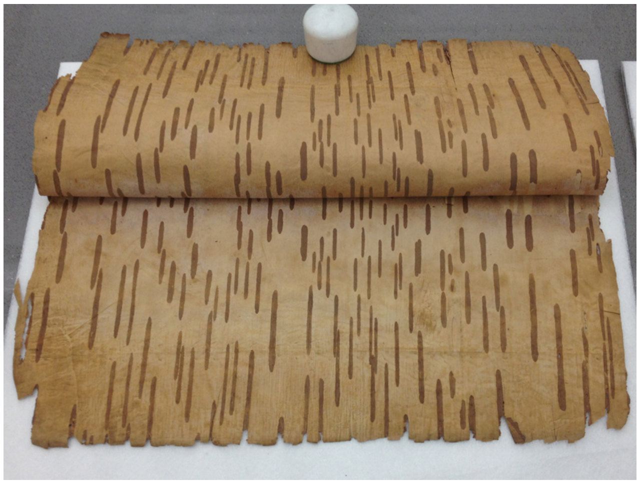

Fig. 3. Matching lenticel patterns between layers of bark, indicating these layers comprise a natural laminate.

Fig. 4. (1) Mismatched lenticels, cockling of one layer that could indicate wet adhesive use, and (2) inconsistent margin trimming of layers; evidence indicates that some laminates were constructed.

Fig. 5. Tool marks found on manuscript pages: (1) local hatch marks over a bark flaw, (2) small hatch marks to secure an area in the middle of reticulation patterns possibly indicating wet adhesive application to join layer, (3) cross-hatching in an even, fairly regular pattern overall on a leaf, and (4) more irregular cross hatching over a locally over a wide bark flaw.

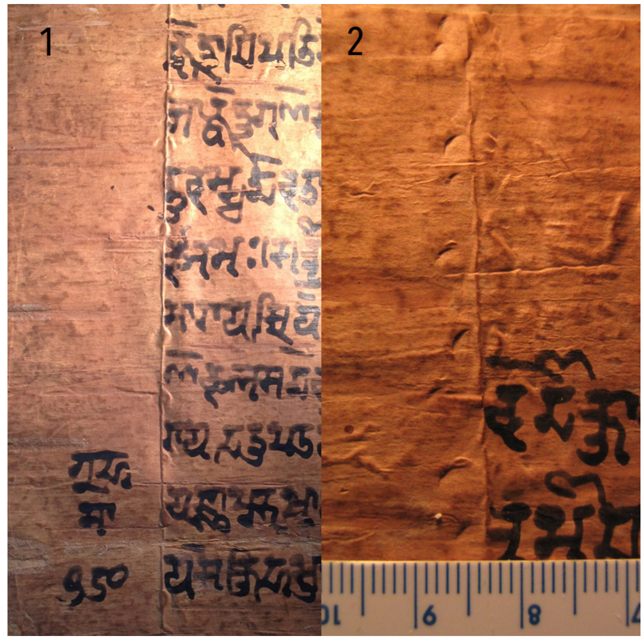

Fig. 6. (1) Ruling line verso viewed in raking light with (2) a closer detail of the recto showing rounded tool indentations and a sharp fold line. The ruler is a centimeter scale, subdivided into millimeters.

ARTIFACT CONDITION

We now move to fill in data for quadrant three of figure 2: we examine the specific physical object, its condition, and seek to determine a course of treatment to guide it toward a determined desired state of preservation. This quadrant is perhaps that most traditionally associated with the work of conservation, as its data is generally contained within a standard condition report and treatment proposal.

The manuscript as it entered the conservation lab suffered from a number of condition issues. To aid in project planning, a spreadsheet was used to track the condition of each leaf and permit extrapolations of treatment times; the overall condition issues and the number of sheets affected by each are summarized in the table below. Each bark laminate ranged from three to seven layers; most pages consisted of five layers of bark. Overall handling the manuscript was very difficult in its initial condition: curling at the edges coupled with running horizontal tears and delamination of bark layers made it non-trivial to ascertain where the layers of one page stopped and the next began. The bark, while still surprisingly supple (draping beautifully as pages were turned (see figure 7.1)), was locally very brittle. Small fragments detached easily, and over the course of the manuscript's history, friction between the nested leaves and the adjacent folios (as well as between the folios and their archival paper storage folders) had resulted in both small and quite extensive delaminations of the top, text-carrying layer of the bark. The fact that the bark had

Condition issue	Description	# of pages affected	Relevant image(s)
Delamination of bark layers	Layers of the (natural or artificial) bark laminate were in some places almost completely detached; more often local areas of detachment were found adjacent to other areas that were still firmly attached.	57 major; 28 medium; all 176 with perimeter delamination	See figures 7.1, 7.2
Splitting, cracking or tearing	The bark is anisotropic, tearing primarily in the horizontal direction. Splits may run through one, several, or all of the bark layers of a leaf. Often complex "shelves" of tears occur: the split in one layer is displaced several millimeters from that in the next layer. Fragmented nodes can be a starting point for splits.	65 with major splits; all 176 with minor splits	See figures 7.2, 7.4
Surface dirt and efflorescence	Dirt, dust and caked on mud (particularly at head and tail) or waxy efflorescence (likely betulin or suberin that migrated to the bark surface over time) presented the surface cleaning questions.	19 cases of waxy efflorescence; surface dirt on all 176	See figure 7.3
Complete detachment along spine fold	The spine fold was often weak and partially broken at head and tail, but in most cases remained intact in the inner parts of a signature. The outer leaves in any folio were the most damaged; several detached leaves accompanied each folio.	19 completely detached leaves; 3 were also torn into several pieces	See figure 7.4
Curling of bark	Most curling was located around the edges, particularly the fore-edge. Often coupled with splitting and delamination. Layers of one page could be curled around those of the next.	All 176 to varying degrees	See figures 7.7, 7.8, 7.9
Loss of text layers	Delamination of the top text-carrying layer was observed in both natural (figure 7.5) and artificial laminates (figure 7.6).	29 major text losses; many minor losses	See figures 7.5, 7.6, 7.7

Table 1. Condition issues affecting the birch bark manuscript prior to treatment.

Fig. 7. Before treatment condition Issues: (1, 2, 5, 6) full and partial delamination of layers; (3) surface dirt and waxy surface efflorescence (3); horizontal splits through (2) single layers and (4) through entire leaves; loss of text due to delamination of (5) a natural laminate and (6) an artificial laminate; partial curling of edges at the (7) spine, (8) fore-edge, and (9) entangling multiple leaves of bark together (9); former bark suppleness indicated by (10) a hard fold in localized area.

been much more supple prior to aging was evidenced in the fact that some full folds were found in the manuscript (figure 7.10); the bark could not presently stand for even a 60 degree angle without breaking. Indeed, small fragments were easily accidentally broken from the bark edges with only the slightest flexing or handling.

CASE FOR CONSERVATION

To inform the decision to perform a time-intensive conservation treatment, we now move onto the fourth and final quadrant of information for figure 2: the intangible side of this specific manuscript. Under consideration are the more curatorial aspects of this manuscript. How did the manuscript come to be at JHU in the first place? What value does the manuscript hold? What sort of information does it contain, and who are its present stakeholders (in addition to the Kashmiri Pandits discussed above)?

The manuscript's presence at JHU can be traced back to Dr. William Stratton. Stratton received his PhD studying Sanskrit and Comparative Philology at JHU in 1985, studying under renowned philologist, and then-Chair of Sanskrit Literature, Maurice Bloomfield. Stratton then moved to Lahore to become Principal of the Oriental College there, as well as Registrar to the Punjab Museum in 1899; during this time, he toured Kashmir, presumably acquiring the manuscript. He unfortunately contracted "Malta fever" shortly after moving to India, dying in 1902 (Bloomfield 1902). Upon his death, his widow left his papers, including the birch bark manuscript, as well as several other Sanskrit manuscripts on paper, to the JHU libraries.

During his 1990's manuscript survey, Dr. Christopher Minkowski identified the artifact as being a genre of manuscripts called rcaka or the "text that has verses in it." In Dr. Minkowski's words such a manuscript "usually begins with passages copied from the […] Vedas, but then proceeds with a collection of various ritual manuals. Each [manuscript] is different, because each one is prepared by a Kashmiri pandit/priest for his own use. Therefore various things may be copied into it that are not preserved elsewhere, and it cannot be predicted all that will be found in any individual [manuscript]." After noting that it is rare to find in an American collection, Dr. Minkowski stated that the manuscript seemed to contain some rather unusual and interesting ritual practices (Minkowski, 1996). Dr. Minkowski examined the outside of each signature only, but was unable to find a colophon. He dated the manuscript as 18th century or earlier, as this was the latest date that he knew of such manuscripts on birch bark being produced (Minkowski, 1999).

Dr. Alexis Sanderson of the Oriental Institute at All Souls College, Oxford examined digital images of some of the manuscript and further identified the manuscript as "'A Guide to the Rituals of the Kashmirian [Brahmins]'. In such texts we find the procedures for and Mantras to be recited in the various rituals that are performed by Kashmirian priests for the families they serve." Sanderson viewed several early pages of the before treatment documentation images of the manuscript, digitized and among other observations stated that "the manuscript seems to me to be likely to reward close study, being rather older than most that I have seen" (Sanderson, 2013).

Acknowledging that the manuscript was likely to contain unique information, that the constituents who could read the script in the manuscript were unlikely to be getting larger (both within the Kashmiri Pandit community (see the discussion of the Sharada script, above), and within the scholarly academy)[7] and that the stakeholders in the manuscript were unlikely to be geographically located near Baltimore, MD, the logical conservation path was deemed to be stabilization of the manuscript sufficiently to permit access to the manuscript through digitization. "Sufficiently" in this case was to include surface cleaning, stabilization of layers (including uncurling the edges, re-adhering delaminations and repairing splits and tears), and rehousing in a manner to prevent further future loss of text layers due to friction either between the manuscript pages or with the housing materials.

TREATMENT STEPS

Only several of the treatment steps (surface cleaning and uncurling bark edges), will be discussed in depth in this article. Adhesive and repair material choice will be touched on more globally. Together, these treatment "vignettes" will be used to illustrate the process by which treatment decisions were made.

For surface cleaning, the literature indicated that organic solvents could not be brought in contact with the bark, due to the possible extraction of up to 20%(w/w) of bark components, causing color changes as well. Likewise, hot water could leach from 1-4%(w/w) of bark extractives; alkalis and acids similarly need to be avoided (Agrawal 1984; Agrawal and Suryawanshi 1987; Anastassiades 2001). Cold water, however, was demonstrated in the same studies to have little to no solvent effect on any bark components, though one author (Yamuachi 2009) did note some removal of color with water; in the case in question it was theorized to be a colorant added to the bark (orpiment). Monitoring test cleaning of the JHU manuscript under the microscope, natural rubber sponges (Absorene® soot sponges) and DI-water moistened cotton swabs proved viable methods to removed caked on dirt and mud and to reduce the waxy surface efflorescence without altering the bark surface (see figure 8). Purchased sterile cotton swabs proved more cohesive and less likely to catch on brittle bark fragments than self-rolled swabs. It was established that the surface efflorescence was an original bark material, however, its surface deposition was deemed to decrease the contrast of the text sufficiently to warrant some reduction prior to digitization.

When the conservation labs looked at treating the JHU manuscript in the 1990's, one leaf was humidified with water vapor. At the time, they found that any relaxation of the bark was insufficient to flatten the curled edges. By 2008, the treated leaf was more completely delaminated around the edges than the majority of the other leaves. As such, relaxing the curled bark relied heavily on the work investigating the use of solvent fumes to plasticize bark (Gilberg 1986; Gilberg and Grant 1986). Methanol was shown to be the most promising solvent in this work, but as the research to date had primarily been performed on a North American species of birch, and due to the greater toxicity of methanol, simple in-lab trials were used to compare ethanol and methanol vapors.

Using a compound microscope with a motorized stage and an integrated digital camera, it was possible to secure a

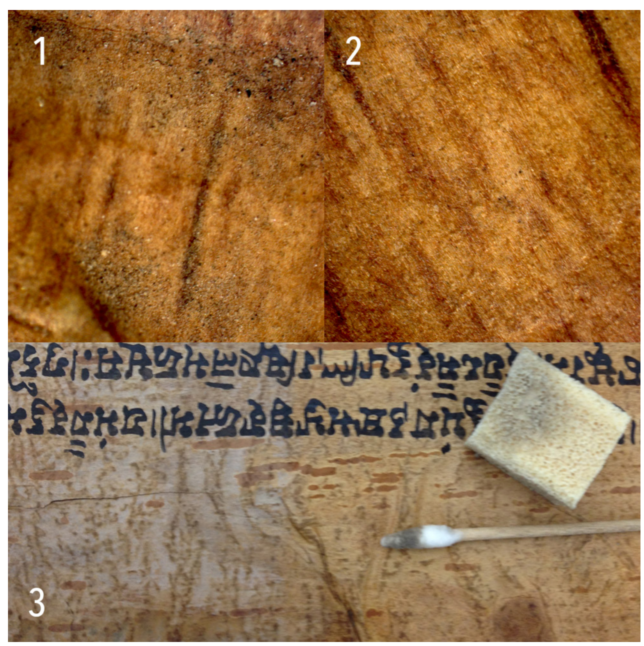

Fig. 8. 100X magnification (1) before and (2) after cleaning with a DI water-dampened swab. (3) An area of waxy surface efflorescence and light grime, shown before (left) and after (right) cleaning with a smoke sponge and a damp cotton swab.

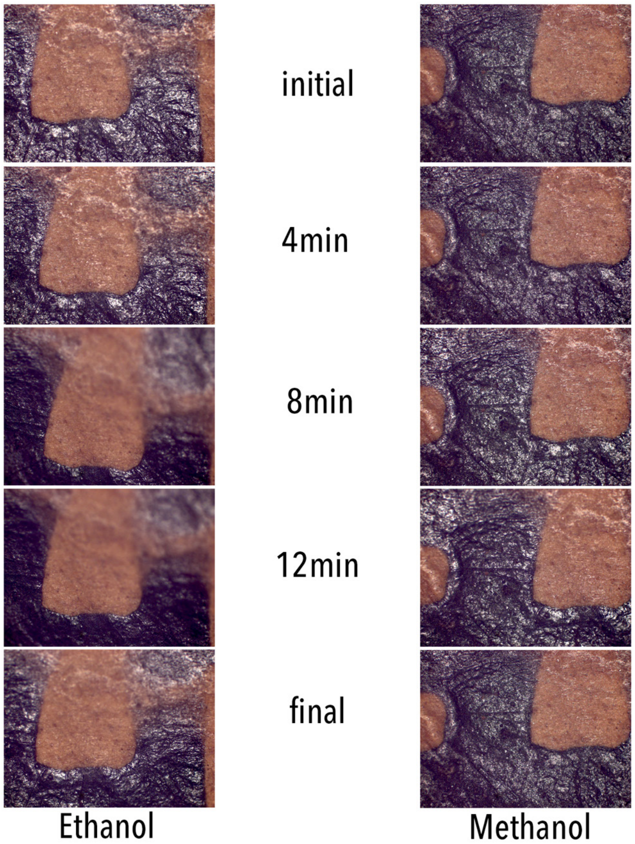

Fig. 9. Solvent vapor tests, under 50X magnification with timed exposure to ethanol (left column) and methanol (right column) solvent vapors. The initial image is recorded before any solvent vapor is applied; the final image is recorded after several minute of evaporation. More movement of bark components is visible with the ethanol vapor.

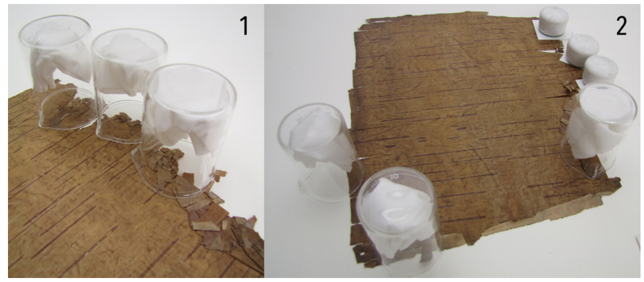

Fig. 10. (1) Solvent chambers made of inverted beakers with lightly methanol-dampened tek-wipe wadded inside and (2) the light weights and blotters used to plasticize and re-align bark layers while the solvent chambers worked elsewhere on the leaf. Full alignment often required multiple solvent vapor applications.

Fig. 11. Bark before and after realignment by methanol vapor plasticization: (1) effective through many layers with multiple application of vapor, and (2) useful on very fragmentary pieces of bark.

bark sample to the stage, record an image at 50X magnification, drop the stage and expose the sample to a solvent vapor for a set period of time and then raise the stage to exactly the same location to record another image. In such a manner, two bark fragments containing ink lines were imaged after exposure in four-minute intervals to a cumulative twelve minutes of either ethanol or methanol vapor. The final image was recorded after an additional twelve minutes of wait time, to allow most, if not all of the solvent to evaporate from the bark. More perceptible change in the surface, including possible re-deposition of a waxy surface efflorescence, was visible with the ethanol-exposed sample than the methanol-exposed sample (see figure 9).

A system of small inverted beakers with wadded absorbent materials (cotton or tekwipe) lightly dampened with methanol kept solvents use to a minimum. After plasticization, very light weight over blotters kept the bark in its new alignment (see figure 10). The same area of bark could be exposed to solvents several times in order to slowly align all of the individual layers. The plasticization was effective even on very small, brittle-looking areas of bark (see figure 11).

Adhesive and repair material choice presented another interesting challenge. The literature speaks of cellulose ethers (Agrawal 2010; Anastassiades 2001; Shah 1993; Gilroy 2008; Yamuachi 2009; Suryawanshi 2000), starch pastes (Nichols 2004; Teygeler and Porck 1995; Majumdar 2000; Anastassiades 2001; Agrawal and Suryawanshi 1987), or combinations of the two (Ubbink 2011; Nichols 2004). Other authors have tried animal glues, gelatin or isinglass (Bentchev 2003; Agrawal and Suryawanshi 1987; Anastassiades 2001) or have experimented with synthetic adhesives (Anastassiades 2001; Agrawal and Suryawanshi 1987; Bentchev 2003; Gilberg and Grant 1986). In the case of the JHU manuscript, sensitivity to Hindu nature of the manuscript precludes use of animal-based adhesives, and synthetic adhesives seemed likely to be far too strong and tacky. Both methyl cellulose (A4M, 1%) and mixtures of wheat starch paste and methyl cellulose (1:1) seemed to perform well. However, in the end the author's greater familiarity with the working properties of wheat starch paste, as well as its great versatility at different concentrations seemed to produce the best and most consistent repair results. Very dilute paste worked well for re-laminating separated layers; slightly more concentrated paste served for local repairs with various Kozo fibred Japanese papers. The matte quality of paste also served the project well. The choice of a single adhesive, rather than switching between methyl cellulose and paste for different types of repairs, also worked best for consistency in treatment when two project conservators, Vania Assis and Cristina Morilla, began also working on the manuscript.[8]

CONCLUSIONS

There is nothing particularly unique about the approach taken to treat this manuscript. Each treatment requires the conservator to fill in many of the spaces in a mental grid like the one found in figure 2; we often just fill in the data without explicitly contemplating each component. Information from literature surveys, conversations with colleagues in either conservation and in allied professions (curators, scholars or researchers, industry etc.), examinations of the construction and condition of the artifact in question, and testing of treatment options directly allows conservators to map a course of treatment (or non-treatment) appropriate to the artifact at hand. As such, we are constantly expanding our limits: often it is just a bit at a time, with artifacts close to our comfort zones. Then, every so often in the course of a career, we confront the unexpected: we stretch our capacities, and take on an unusual artifact or problem that not only broadens our limits, but causes reflection on how and why we do what we do.

ACKNOWLEDGEMENTS

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NOTES

1. This is the fourth item in the 1994 AIC list of "principles that guide conservation professionals and others who are involved in the care of cultural property", which goes on to conclude "as well as within the limits of the available facilities". http://www.conservation-us.org/docs/default-source/governance/code-of-ethics-and-guidelines-for-practice.pdf?sfvrsn=7 (accessed June 17, 2016)
2. This is the fifth principle of ethical behavior listed in the third edition of the CAC/CAPC code of ethics, 2000 (reprinted 2009). https://www.cac-accr.ca/files/pdf/ecode.pdf (accessed June 17, 2016)
3. Note that the term "leaves" is used throughout this article in the anatomy of a book sense (each leaf of a book is two pages, a recto and verso), rather than in a plant biology sense.
4. Professor Christopher Minkowski, then of Cornell University, now the Boden Professor of Sanskrit at Balliol College of Oxford University, performed a survey of Sanskrit manuscripts in several University Library Collections in the United States.
5. As opposed to the modern administrative division of the same name inside the Indian state of Jammu and Kashmir.
6. The history of people groups in the Kashmiri valley is very complex and still very politically fraught (as are the modern borders of Kashmir). Some further insights can be gained into the referenced events by reading the various articles linked through the "Kashmiri Pandit" Wikipedia article, but to fully examine the nuance of this subject is beyond the scope of this paper. https://en.wikipedia.org/wiki/Kashmiri_Pandit (accessed June 27, 2016)
7. Scholarship of area of Indology is not as wide spread as during the 19th and early 20th century; for instance, there is no longer a Chair of Sanskrit Literature at JHU, a position that was quite renowned. The author was quite encouraged to see, however, while preparing for the talk on which this paper is based, that there has been resurgence in interest inside India in reviving Sharada. A New Delhi-based NGO (Millennium India Education Foundation) is partnering with the Special Centre for Sanskrit Studies, Jawaharlal Nehru University to continue education of the script. See "Reviving the dying Kashmiri script" http://www.dawn.com/news/1205725 (accessed June 28, 2016)
8. Funding was secured to bring in two project conservators. Vania Assis and Cristina Morilla worked intensively on the project for several months, each treating close to a third of the manuscript pages. Their contribution was invaluable as each brought treatment knowledge of palm leaf, papyrus or tapa bark cloth materials.

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The Challenge of Scale: Treatment of 160 Illuminated Manuscripts for Exhibition

ABSTRACT

The senior conservators at the Weissman Preservation Center at Harvard University routinely establish protocols for the treatment of large collections and projects. These protocols are designed to integrate expert skills and techniques, quality control, and an efficient workflow. This paper highlights the principles for the consolidation of flaking and friable media that was used to prepare 160 illuminated manuscripts for exhibition. This protocol is rigorous and includes procedures to evaluate, treat, and document the consolidation of the manuscripts.

The protocol ensures uniformity in treatment procedures and judgment. Consensus is an essential component on large projects involving many conservators. We have learned that the degree of uniformity and treatment quality is substantially greater when multiple conservators collectively agree and follow the same guiding principles. This approach goes beyond procedural processes—it aligns decision-making and judgment.

The result of having all conservators follow the same protocol gives the appearance that one person treated the entire collection. Best practices are achieved through collective and collaborative understanding. The process of developing the protocol requires extensive discussion, being open-minded, sharing observations and suppressing ego. A team approach (of two or more people) is essential to help ensure the development, refinement, and execution of best standards of practice. By sharing the workload, large quantities of high-quality work can be performed throughout the entire project without burnout and in a reasonable time frame.

INTRODUCTION

This paper outlines the strategies for workflow and treatment that the conservators at the Weissman Preservation Center—the special collections conservation and preservation unit for the Harvard Library—implemented in the preparation of the largest-ever exhibition of Medieval and Renaissance illuminated manuscripts mounted in North America, and did so on short notice. Concurrently, the conservators took this opportunity to refine and codify our own best-practice procedures for the consolidation of flaking and friable media.

While there is never quite enough time it seems for any conservation project, our task was to prepare over 160 illuminated manuscripts in barely two years for the exhibition, *Beyond Words: Illuminated Manuscripts in Boston Collections,* which had three simultaneous venues, beginning in September 2016. Each manuscript required close examination, documentation, and in most cases, media consolidation and structural repairs as well as exhibition cradles. Alan Puglia and Debora Mayer, senior conservators at the Weissman Preservation Center, managed the conservation workflow.

The first portion of the paper covers our estimating procedure and how we grappled with staffing and workflow to match the scale of the project. The second portion highlights the treatment protocol the Weissman Preservation Center staff developed for the consolidation of friable media typical of illuminated manuscripts. The protocol incorporates expert skills and techniques, uniformity in judgment, quality control, efficient workflow, and a schedule sensitive to staff fatigue in order to maintain high-quality workmanship throughout the project—regardless of who is performing the treatment. The workflow for media consolidation in this project utilized two stereo binocular microscope stations [figure 1].

THE WEISSMAN PRESERVATION CENTER AND OVERVIEW OF THE MANUSCRIPTS

The Weissman Preservation Center is a fully equipped facility with a staff of 25 conservators, technicians, and interns. The Center is responsible for the conservation and preservation of the vast holdings of special collections in the Harvard Library,

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Fig. 1. One of two stereomicroscopy stations for consolidation. The floor stand makes this microscope ideal for large format materials.

Fig. 2. Manuscript supported in temporary corrugated board cradle for consolidation. Detached and fragmented board. MS Lat 129. Breviary. Houghton Library, Harvard University.

Fig. 3. Large manuscript supported with foam cradle. MS Typ 79. Gradual. Lippo Vanni. Houghton Library, Harvard University.

the rare and unique materials of 73 individual repositories. Given the magnitude of the holdings, the Center routinely develops strategies to care for and treat individual items and entire collections.

This project however, was the Center's first experience in treating so many individually complex, challenging materials, and structures within a firm deadline. Furthermore, all treatment work required conservator-level experience and expertise in media consolidation utilizing the stereomicroscope.

The illuminated manuscripts in the exhibition date from the 9th to the 16th centuries and include bibles, books of hours, antiphonals, graduals, breviaries, and secular manuscripts. They range in dimension from pocket manuscripts that fit in the palm of a hand to large and heavy antiphonals that require two people to lift. [figures 2 and 3] The manuscripts vary in condition structurally from original, intact bindings to manuscripts with detached boards and broken sewing. The media varies from full color medieval palette applied in multiple layers of paint and gold leaf covering most of the parchment page to minimal drawing and pale washes of color.

Typical types of media damage include abrasion to the media surface in which the disturbed area is friable while surrounding surface is stable [figure 4], flakes of paint sometimes standing on edge [figure 5], massive loss of media [figure 6], and loss of media from flexing of the parchment [figure 7]. We learned by prior humbling experience that visual observation alone, even with magnification, was insufficient to judge the stability of media. Media that appears stable is not necessarily so, and media with major losses may not necessarily be unstable as seen in figure 6. Therefore, we test all media for stability, regardless of visual appearance.

Each manuscript is in itself a unique object and worthy of technical study. Although we were able to study some manuscripts in more detail, the exhibit deadline did not permit extensive study.

TREATMENT PARAMETERS AND ESTIMATING TREATMENT TIME

Because of the short time frame and scale of the project, we could not consolidate all illuminations in every manuscript —our preferred approach when preparing them for exhibition or imaging. After consultation with several conservators in other institutions, we adopted a policy of examining, and treating as necessary, only the illuminations within ten leaves of the display opening. We also included any illuminations on the first leaf, recognizing that it most often receives excessive handling. We focused on binding and structural issues that would impact handling during consolidation, travel to off-site venues, and for the manuscript to remain open for the three to four month-long exhibition.

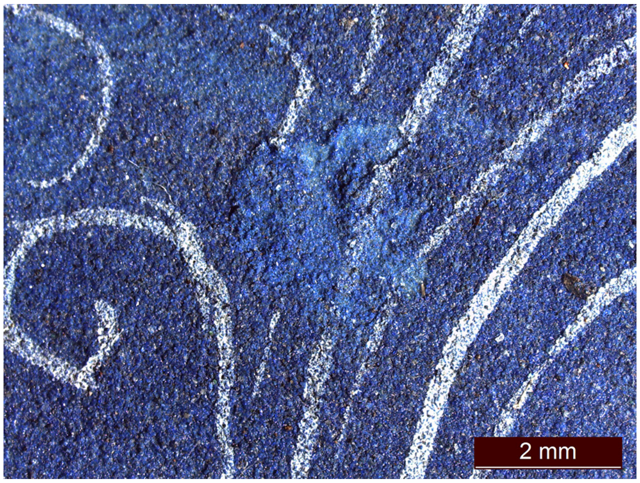

Fig. 4. Friable media resulting in loss of surface design, likely caused by abrasion. 15x. MS Typ Inc 2756. Missal. Houghton Library, Harvard University.

Fig. 5. Chips of paint standing on edge and friable. 15x. MS Typ 489. Houghton Library, Harvard University.

Fig. 6. Despite massive loss of media overall, the remaining media tested stable and did not require treatment. MS Typ 322.

Fig. 7. A typical loss of media caused from flexing of the parchment support, as viewed in transmitted light. MS Lat 161. Houghton Library, Harvard University.

With these parameters in mind, conservators reviewed all manuscripts considered by the curators—systematically collating information that impacted treatment and display.

DATA GATHERING

To estimate time for consolidation treatment, we measured all of the illuminations on the folios to be examined. This measurement became the core of our consolidation treatment estimate. We learned from prior consolidation projects that our procedure takes, on average, 2.5-3 minutes per square centimeter to complete.

For structural issues, any limitation of the binding opening was noted and used to determine the angle of display opening. Time estimates were made for recommended repairs, such as board re-attachment or other structural stabilization.

Extra time was added for unusual, heavy, or large items.

The estimate included time for the examination, report writing, and extensive imaging.

Other non-treatment information gathered for the project estimate included housing needs, cradle making, framing of single leaf manuscripts, condition checking, packing, and installation. The time for these activities was substantial and impacted the treatment timeline; however, these aspects are not addressed in this paper.

Excel worksheets were used to tabulate the time to treat all the manuscripts as well as the time to treat each manuscript individually. From this information, we planned workflows.

THE ESTIMATE RESULTS AND PLANNING THE WORKFLOW

Data collected from the reviews revealed that there were 57,000 square centimeters of illumination to examine and potentially treat. 57,000 square centimeters of illumination is comparable to a 2 x 3 meter or 6 x 10 foot tabletop filled solid with illumination. Thought of in this way, the total seemed smaller than expected but we recognized that consolidation is meticulous work performed through the microscope, one millimeter at a time. The consolidation estimate alone, at three minutes per square centimeter, was 2800 hours.

Consolidation was more than half of the total conservation estimate. Oversize manuscripts, structural repairs, documentation, and fabricating or modifying housings were estimated to require approximately 2200 hours.

The two estimates combined resulted in 5000 hours of conservation treatment time. This correlates roughly to three conservators working full time, solely on this project and no other treatment-based projects. Unfortunately, the manuscript exhibit was only one of numerous conservation and exhibition projects that needed to be completed throughout the two-year time span.

The deadline for completing conservation treatment was set by counting back from the installation dates the time required for fabricating cradles and sealed framing packages, performing condition reviews for loaned materials, and installation time itself. We determined that with ten of our conservators, essentially all our book and paper conservators, working half-day shifts, we could finish the consolidation work by the deadline. The team approach would allow us to avoid staff fatigue and continue with other concurrent projects.

THE WEISSMAN CONSOLIDATION PROTOCOL

Our challenge was to form a team of ten conservators with different backgrounds and approaches to work collectively in an efficient workflow.

The Weissman Consolidation Protocol evolved over the years. Book and paper conservators, working alongside curators, discussed goals and researched trends in media consolidation to create a manual, for staff to follow.

KEY ELEMENTS OF THE PROTOCOL

A shared goal of the protocol was to achieve *excellence and uniformity in treatment* so that all the work appeared to be performed by one hand. This was obtained by implementing:

- *Consistent procedures.* An example is the use of the same magnification (15x) and tools to judge stability/ friability of media.
- *Uniform judgment parameters*. The decision to treat is based on the actual detection of loose or friable media. Consolidation is not considered a proactive measure. Media that is cracked or looks horrible but tests stable is not treated.
- *Quality control.* One conservator treats a given illumination and a second conservator reviews the work to ensure treatment success. In this way we make sure that we do not miss areas, the consolidation is effective and that there is no change in media appearance.
- *Open and frequent communication*. Best practices are achieved through collective and collaborative understanding, which requires discussion, being open minded, sharing observations, and letting go of ego.

THE MICROSCOPY STATION AND TOOLS

An overview of the microscopy station is seen in figure 8. In the center of the image, the manuscript is supported with a cradle and strapped so that the page being treated is relatively planar. Because the illumination on the verso of the leaf is being treated, the manuscript is oriented upside down to the viewer, a setup which is arranged for right-handed conservators. On the far right is a dilute solution of bovine gelatin- our typical consolidation adhesive—in a mini Erlenmeyer flask warmed in a *bain marie* or water bath on a cup warmer. We find that keeping gelatin at about 100 degrees Fahrenheit or 38 degrees Celsius yields a more viscous solution that sets faster and reduces the risk of penetration into the parchment. The working solution also degrades slower over the course of a week than gelatin kept at a higher temperature. To achieve the desired temperature, the cup warmer is plugged into a variable transformer placed on the floor.

The magnification and focus knobs on this microscope are separate from the body of the scope and can be positioned per operator preference. Removing the controls from the main body of the microscope allows greater access to the

Fig. 8. The photograph is a slight panorama so the desk looks a bit round. The microscopy station from right to left includes; an assortment of tools, consolidation adhesive warmed on a cup warmer plugged into a variable transformer, the manuscript supported in a cradle, bench top magnification and focusing controls with foot pedals below, the computer monitor displaying the during treatment image of the illumination, and the notebook of treatment records.

gutter of the manuscript and rapid focus adjustments. This microscope also has an option for foot petal controls so both hands can be free to hold tools. The foot petals are on a step stool under the bench.

The computer monitor displays the before treatment digital image of the illumination—enlarged and focused on the area being treated. Using Photoshop, all treated areas are color-coded in a bright color to indicate the type of adhesive used—typically magenta for bovine gelatin.

Below the monitor is the treatment notebook which includes documents relating to the manuscripts currently in treatment. The notebook contains a copy of the treatment proposal, a time sheet, and a print-out of each illumination being treated. The paper print-out serves as the written platform for communication between team members and records the status of treatment.

Fig. 9. The microscopy station as seen from above, including ergonomic arm support.

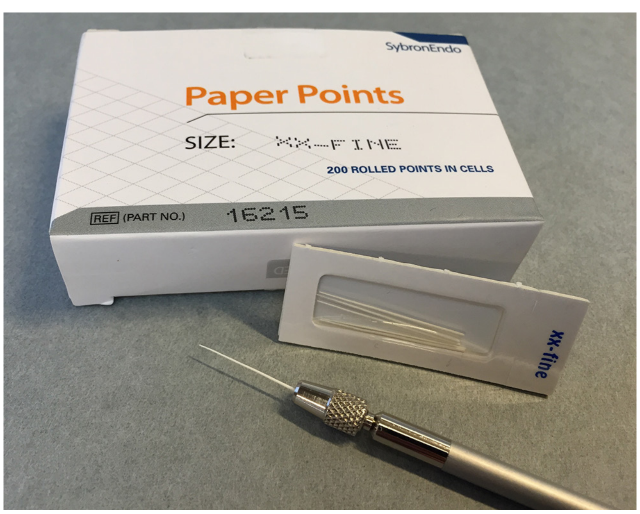

Fig. 10. Paper point for media testing mounted in a pin vise.

A view of the consolidation work-station from above can be seen in Figure 9. Everything needed is close at hand. Notice the arm support which can be used to steady the arm and reduce worker fatigue. The microscopy station is considered its own space and conservators sign up to use the setup on a shared calendar.

The typical consolidation tool set-up includes gelatin on the cup warmer, an assortment of fine brushes, spatulas, paper points, and ethanol which is sometimes used to modify the gelatin application. The tool used to test for media stability is a fine paper point inserted into a pin vise. Paper points are narrow, feather-weight rolls of paper commonly used by dentists to wick fluid and adopted by conservators for inpainting. [figure 10]

THE TREATMENT PROCEDURE

While looking through the microscope the conservator uses the paper point to lightly touch the media to detect media insecurity. We settled on this technique because team members consistently reached the same determination of media stability or instability when using the paper point. During trials using a fine brush we did not reach consensus and judged situations differently. [figure 11]

A typical example of cracked media and granular pigment surface at our working magnification of 15x is seen in figure 12. Crevices and surfaces are both tested for loose particles and flakes. Using the paper point we can, more often than not, precisely locate the area of instability resulting in a targeted placement of the consolidation adhesive. We found testing with a brush was less straightforward and precise. [figure 12]

For the presentation at the conference, a series of videos, taken through the microscope, were shown to demonstrate the three-part procedure for consolidation: evaluating media, applying consolidation adhesive, and re-testing the area for treatment success. To detect loose media, especially around an area of loss, observe the paper point as it lightly touches the chip of media, watching to see if a shadow increases or decreases. [figure 13] A change in the shadow profile shows that the chip is loose and indicates that there is blind cleavage- and the flake should be treated to secure it in place. To detect powdery or friable media, observe if small particles move as the paper point lightly touches and strokes the surface. Offset of media to adjacent areas or to the facing page is a clue of disturbed media and the corresponding area may require treatment.

Loose flakes and friable media are generally consolidated with dilute gelatin, typically applied with a small brush into the area of loss to secure the chip of paint or the friable surface. When the adhesive application goes according to plan, it flows perfectly under the flake and secures it in place or into the porous interstices of the paint matrix. [figure 14] If, by chance, the adhesive application is excessive, the absorbent paper point can be used to wick the excess gelatin. The

Fig. 11. Endontic absorbent paper points used for media testing. Conservator steadies hand with pinky finger on fiber optic light stem.

Fig. 12. Absorbent paper point in use at 15x, the magnification used for media testing. MS Typ Inc 2756. Missal. Houghton Library, Harvard University.

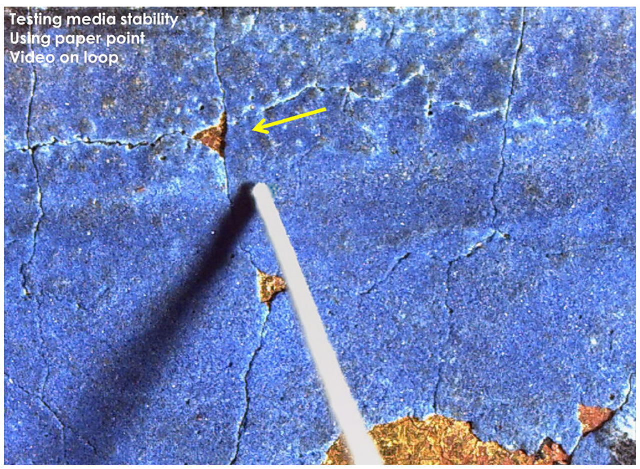

Fig. 13. Frame capture from a video of testing media for stability. Observing change in shadow profile as the chip is lightly touched with the paper point. 15 x. MS Typ 443. Houghton Library, Harvard University.

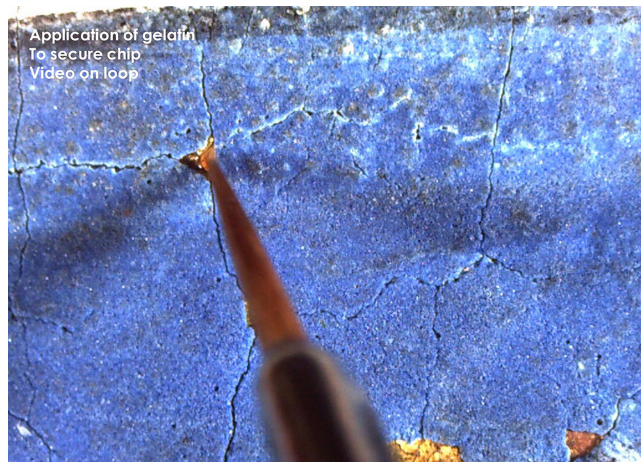

Fig. 14. Frame capture from a video of applying gelatin adhesive to flow underneath the paint chip. Same area of loss as in figure 13. 15 x. MS Typ 443. Houghton Library, Harvard University.

adhesive is applied sparingly to avoid over-wetting of the media and parchment. If additional adhesive is required, it is applied after the area has dried.

Following initial consolidation treatment, the entire illumination is checked both for unstable media that was missed or treated media that requires additional attention. At least one full day is allowed after treatment to ensure that adhesives have set and dried fully. The checking procedure is exactly the same as the initial testing process described above. Success is determined by no movement of the media as indicated by: no change in shadow, friable media is no longer dislodged, and there is no visible change to the media surface from treatment. In the video you could see that after treatment, the chip did not move when touched with the paper point, there was no change in the shadow as before and the media surface was not visibly altered. The evaluation, treatment, and checking steps are repeated as necessary with successive rounds concentrating on problematic areas to ensure success.

The checking step is a key feature of the protocol. Since all consolidation work is performed with magnification, there is no other way to verify treatment success except through the microscope. And we have learned that two sets of eyes and hands ensure that we have performed the best job possible. In the team approach, ego must be set aside as one's work is reviewed by fellow conservators. Open, non-judgmental minds allow the team as a whole to learn from mistakes, improve techniques, and produce results superior to working alone.

As treatment progresses, the digital image displayed on the monitor is marked up using Photoshop to delineate the areas of consolidation treatment. At the same time the photocopy in the binder is also marked up and serves as a place to write notes. The marked up areas on the images will not be obvious in the printed black and white images but can be seen in the downloaded version in color from the web. [figure 15]

The left photocopy in figure 16 shows a straightforward treatment. The conservator signed and dated the photocopy when they treated the illumination. The diagonal line across the bottom corner signals that the illumination is ready to be checked. After a day or more has passed, a different member of the team checks the entire illumination and signs off that it is OK—meaning all media was found to be secure when they did the check.

The right photocopy in figure 16 shows a more complex treatment. Notice the commentary, which we often leave for each other, about our observations of trouble areas or sometimes information regarding material inquiry or delight. This manuscript required multiple checks and re-application of adhesive in selected areas before the consolidation was considered complete.

Most often we use bovine gelatin (Acros Organics, type b, ~100 bloom), at a 1.5% w/v solution in deionized water, with the addition of a few drops of ethanol. In certain instances, fish gelatin (Norland Products, high molecular weight) is used when stronger adhesion, better flow, or greater dilution is warranted. In the dry granular form, bovine gelatin is amber in color and the fish gelatin is the color of light cream. In this project we found that brush application of the consolidation adhesive worked very well. In other consolidation treatments we have used a nebulizer to create an adhesive mist to apply, often through a template or shield, to broad fields of powdery and friable media.

Some favorite tools are fine brushes, rounded dental tools, Delrin spatulas (polyoxymethylene) and standard spatulas fitted with an extension of silicon-coated release Mylar. The spatula has a slight arc to keep the Mylar oriented upward to avoid an accidental touch or poke of the media. The rounded dental tools and the Delrin spatulas are used when slight pressure is needed to encourage adhesion. [figure 17]

Setting down gold leaf is a common instance where slight pressure may be helpful. Occasionally fish gelatin is used when prior application of the bovine gelatin is insufficient. After the adhesive is applied, encouraging adhesion is a two-step process. First the silicon release Mylar is laid in place as a barrier and then the Delrin spatula is used to apply slight pressure through the release Mylar. [figure 18] It is important to wait several seconds after the adhesive is applied before applying pressure so the media is not too wet during the procedure.

After all treatment is completed, a final report is written which includes tasks performed, materials used as well as the names of the conservators who worked on the manuscript. The report and all the images (before and after treatment as well as the marked up images in Photoshop) are incorporated into the treatment record database and uploaded into a digital

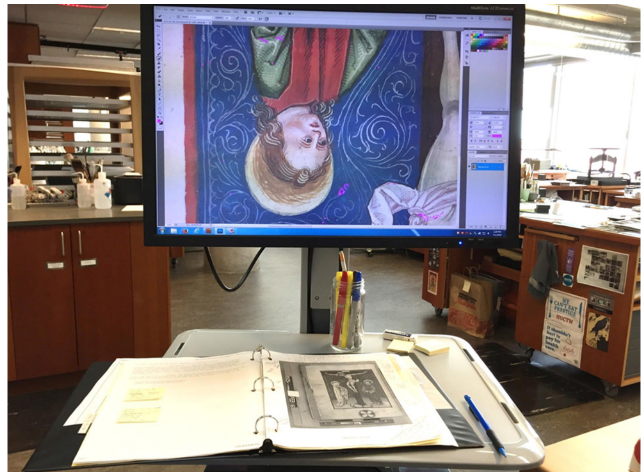

Fig. 15. Computer screen shot showing during treatment image with areas of consolidation treatment marked in magenta using Photoshop. The photocopy in the treatment notebook (below) is marked in red pencil to denote areas of treatment.

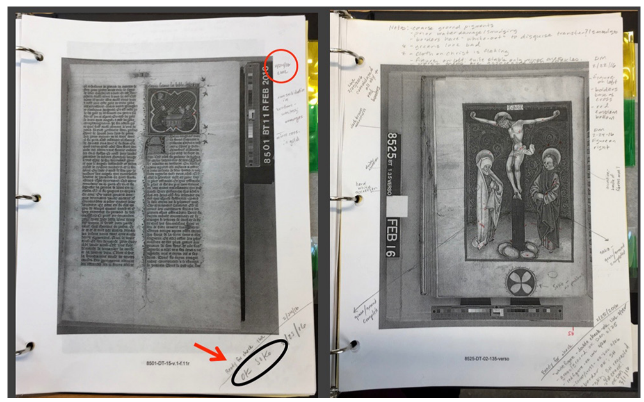

Fig. 16. Left: An example of a treatment tracking sheet for a straight forward consolidation treatment. One conservator consolidated the illumination and a different conservator checked the manuscript for treatment success. No issues noted. Right: An example of a tracking sheet for a complex consolidation treatment. Note the various notations in the margins to inform all team members of problem areas, areas of interest, and the multiple re-checks.

Fig. 17. Typical selection of hand tools in our consolidation process. Short handle brushes 4/0 to 5/0, round-ended dental tool, home-made shaped Delrin spatula, and spatula with extension of silicon-coated release Mylar.

Fig. 18. Following application of fish gelatin, a Delrin spatula is used to apply gentle pressure through silicone-coated release Mylar to encourage adhesion of gold leaf. 15x MS Typ 127. Houghton Library, Harvard University.

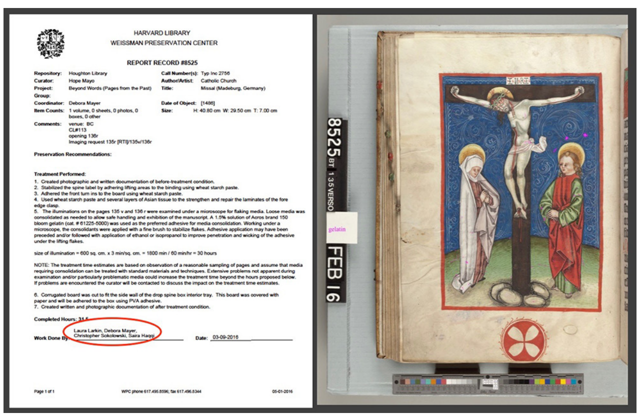

Fig. 19. Completed treatment report from ACORN, the Weissman Preservation Center's record keeping data base and the accompanying screen view of completed during treatment image with a label denoting that gelatin was the consolidation adhesive used. MS Typ Inc 2756. Missal. Houghton Library, Harvard University.

repository for permanent record storage. [figure 19] For more information on the Weissman Preservation Center's record keeping database, see Debra Cuoco's 2016 AIC Conference poster on *ACORN*, our conservation documentation system.

CONCLUSION

We have learned that consolidation treatment is a relentlessly demanding activity that is ultimately humbling.

We believe a team approach consisting of two or more people is ideal with regard to consolidation of illuminated manuscripts. By sharing the workload and setting standards, large quantities of high-quality work can be performed without burnout and in a reasonable time frame.

The conservators at the Weissman Preservation Center have also learned that the quality of treatment and the degree of uniformity are substantially greater when multiple conservators collectively agree and follow the same guiding principles. This approach goes beyond procedural processes—it aligns decision-making and judgment.

We hope this presentation illustrates the benefits of establishing protocols. Keep in mind that these procedures can be adapted to fit your lab needs by using your preferred tools and techniques, selecting different adhesives, and even altering judgment parameters.

ACKNOWLEDGEMENTS

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SUPPLIES AND TOOLS

MICROSCOPE

- Leica MZ16 microscope: Leica Microsystems, http://www.leica-microsystems.com .63 objective, 10x eyepieces, Ergo tube 10 deg. to 50 deg., Motor focus with inclinable column, Motor focus footswitch and manual bench-top control knobs
- Schott, KL 1500 LCD: http://www.us.schott.com/lightingimaging/english/microscopy/products.html

CONSOLIDATION TOOLS

Paper points

- Kerr Endodontics Absorbent Points, XX-Fine (16215): Sourced from Darby Dental, https://www.darbydental.com/scripts/ProdPage.aspx?grp=8540198

Brushes: Brush options come and go frequently. Current favorites are:

- Escoda Perla synthetic 5/0 and 4/0, round, short handle, http://www.dickblick.com/products/escoda-perla-toray-white-synthetic-round/

- Escoda Barroco Toray gold 5/0 and 4/0, round, short handle, http://www.dickblick.com/products/escoda-barroco-toray-gold-synthetic/
- Kolinsnky Raphael 5/0 and 4/0, may no longer be available

Nebulizer
- Pari LC Plus nebulizer
- Devilbiss Traveler compressor

Delrin micro spatula (Fabricated in-house)
- Delrin: 1/8" x 1" wide, sourced from McMaster-Carr http://www.mcmaster.com/#8739K11

ADHESIVES
- Acros, Gelatin type B (#61225-5000): Sourced from VWR Scientific, https://us.vwr.com/store/product/18604377/gelatin-type-b-laboratory-grade
- High Molecular Weight Fish Gelatin: Norland Products, https://www.norlandprod.com/

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Paper Tapestry: Wallpaper Preservation

From 1866 to 1982, Spadina Museum: Historic House & Gardens was home to four generations of the Austin family. Opened to the public as a museum by the City of Toronto in 1984, Spadina Museum is one of ten historic museums operated by the City of Toronto. Toronto's Economic Development and Culture division decided to update the original restoration of Spadina Museum commencing in 2009. After extensive interior renovations to depict how the Austins lived during the 1920's and 1930's, it was reopened to the public 2010. The first and second floor renovations included digital reproductions of the wallpaper based on original source material maintained in the Austin family's records. That restoration project was presented at the 2011 CAC Conference in Winnipeg. This paper picks up where that one left off. In 1912/1913, the Austin family added a third floor to their Spadina home which included servant spaces. The third floor was not included in the previous restoration activities. In 2012, in preparation for opening the third floor servants' quarters to the public for the first time, Spadina Museum undertook the in situ stabilization and treatment of the wallpaper in the servants' hallway, believed to be original to the 1912/1913 renovation. This space shines a light on "the other half" of life at Spadina allowing visitors to now see the servants' living quarters, including the bathroom and water closet, a bedroom and the servants' living quarters, including the bathroom and water closet, a bedroom and the servants' sitting room, all of which are accessed by a hallway decorated with tapestry inspired wallpaper. The space was also the site of a travelling exhibit featuring costumes from the popular television series "Downton Abbey".

Prior to the 2012 renovation, the servants' space was being used by museum staff as a storage area and had been renovated to incorporate an elevator. As a result, the wallpaper suffered physical damage from items being moved through the space and from construction related activities. Damage included numerous small losses and abrasions to the wallpaper; areas where the paper was delaminating from the walls; and other areas of significant large losses. Additionally, there were water stains from previous ceiling damage, and tears in the wallpaper due to cracks in the lathe and plaster structure it was pasted to. The wallpaper was further obfuscated by a buildup of decades of soot, dust and grime. A different approach was taken with the restoration of the servants' quarters. The original wallpaper was preserved by modifying traditional conservation techniques to clean and treat in-situ, whereas the large losses were infilled with full scale digitally reproduced wallpaper. This paper will discuss the challenges of undertaking this treatment in-situ and those of color matching and achieving the correct scale, proportions and perspective for the digitally reproduced paper, as well as working as an independent contractor with staff and volunteers at the historic property and other City of Toronto divisions and private "partners". This project highlights an emerging approach and modality in conservation and tells the next chapter in the renovations at Spadina Museum.

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All Over the Map: Bringing Buffalo's Stars of Cartography to Light, One Lining at a Time

INTRODUCTION

The Buffalo and Erie County Public Library Special Collections Department, which includes the Rare Book collection, holds nearly 500,000 titles including monographs, serials, scrapbooks, microforms, manuscripts, organizational archives, phonograph discs, sheet music, scores, orchestrations, and an estimated 70,000 maps.[1] The conservation treatment of eight rare maps of the city of Buffalo in the library's collection was funded by a New York State Conservation/Preservation Discretionary Grant and highlighted in a recent exhibit in the library's Rare Book Room entitled, "You Are Here: Buffalo on the Map". The exhibit included more than 25 maps of the city (both originals and facsimiles) spanning virtually the entire 19th century, and featured seven of the eight conserved maps. Only one conserved map, showing the city of Buffalo at the turn of the 20th century, was left out of the exhibit due to limited secure display space.

HISTORICAL BACKGROUND[2]

The eight conserved maps collectively depict the growth of Buffalo, New York, from village to town to bustling city between the years 1805 and 1909. The story begins with *Map of Buffalo Village: 1805* (fig. 1). This earliest depiction, though drawn in 1850, dates to 1805, combining handwritten text about the village of Buffalo with a map depicting the city's original plan in its early days as a pioneer settlement, then called New Amsterdam. The map's text outlines the initial survey of lots and sales by the Holland Land Company and its local agent, Joseph Ellicott. It also lists the city's early newspapers and religious congregations, along with population numbers and early Buffalo history. With less than 100 dwellings recorded in 1811, the region would survive the burning of almost every building during the War of 1812 and begin a period of tremendous growth due, in large part, to

Fig. 1. Detail of *Map of Buffalo Village: 1805*, 1850, watercolor and ink on paper, 124 x 91 cm (Buffalo and Erie County Public Library, 31M-8).

the completion of the Erie Canal in October of 1825, which linked Lake Erie to the Hudson River.

In 1825 local historian Sheldon Ball wrote a brief pamphlet on Buffalo's early history, which included the first engraved view of Buffalo Harbor and a hand drawn map (fig. 2). *Ball's Plan of the Village of Buffalo* was the first attempt since Joseph Ellicott surveyed the area for the Holland Land Company

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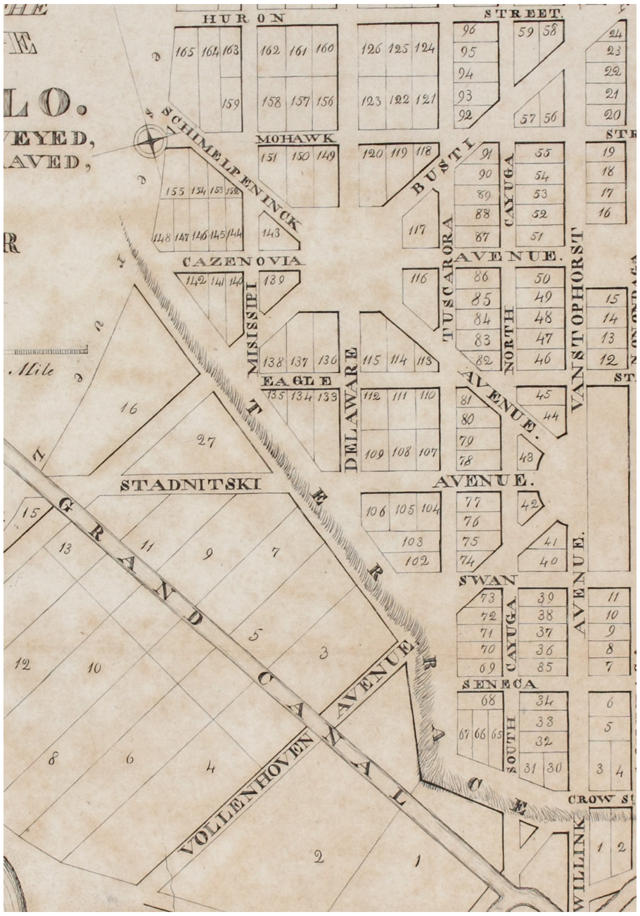

Fig. 2. Detail of *Ball's Plan of the Village of Buffalo*, 1825, engraving on paper, 24.2 x 17.5 cm, (Buffalo and Erie County Public Library, RBR Print 251).

to extend the proposed geometrical layout of a plaza with eight streets radiating at equal angles, now known as Niagara Square. The map also notes the location of the "Grand Canal" which, at only four feet deep and 40 feet wide, was an engineering marvel of its time.

Hand-drawn in 1836, *Map of a Part of the Lower Village of Buffalo* shows how development began to focus on the harbor waterfront with a design as recommended by the minutes of a meeting of the village trustees from six years prior (fig. 3).

The first hand-colored original map of the city in the library's collection and the third oldest, *Map of the City of Buffalo* is of particular historical importance as it depicts Buffalo in 1833, just one year after it had incorporated as a city (fig. 4).

Produced in 1847 after the growing city saw a need for more facilities in an atmosphere of increasing commerce on the lake, *Map of Buffalo and Black Rock Harbors* depicts a proposed break water and new sea wall, along with a 300 ft. wide ship canal that would run just west of the Erie Canal and Buffalo Harbor (fig. 5).

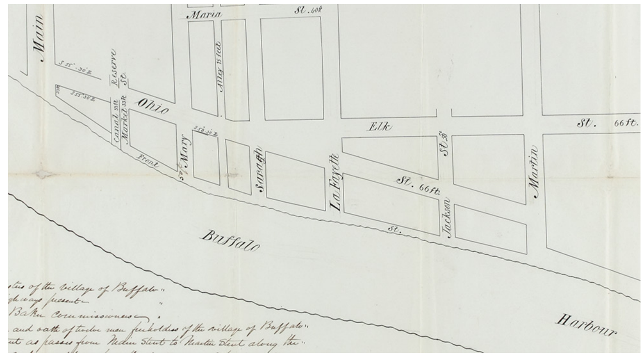

Fig. 3. Detail of *Map of a Part of the Lower Village of Buffalo*, 1836, ink on paper, 43 x 52 cm, (Buffalo and Erie County Public Library, 34M-320).

Fig. 4. Detail of *Map of the City of Buffalo*, 1833, lithograph on paper with hand-coloring, 81 x 86 cm (Buffalo and Erie County Public Library, 32M-3).

Fig. 5. Detail of *Map of Buffalo and Black Rock Harbors*, 1847, lithograph on paper with hand-coloring, 35 x 94 cm (Buffalo and Erie County Public Library, 32M-4).

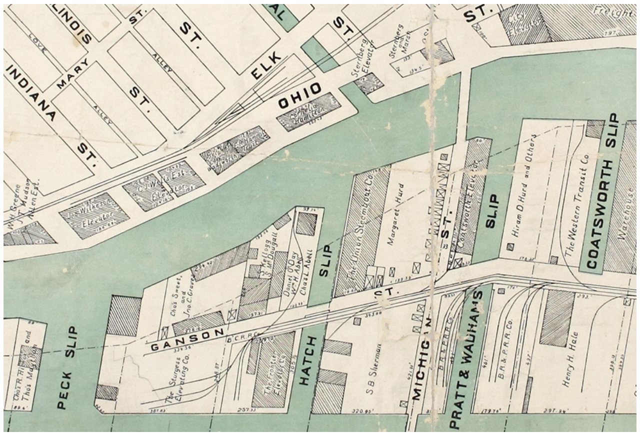

Fig. 6. Detail of *Mann's Map of Buffalo Harbor & the Island*, 1888, relief print on paper, 89 x 146 cm (Buffalo and Erie County Public Library, 38M-13).

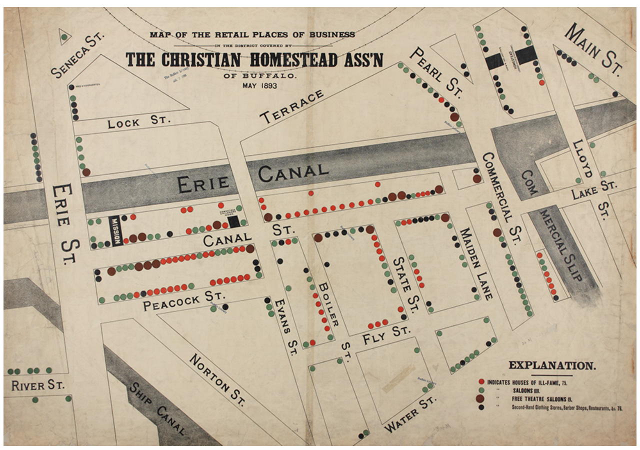

Fig. 7. *Map of the Retail Places of Business in the district covered by the Christian Homestead Association*, 1893, color lithograph on paper, 81 x 115 cm (Buffalo and Erie County Public Library, 34M-24).

Fig. 8. Detail of *The Matthews-Northrop New Map of the City of Buffalo*, 1909, relief print on paper, 105 x 63 cm (Buffalo and Erie County Public Library, 34M-50).

Mann's Map of Buffalo Harbor & the Island of 1888 provides a detailed record of Buffalo's industrial age and development as a major inland port of the late 19th and early 20th centuries (fig. 6). The map documents long missing portions of Buffalo Harbor history by giving us the locations of commercial slips, but also the businesses on the harbor by name.

Those who like their history a bit on the gritty side will get a kick out of the 1893 *Map of the Retail Places of Business in the district covered by the Christian Homestead Association,* commonly referred to as *The Christian Homestead Ma*p (fig. 7). The Christian Homestead Association was one of many Buffalo charities devoted to rescuing "the unfortunate and erring through mission work". The homestead was headquartered in the heart of the canal region, or the "infected district," where all the sailors added to the increase of prostitution in the area. The lower right corner of the map tells the story with colored dots, identifying 75 "houses of ill-fame," 108 saloons, 19 "free theatre saloons", and 76 other retail establishments. Maps outlining areas of prostitution are extremely rare and this map is truly one of a kind.

The Matthews-Northrop New Map of the City of Buffalo presents a picture of the city shortly after the turn of the 20th century (fig. 8). With close to 350,000 inhabitants, it was the eighth largest city in the US. Its strategic location and unique charm secured it as the venue for the Pan-American Exposition of 1901. The advent of alternating current allowed designers to light the Exposition using power generated 25 miles away at Niagara Falls, gaining Buffalo the nickname, "The City of Light".[3] Buffalo's Pan American Exposition is also known as the place where America's 25th President, William McKinley, was shot and killed. Interestingly, the newly developed X-ray machine, one of conservation's most

Fig. 9.

TOP TO BOTTOM

a. *Map of Buffalo and Black Rock Harbors,* before treatment, raking illumination.

b. After treatment, raking illumination.

valuable examination tools, was displayed at the fair, but doctors were reluctant to use it on McKinley because they did not yet know the possible side effects.[4]

CONSERVATION TREATMENT

While the original treatment plan outlined in the grant proposal described a complete restoration of the maps, plans had to be scaled back due to an unfortunately late notification of the library's award and a drastically reduced timeline for the work. Six of the eight maps required linings to strengthen the weak paper supports, but traditional paste linings were not feasible in several instances due to sensitivity of media as well as poor quality papers that were compromised by water damage. In the interest of balancing the preservation needs of the maps with the need for economy of time and materials, a dry lining technique using toned heavyweight Japanese paper and a heat-set film of Lascaux 498 HV and 303 HV adhesive was developed to simultaneously stabilize the maps and compensate for loss.

Map of Buffalo and Black Rock Harbors was the only map which received a wet paste lining. This map's paper support was severely discolored and embrittled, with an aged surface coating contributing to the overall darkened appearance of the map. The map was backed with a deteriorated textile which offered little structural support and areas of the paper were actively lifting from the backing. Stored folded in half, the paper support was fractured down the middle and sustained substantial damage to the left and right edges including skinning, creasing and loss (fig. 9a). After surface cleaning and varnish removal, a temporary facing of Japanese tissue was adhered with wheat starch paste to fractured and weakened areas of the map to stabilize them during washing and backing removal. The map was first lined to lightweight Japanese paper with a 3:1 mixture of wheat starch paste and methyl cellulose and dried between felts. It was then humidified and lined with paste to heavier weight Japanese paper. The map was dried face-in on a drying board and losses in the paper support were toned directly on the intermediary lining paper using pastel pencils (fig. 9b).

The paper support on *Map of Buffalo Village: 1805* was discolored and heavily soiled. The map was backed with textile and stored folded. Fractures through both the paper support and the backing had formed at the folds from use and were held together by pressure sensitive tape on both the recto and verso, causing adhesive staining as well as delamination and cracking of the paper support. The support exhibited numerous losses at the edges and around creases and tears with the paper support actively lifting from the backing at these sites (fig. 10a). The large map was treated in quadrants after

Fig. 10.

LEFT TO RIGHT
a. *Map of Buffalo Village: 1805*, before treatment, raking illumination.
b. After treatment, raking illumination.

Fig. 11.

LEFT TO RIGHT
a. *Mann's Map of Buffalo Harbor & the Island,* before treatment, raking illumination.
b. During treatment, shown face-up on prepared table after lining.
c. After treatment, raking illumination.

being separated along preexisting fracture lines. It was surface cleaned and pressure sensitive tapes were removed. The cloth backing was removed wet. The quadrants were suction washed before lining with an intermediary light weight Japanese paper and then dried between felts. Unfortunately, several new tears were introduced in the paper support from the stress of the wet-dry cycle of the aqueous treatment. The quadrants were reassembled and the entire map was dry-lined using Lascaux heat-set adhesive and a heavier weight Japanese paper. Losses were toned directly on the intermediary lining paper using pastel pencils and the lined map was stretch-mounted to archival foam board with Japanese paper hinges to prevent flexing of the support (fig. 10b).

Two of the maps were so fragile that backing removals were deemed too risky, and the new linings were carried out over the existing cloth backings. *Mann's Map of Buffalo Harbor & the Island* was heavily creased and dirty and the thin coated paper support was delaminating, as well as lifting from the textile backing. Stored folded in four, the support had fractured at its folds. The bottom left corner was completely lost and flexing of the paper support along creases had resulted in numerous small losses (fig. 11a). Delaminating and lifting paper was first consolidated using dilute wheat starch paste applied by brush and set with a tacking iron to mitigate the formation of tidelines. Testing of the application and removal of temporary facings was carried out to assess whether backing removal was feasible; however, none was removed satisfactorily without disruption of sensitive media or damage to the paper support. Facing materials tested included Japanese tissue adhered with methyl cellulose and various heat-set tissues, including Crompton coated tissue, Bevatex, and a Plextol impregnated Tengu-jo made in house. Backing removal was deemed inappropriate, so the verso was brushed of loose surface dirt and the map was dry-lined to toned heavyweight Japanese paper prepared with a heat-set film of Lascaux adhesive with the textile backing still in place (fig. 11b). The lined map was then stretch-mounted to foam board to prevent flexing of the fragile support (fig. 11c).

Fig. 12.

COUNTER-CLOCKWISE FROM TOP LEFT
a. *The Matthews-Northrop New Map of the City of Buffalo,* before treatment, raking illumination.
b. Before treatment, detail showing fractured state of bottom and previous repairs on verso.
c. After treatment, raking illumination.

The coated paper support used for *The Matthews-Northrop New Map of the City of Buffalo* was also delaminating and lifting from the severely deteriorated textile backing. There were numerous areas of loss, especially at the bottom where the map sustained water damage (fig. 12a). Previous restoration campaigns included Japanese tissue repairs and reinforcement of the entire water-damaged bottom edge on the verso with tissue (fig. 12b). Despite these efforts to strengthen the weakened bottom edge, the bottom right corner had since fractured. Delaminating and lifting paper was consolidated using dilute methyl cellulose applied by brush and set with a tacking iron. Facings using wet adhesives were rejected due to the sensitivity of the paper and ink to water and organic solvents. Again, various heat-set tissues were tested; however, none was removed satisfactorily without damage to the map's surface. So, like *Mann's Map*, the *Matthews-Northrop Map* was lined with the current backing in place. The verso of the backing fabric was brushed of loose surface dirt and Japanese tissue repairs were removed. Some tissue was left in place in the water-damaged bottom edge due to the extreme fragility of the deteriorated support. Dry wheat starch paste was brushed through the fabric backing in certain areas to secure the detaching paper support to the fabric, followed immediately with a tacking iron to mitigate staining of the recto. Beva 371 film was selected as the lining adhesive in this case, instead of Lascaux, after mock-ups demonstrated the stronger bond this heat-activated film would provide to such a deteriorated backing and fragile support. After lining, the map was stretch-mounted to foam board to prevent flexing of the support (fig. 12c).

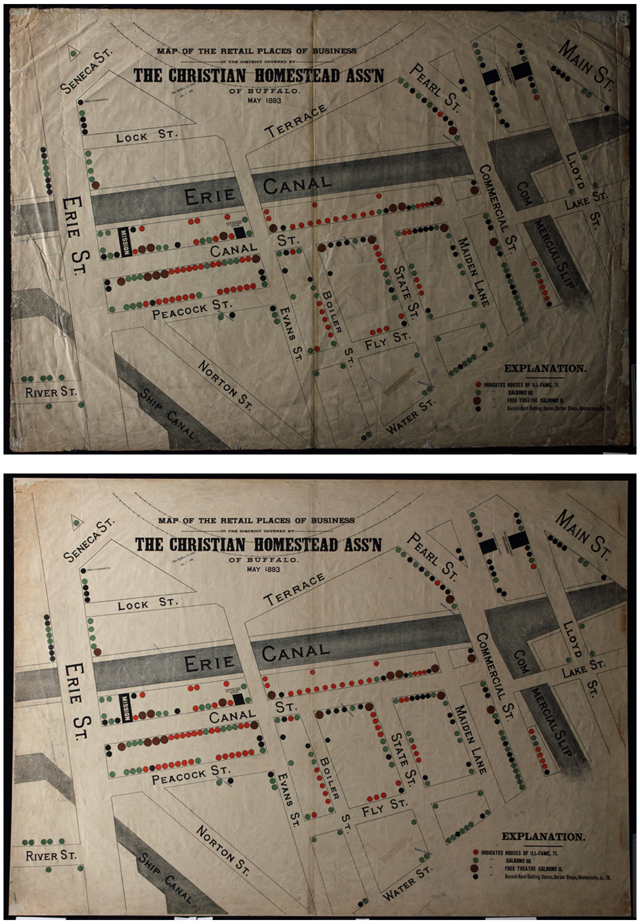

Fig. 13.

TOP TO BOTTOM

a. *Map of the Retail Places of Business in the district covered by the Christian Homestead Association,* before treatment, raking illumination.
b. After treatment, raking illumination.

The last two maps were approached similarly in terms of the lining process. The thin paper support of *The Christian Homestead Map* was slightly discolored overall and heavily creased and dirty. The support was lifting from the textile backing along creases and suffered from multiple edge losses. Pressure sensitive tape was used to reinforce a fold down the middle of the paper support and secure a tear in the bottom right (fig. 13a). After surface cleaning and removal of tape, squares of Japanese tissue were applied with 4% Klucel G in ethanol to stabilize torn and weakened areas of the support before dry removal of the fabric backing and lining to toned heavyweight Japanese paper prepared with Lascaux heat-set adhesive (fig. 13b).

Map of the City of Buffalo was probably in the worst condition of all the maps. The paper support was discolored and heavily soiled and a once-protective coating of varnish (likely shellac) had deteriorated, leaving an uneven glossy surface with an orange cast. The map had been backed twice with cloth; however, the brittle paper support was actively lifting from the original desiccated backing. Areas of loss were numerous, most notably at the top where the map sustained water damage and was stained with tidelines (fig. 14a). Found inside its storage folder and scattered on the surface of the map were detached fragments of the paper support. Fragments were repositioned and surface grime was reduced using cotton swabs moistened with distilled water, while varnish was reduced using cotton swabs moistened with ethanol. The use of water was avoided in areas with green and blue hand-coloring, which had demonstrated solubility during tests. A temporary facing of Japanese tissue was adhered with 4% Klucel G in ethanol to fractured and weakened areas of the map to stabilize them during backing removal (fig. 14b). The map was placed face-down and the second (newer) textile backing was removed dry, by tearing away in strips at a very low angle, followed by removal of the first (older) textile backing in the same manner. The verso of the support was lightly sanded with fine sandpaper to reduce adhesive residue and dust and dirt were vacuumed from the surface to prepare it for attachment of the lining paper (fig. 14c).

TONING OF THE LINING PAPER

Because losses in the maps were not to be filled due to time constraints, it was desirous that the lining paper which showed through in areas of loss should blend in with the original paper support as closely as possible. Okawara machine-made Japanese paper was selected as the lining paper and was toned using Golden fluid acrylic colors to match the variably stained support papers.

USE OF ACRYLIC DISPERSION LINING ADHESIVE

The methodology used in preparing the lining paper was developed after consulting Samantha Sheesley's article in the 2011 Book & Paper Group Annual, "Practical Applications of Lascaux Acrylic Dispersions in Paper Conservation" and after speaking with Jamye Jamison regarding her tip in the 2013 BPG Annual describing ICA Art Conservation's lining of oversized park plans using Lascaux adhesive. Lascaux 498 HV and 303 HV are both water dispersions of methyl methacrylate and butyl acrylate, thickened with acrylic butylester. In the case of Lascaux 498 HV, the thermoplastic polymer dries to film that is elastic and hard, while Lascaux 303 HV produces an elastic film that remains soft and tacky when dry. The 498 HV has a minimum sealing temperature of between 68-76°C (154-169 °F) vs. the 303 HV at a much lower 50°C (122 °F)[5]. Lascaux 303 HV is currently sold as the replacement for the now-discontinued 360 HV.

After working through numerous mock-ups, Jamison's approach of preparing lining papers by brushing on a mixture of Lascaux 498 HV and 360 HV won points with the ease of application of the adhesive; however, the resulting

Fig. 14.

LEFT COLUMN TOP TO BOTTOM

a. *Map of the City of Buffalo,* before treatment, raking illumination.

b. During treatment, after facing.

c. During treatment, after backing removal.

RIGHT COLUMN TOP TO BOTTOM

d. Detail, before compensation for loss.

e. Detail, after compensation with cellulose powder, dry pigment, and pastel media.

f. After treatment, raking illumination.

translucency and pronounced darkening of the toned lining paper was deemed unsatisfactory. Sheesley's technique of heat-transferring a dried film of Lascaux 498 yielded a more aesthetically pleasing lining paper, although the slight yellow cast and glossy sheen of the adhesive film would need to be corrected. Applying cellulose powder to areas of the exposed film after heating and softening with a hairdryer did the trick, but it also caused localized planar deformations in the lining paper, which would then have to be weighted as they cooled in order to remain flat. A mixture of Lascaux 498 HV and 303 HV was tested as a cast film and transferred with heat to the lining paper. The addition of the Lascaux 303 HV resulted in a slightly tacky dried film which allowed for the application of cellulose powder without the need to thermally reactivate the adhesive.

PREPARATION OF THE LINING PAPER

The challenge now was to replicate the successful mock-up on a large scale. An 8 x 4 ft. wide, half in. thick aluminum sign was set up on sawhorses as the lining table for its smooth surface and ability to conduct heat. The surface was sprayed with water and sheets of silicone release Mylar were laid down flat with a silkscreen squeegee, overlapping slightly, to cover the table. A 2:1 undiluted mixture of Lascaux 498 HV and 303 HV was distributed in daubs over the prepared surface and spread out quickly using an 8 in. long hard rubber brayer to prevent undue drying of the thin film. Several application methods were tested, including various house paint rollers and printmaking brayers, but the hard rubber created the least amount of perceptible texture in the resultant dried film, which helped mimic the smooth support papers of the maps. The film was dried with a hairdryer and allowed to cool for 15-20 minutes.

Once cooled, the lining paper was placed toned side down in contact with the Lascaux film and hand-smoothed onto the adhesive. A clothes iron set to medium heat was measured with an infrared thermometer at approximately 75°C[6] and was used with moderate pressure (and without steam) to tack the lining paper down from the verso through silicone release paper. Heat application started in the center and worked outwards in order to prevent creases and wrinkles from occurring. Once adhered, the paper was allowed to cool for 15-20 minutes. As an added security measure, a printing barren was used to apply pressure through the verso of the lining paper, ensuring overall physical contact between it and the Lascaux film. The lining paper was removed from the table with silicone release Mylar still in place on the recto.

HEAT-SET LINING

Following adhesion of the Lascaux film to the lining paper, the table was prepared again with new silicone release Mylar. The lining paper was placed recto up on the prepared metal table and the silicone release Mylar attached to the lining paper was removed carefully, ensuring that the adhesive was not pulled away or torn. Any areas showing an affinity for the Mylar were smoothed back into contact with the lining using a Teflon spatula. Missing or noticeably thin areas of adhesive were patched using cut sections of prepared Lascaux film on silicone release Mylar. The map was then placed face-up on the lining paper and tacked into position with a tacking iron. Then the sandwich was inverted on the table. The lining paper was first smoothed by hand. Then on medium heat and with moderate pressure, the iron, through silicone release paper, was used to thermally activate the Lascaux adhesive and attach the lining paper to the primary support. The application of heat was again applied from the center while moving outwards. Following the application of heat, the lined map was allowed to cool on the table for 15-20 minutes before being removed to press overnight between Tycore panels.

Next, the temporary facing was removed by peeling off the dry tissue at a very low angle. Tissue and adhesive residues were removed by swabbing lightly with distilled water and then applying a square of blotter and weighting to dry. Swabs moistened with ethanol were used to remove facing residues in areas with green and blue hand-coloring. Any lifting areas of the paper support around losses/tears were secured with a tacking iron.

LOSS COMPENSATION

A mixture of cellulose powder and dry pigment was pounced with a stiff brush into areas of loss in order to reduce the slight tack and sheen of the exposed adhesive film. Any residual Klucel left from the facing interfered with the application of the cellulose powder and had to be carefully cleaned from areas of loss. Losses were further toned and stains were retouched with pastel media (figs. 14d–e).

PRESSURE-SENSITIVE LINING

To further stabilize the fractured support of *Map of the City of Buffalo* and reduce flexing of the lining paper, a second lining was carried out using Okawara paper prepared with a film of Lascaux 303 HV, applied by brush and dried. The pressure-sensitive lining support was adhered to the verso of the map using moderate even pressure with a printing baren. The lining paper was trimmed and the map was pressed for a week between thick Tycore panels to encourage bonding of the lining support (fig. 14f).

HOUSING

Finally, the six lined maps were each placed in a custom archival foam board storage folder with an image label on the front to reduce unnecessary handling.

CONCLUSION

While the extreme fragility of the Buffalo maps, combined with time constraints and a tight budget, precluded a full restoration of the maps using traditional wet lining techniques, these limitations also gave rise to the adaptation of a dry lining technique that proved to be quite successful at physically stabilizing the map supports, as well as facilitating the compensation of loss. Before conservation treatment, several of the maps could not be unfolded in order to view them in their entirety without risking further damage. Library staff were extremely pleased with the results of treatment and felt confident that the maps could safely withstand any increase in handling due to requests for access inspired by the exhibition. In an effort to curtail over-use and to make the maps even more accessible to the public, several of the conserved maps will be digitized and made available for online purchase as reproduction prints with proceeds from the sales dedicated to the Rare Books & Special Collections.[7]

ACKNOWLEDGEMENTS

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NOTES

1. "Grosvenor Room," Buffalo and Erie County Public Library, accessed June 2, 2016, https://www.buffalolib.org/content/grosvenor.
2. Historical background information, unless otherwise indicated, is principally taken from exhibit labels displayed next to the maps in the exhibit, "You Are Here: Buffalo on the Map," on view from October 2014-2015 in the Rare Book Room of the Buffalo and Erie County Public Library.
3. "Buffalo, NY," Wikipedia, accessed February 21, 2016, https://en.wikipedia.org/wiki/Buffalo,_New_York.
4. "Pan American Exposition of 1901," University at Buffalo Libraries, accessed March 11, 2016, http://library.buffalo.edu/pan-am/.
5. Technical data for these and other Lascaux adhesives are available at http://lascaux.ch/pdf/en/produkte/restauro/58370.02_Adhesive_and_Adhesive_Wax.pdf.
6. Several temperature readings were taken from various spots on the face of the iron with a Ryobi IR Thermometer (model #IR002) and averaged.
7. To purchase your own copy of *The Christian Homestead Map* or other Special Collections items visit https://buffalo-erie-county-public-library-online-store.myshopify.com/.

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A Low-Oxygen Capable Storage and Display Case for the Proclamation of the Constitution Act

In memory of Shin Maekawa

ABSTRACT

Library and Archives Canada (LAC) holds the two original copies of the Proclamation of the Constitution Act, 1982 in the collection. One was signed outdoors and exposed to water droplets, and subsequently became known as the 'Rain Drop' copy. The second was signed indoors; however, it later suffered intentional damage from an activist in 1983. This copy is described as the 'Red Paint' or 'Red Stain' copy. Microfade testing conducted in 2011 by the Canadian Conservation Institute (CCI), concluded that the signature inks used on both copies are highly light sensitive. This information, coupled with an increasing demand for the long-term display and loan of the objects, compelled LAC to collaborate with CCI on the design of a pair of custom storage cases. The enclosures were specifically developed with the capability of maintaining low oxygen conditions for the duration of a typical loan, since the technique has shown promise for slowing the fading rate of many light-sensitive colourants.

The broader project included several sub-components: design and construction of the sealed inner display case (or storage case); design of a document mounting system suitable for display and transportation; and procurement of a specialized outer case that addressed additional functional requirements. These elements are described in the context of a loan that prompted rapid completion of the work. The results of preliminary lightfastness testing of fountain pen inks are also presented.

BACKGROUND

The Proclamation of the Constitution Act, 1982 is an extremely important document for all Canadians. It signifies Canada's evolution from colony to independent nation. The Proclamation brought into force the act that gave Canada the power to make changes to its own constitution, and also entrenched a Charter of Rights and Freedoms.

One copy was signed by Queen Elizabeth II during a ceremony on Parliament Hill on a rainy April day in 1982, and suffered light water damage. This copy is unofficially referred to as the 'Rain Drop' version. The other was signed privately indoors, later suffered intentional damage by a protestor, and has become known as the 'Red Stain' version. Library and Archives Canada holds both versions of the Proclamation in the collection.

This article details the successful collaboration between LAC and CCI to design and fabricate two custom storage cases to safely protect and house these important documents. A brief history of the Proclamation is also outlined for context.

VANDALISM

A little over fifteen months after the signing of both copies of the Proclamation, the pristine copy (signed indoors) was intentionally damaged. In 1983, 24-year-old Peter Greyson entered the National Archives building in Ottawa, posing as an art student conducting research on the design and calligraphy of the Proclamation. James Whalen, then archivist and custodian for the document, later wrote,

> As the well-dressed and polite art student had properly identified himself and appeared to be a legitimate researcher, I had no reason not to trust him and retrieved the Proclamation from storage. (Whalen 2006, 291)

Greyson asked to be left alone to study the document, but his request was refused. He began leaning over, and suddenly there was a red substance spreading out over the document. The liquid had been hidden inside Greyson's suit coat pocket and it was later found to be red paint that came from a small "Elmer Safety Glue" container. Later in court, Greyson testified that he was protesting against Prime Minister Pierre

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Trudeau's decision to allow the United States to test cruise missiles over Canadian air space. Greyson stated that he believed this was a violation of his rights under the new Canadian Charter of Rights and Freedoms (Whalen 2006, 293). The previously undamaged copy subsequently became known as the Red Stain version.

TREATMENT CONSIDERATIONS

The conservation labs were fortunately located in the same building at the time of the incident, and went into immediate action. Conservators began by attempting to remove as much paint as possible through suction; however, due to the nature of the paper (hand-laid Manitoba Flax), the paint was quickly absorbed leaving the document permanently stained.

Over the next few months, different tests and analyses were carried out and various treatment options were considered: chemical destruction of pigments; photo-chemical bleaching; laser cleaning technology; and physically altering the document (removing and replacing the stained area). On December 9, 1983, in a letter to W.J. Kozar (Director General, Canadian Conservation Institute), K.F. Foster, (Director General, Conservation and Technical Services, National Archives of Canada), summarized the lack of progress to-date:

> The present situation offers a difficult conservation problem, recognizing that the paint is lead-based and inert, we are presented with a problem against which no conventional conservation process has proved effective. We would appreciate it if your staff could review the reports and offer any advice they think might be helpful in this matter. (Foster, 1983)

Eventually, after many months of testing and weighing of options, then Dominion Archivist, Dr. Wilfred I. Smith made the decision that the stain should be left. The vandalism had become part of the history of the document, and any attempts to alter or replace portions of the document would affect its authenticity and integrity (Whalen 2006, 295). This incident had long-term effects on access and security procedures for prestigious documents at LAC and factored heavily into the design of both new storage cases.

EXHIBITION HISTORY

The two copies of the Proclamation have been exhibited extensively since 1982, and their popularity as exhibit items often led to discussions over the cumulative effects of exposure to light. From 1987 to 1998, both copies were alternately displayed every July 1st at 395 Wellington Street in Ottawa. In 2000, both versions were on display in the Hall of Honour on Parliament Hill for a period of five months. This was followed by a loan of the Rain Drop copy to the Royal Ontario Museum in 2008. In September 2014, the Rain Drop copy was loaned to the Canadian Museum for Human Rights (CMHR). The timeframe for the loan to the CMHR created the deadline for the completion of work described in this paper.

It is difficult to estimate the total cumulative light dose for each document since accurate data regarding lux levels and duration of past exhibits were not always recorded. From the information available, a conservative estimate of total exposure to date (calculated prior to the most recent loan of the raindrop copy to CMHR) amounts to approximately 4,000 hours of display for each document at varying lux levels and light sources. This information, along with the results of microfade testing on the signature inks (indicating that they continue to be at risk of fading), underscored the urgency to fabricate a custom storage case and a secure display case prior to the loan of the Rain Drop copy to the CMHR.

LIGHTFASTNESS EXPERIMENTS

MICROFADE TESTING OF THE DOCUMENT SIGNATURES

Microfade testing (MFT) (Whitmore, Bailie and Connors, 2000) was performed on the document signatures in 2011 by scientists from the Canadian Conservation Institute (Tse and Begin, 2013) to determine their sensitivity to light fading. The test results indicated that the synthetic dyes in the fountain pen inks used to sign the documents were highly light sensitive, and correspond to Blue Wool (BW) ratings in the range of BW1 to BW3. As a result of this finding, it was evident that the signatures were at risk of significant fading if the documents continued to be displayed as frequently as they had been in the past. Due to the fugitive nature of the inks, and high demand for exhibiting the documents, the benefits of a low-oxygen case were investigated. This was considered in parallel with conventional approaches for mitigating light damage in a museum setting.

TESTS ON PREPARED INK SAMPLES

In a second phase of the lightfastness analyses, experiments were performed on prepared ink samples to allow for greater flexibility with test conditions (Hagan and Tse, 2013). An ink cartridge was available at LAC that was believed to contain ink from a pen used at the ceremony in 1982 (labelled Cross black). Analysis of the reflectance spectra suggested that the ink was not identical to any of the signatures; however, it was still used for comparative measurements. In order to investigate the potential benefits of low oxygen for slowing the rate of fading, a custom test cell was constructed. Figure 1 shows the machined aluminum block with gas fittings for entry and exit of the control gas. A sealed window made from low-iron, anti-reflective, glass provides access to the sample for MFT measurements within the controlled environment.

Samples from the ink cartridge were tested on writing paper, and also as separated components on chromatography paper. Results showed a small improvement of lightfastness

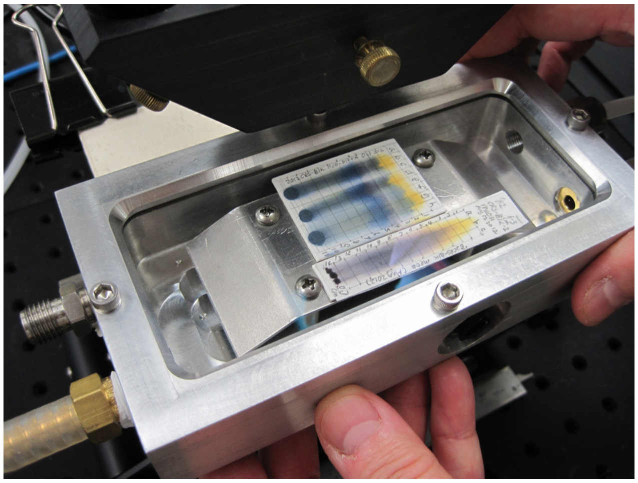

Fig. 1. Enclosure constructed for performing microfade tests under controlled oxygen and relative humidity conditions. Image shows testing of a chromatographic separation of a black fountain pen ink.

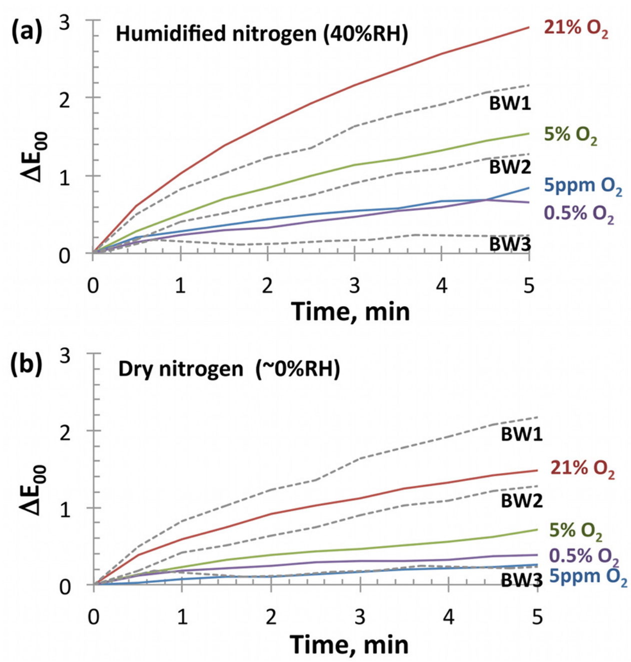

Fig. 2. Microfade test results from a purple component of a black fountain pen ink under varied oxygen concentrations: (a) 40% RH wit; (b) 0% RH. Results shown relative to ambient Blue Wool data.

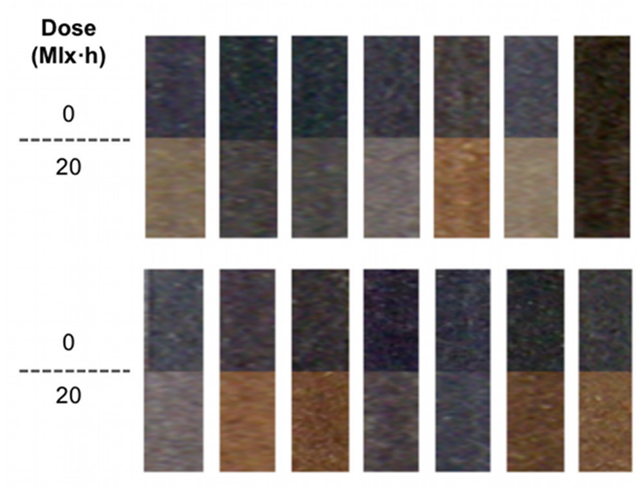

Fig. 3. Image of 14 dye-based fountain pen inks unexposed to light, and exposed to a dose of 20 Mlx·h. Sample ink strokes were prepared on buffered paper with a broad 3 mm wide fountain pen nib.

for the whole ink under low oxygen, and higher improvement for a separated fugitive component. Figure 2a shows the results from testing a fugitive violet component of the ink exposed at 40% relative humidity, and varied oxygen levels. Lowering the oxygen concentration decreased the rate of fading—particularly down to the 0.5% condition. Figure 2b presents data from a similar set of tests using dry nitrogen gas. These results indicate that relative humidity also has an effect on the fading rate of the colourant. Unfortunately, this benefit cannot be fully capitalized since an extremely low moisture content would cause deformations and stresses between bonded materials.

A series of conventional lightfastness tests were also performed on strokes of fountain pen inks using light-boxes with a custom-built enclosure to provide separated zones with ambient and anoxic conditions. Figure 3 shows an image of 14 black dye-based writing inks that were exposed to a light dose of 20 Mega lux hours (Mlx·h) at approximately 20klx. The experiments showed that writing inks are typically in the Blue Wool 2-3 lightfastness category (highly fugitive). These unsuitable products can be avoided by selecting pigmented inks; however, they are typically a special order and lack availability at local office suppliers. Results from the low oxygen experiments indicated little to no visible change of the inks at the same dose.

CASE DESIGN

Funding for the project was approved in 2013, and it was determined that the deliverables would include the construction of two storage cases built to meet the specifications provided to the supplier by LAC. The functional requirements were considered at the onset, and several design specifications and limiting factors were outlined:

- Leakage: hermetically sealed with a leakage rate sufficiently low to permit low oxygen display.
- Glazing: forced entry resistant, UV filtering, anti-reflective and low-iron content.

- Stability: construction involving relatively inert materials, suitable for long-term object display.
- Illumination: control and monitoring of light levels.
- Practicalities: modest budget, short time-frame for delivery (constrained by an upcoming loan).

After reviewing close to a decade of previous research that had been performed at LAC on preservation and display requirements for these documents, the decision was made to segregate the preservation specifications from the majority of the security specifications. The rationale for this separation was that it was not necessary to have a high forced-entry rating for the storage case since it would be primarily located in a secure vault. Instead, the storage cases were designed to address preservation concerns, and to fit seamlessly inside a separate display case that addressed the bulk of the security and lighting requirements during exhibition periods.

This decision would lead to the creation of two separate projects, one for the two storage cases and one for a single custom display case built to accommodate either of the storage cases. Drawing inspiration from the custom cases built by other institutions (National Bureau of Standards 1951; Maekawa 1999; Robinson 2011), LAC and CCI began a collaborative project to design the cases and coordinate their manufacture through local fabricators.

STORAGE CASE (INNER CASE)

The design for the storage case was developed through consideration of related work from the Getty Conservation Institute (GCI) (Maekawa 1999; Beltran, Druzik and Maekawa 2012), Tate (Lerwill, et al 2015), and the National Institute of Standards and Technology (NIST) (National Bureau of Standards 1951; Robinson 2011) in the U.S. This included developments in low-oxygen case design, and also materials testing to determine the benefits and risks of displaying objects under such an environment.

After consideration of design options, it was determined that it was feasible to construct a low-oxygen capable case within the project budget. A solid model was constructed in computer-aided design (CAD) software for the various components, which was then passed to the fabricator for manufacture. Due to the slim profile of the object, it was practical to machine the lid and base from solid aluminum billets. Machining included several tooling stages: cavities in the blocks (document display, accessory compartment and glazing recess), holes for fasteners and gas fittings, and o-ring grooves. Figure 4 shows a simplified cross-section schematic of the primary assembled components. The lid has a machined cavity, a recessed slot for the glazing, and threaded holes for the perimeter fasteners applied from the base underside. The base has a two-step machined cavity for the document display chamber (top), and storage of accessories (bottom).

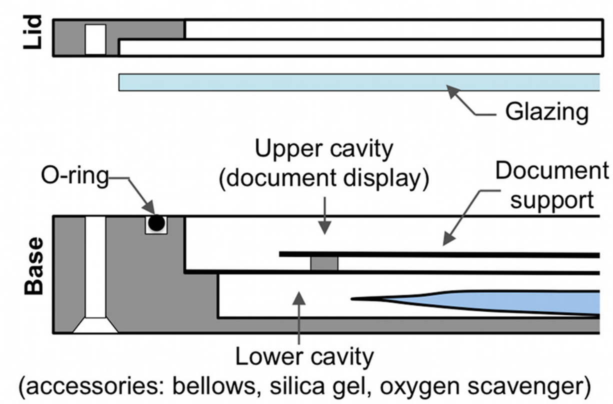

Fig. 4. Simplified cross-section of the case design showing the lid, glazing, and base components.

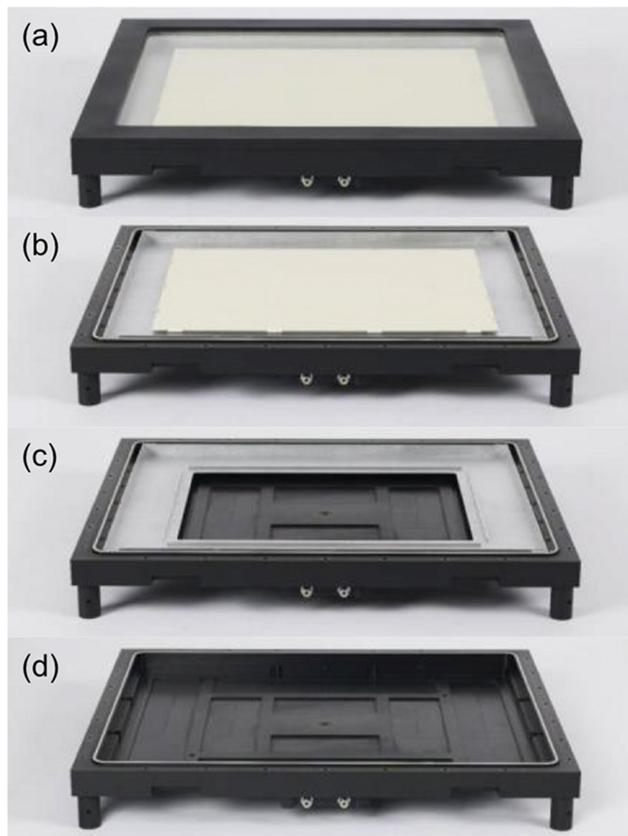

Fig. 5. Images showing disassembly of the case components: (a) complete assembly; (b) lid removed; (c) document support plate removed; (d) base only.

Accessories included the bellows, conditioned silica gel, and activated carbon.

Figure 5 shows four images of the case that were taken prior to final anodizing of the inner metal components: (a) complete assembly; (b) lid removed; (c) document support plate removed; (d) base only. The lid is removed with detachable handles, and the inner document mounting plate is a separate assembly that is removable from the central support plate that separates the viewing chamber from the accessory cavity below (compare Fig. 5b and 5c). In Figure 5d, the base is shown alone with the detachable feet that allow for flexible mounting options within the final display environment. Gas fitting connections are located on the front underside for easy access, while concealed from view.

The completed base assembly was also fitted with a partially inflated bag (bellows) made from heat-sealed aluminized film (Marvelseal). The bellows is connected to a small hole situated underneath the case, venting to the outside environment. This safety feature allows the bag to change size and avoid a pressure differential between the case and the outer environment. Such a situation may occur due to barometric pressure fluctuations, or temperature changes from the condition when the case is initially sealed. The volume of the bellows was not designed to accommodate pressure changes that may occur during air travel; therefore, transportation is restricted to ground travel while sealed (unless special modifications are made). Figure 6a shows the base of the case with the bellows, while Figure 6b shows the underside with the tubing, gas fittings, mounting bracket, and central vent.

An important aspect of the project that required considerable attention was the way in which the document was mounted inside the case. After much discussion, it was decided to physically secure the document around the perimeter as discretely as possible. A custom clip design was developed that uses magnets to hold them in place at predefined points around the perimeter. Figure 7 shows a schematic of the clip design and associated components. The clip was made from steel (magnetic) and formed into a C-shape with a slight hook on the lower end. After assembly, the magnet holds the clip against the lower surface, and the hook prevents the clip from sliding out from the plate. The machined recess on the underside of the plate also prevents the clip from translating side to side. In order to provide gentle pressure against the document, a film of Mylar was formed to fit inside the clip, and overhang slightly onto the document surface. The top surface of the Mylar was roughened with 400-grit sandpaper to reduce reflections, while still providing transparency since it was directly against the document.

Transportation of the case with the object installed raised concerns about how well the assembled components were secured. Several precautionary measures were added to the design in order to provide additional restraint. Small shims of paper, of equal thickness to the document, were attached to the mat board layer at each clip location. These were used to prevent rotation and shifting of the document, and also ensure that the Mylar remained flat along the top surface. When the document plate was secured within the case from the underside, a perimeter of raised metal bars prevented any additional

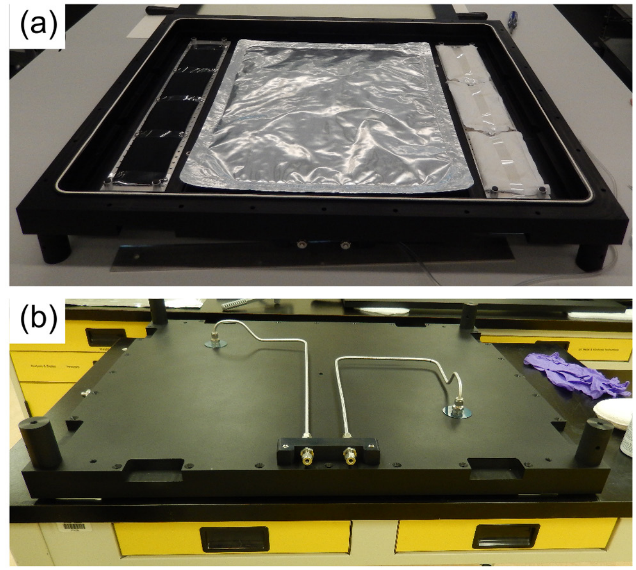

Fig. 6. Images of the base with added accessories: a. top view with bellows activated carbon and silica gel; b. bottom view with tubing, gas fittings and mounting bracket.

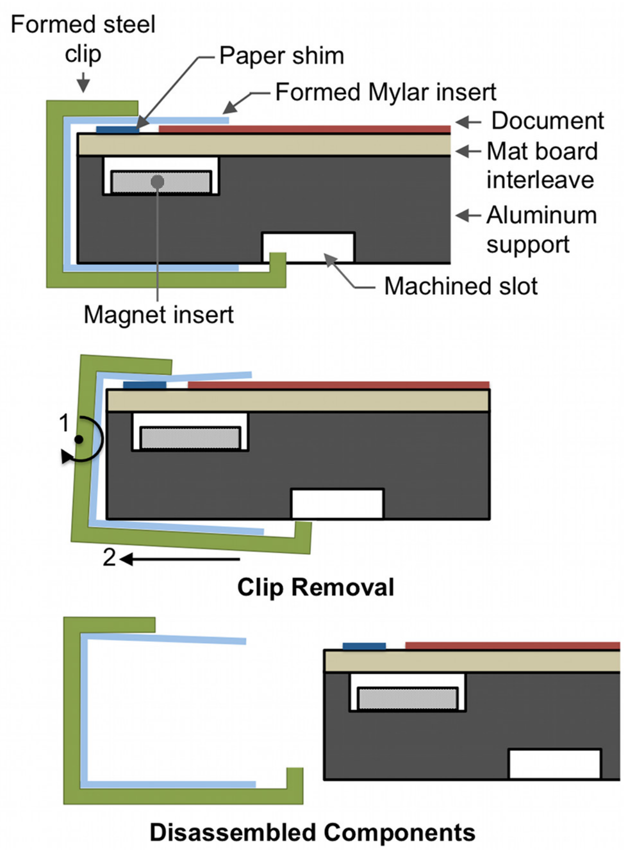

Fig. 7. Cross-section illustration of the clip design used to secure the documents to the support plates.

motion of the clips (slightly visible in Fig. 5c). Finally, lock washers were added to the fasteners beneath the plates to prevent loosening in the event of prolonged vibration.

LEAKAGE TESTS

Prior to installing the documents in the new cases, air leakage tests were performed at CCI using an OxySense optical oxygen analyser. The first experiment was performed with a dry o-ring after flushing the case with nitrogen to remove oxygen. The leakage rate was over 200 parts-per-million per day (ppm/d), which is relatively high for maintaining a low oxygen environment. The second test was performed with silicone grease on the o-ring, which lowered the rate to approximately 20ppm/d. The reduced leakage rate is attributed to the fact that the silicone grease fills imperfections between the mating surfaces. Points of weakness include surface roughness on the base of the machined o-ring groove (esp. machining lines), and the splice joint where ends of the o-ring cord are bonded. Based on these results, it was estimated that after a year, the case would stay below 0.75% oxygen if it is flushed to 100 parts per million without using oxygen scavenger packets. With the oxygen scavenger packets, the case would maintain ppm levels of oxygen for an extended period of time. This fulfills the functional design requirements for a typical loan period.

DISPLAY CASE (OUTER CASE)

The display case was designed and manufactured by Zone Display Cases, a company based in Quebec City. Library and Archives Canada stipulated that the enclosure must meet the necessary security requirements, transport easily to venues across the country, and easily accommodate the two new storage cases. It was also used to address many of the lighting concerns.

In addition to providing a method to securely display the documents, the display case included specialised glazing to control illumination, and a device for monitoring light exposure. Many layers of glazing were incorporated in the design to address a variety of functions. A panel of security glass was used to protect the document from forced entry, and an additional layer of VariGuard (Smart Glass) was added to control the duration of light exposure. By default the glass is opaque; however, when the visitor presses a button, an electrical current excites a material between the layers of glass and it becomes transparent. After a predefined amount of time, the glass reverts back to its opaque state. The signal from the button was also used to activate a set of LED strips to illuminate the document from between the two cases. Finally, a top layer of glazing, which is easily replaceable, served to protect the more valuable glass underneath from scratches.

The display case also features a digital counter to track the cumulative light exposure as visitors to the museum pushed the button. A timer hidden inside the case controls the length of time that the document is visible each time the button is activated. An elapsed time indicator adds the exposure time and allows LAC to monitor the total light exposure while on display through a dose calculation from the known lux level.

CHALLENGES

This project came with many challenges. The idea to build custom cases for these two documents had been discussed several times over the past 30 years. Reading through the large volume of previous research already accumulated on the topic was very time consuming. The timelines for a project that required consultation with many stakeholders was very tight. Testing and design work often had to occur in parallel and designs needed to be adjusted along the way.

Many hours went into determining which materials would be best suited for the project. For example, the first supplier that was approached for the glazing could only provide glass in large uncut sheets. This was not feasible due to budget constraints, so it was necessary to find a different supplier who could cut the glass to our requested dimensions.

Safely mounting the documents to the inner support plate proved far more complex than initially expected. Each document surface was wavy; therefore, it was decided to secure the clips only at the 'valleys' (lowest points) around the perimeter. This required careful measuring and mapping for accurate placement of each clip. The plates were then machined with recesses for the magnets, and slots for the clip restraint using this information.

Finally, it was a significant challenge accomplishing the design specifications while also minimising the associated cost.

PERMANENT INK GUIDELINES

A separate but critical issue that arose from the microfade testing of the signature inks was the need to establish national guidelines or standards for "permanent" inks to be used in signing nationally significant documents. The results of lightfastness tests confirmed that products advertised as pigmented inks have lightfastness ratings significantly higher than conventional formulations that use synthetic dyes.

It was initially thought that standards for writing inks might be used as a guide for ink selection since manufacturers occasionally reference them. Unfortunately, the existing ISO standards are too vague with respect to lightfastness requirements; for example, "The line shall remain visible when tested as specified". (ISO 14145-2, Roller ball pens and refills—Part 2: Documentary use). For archival preservation, an acceptable dose of light exposure to just noticeable fade must be specified. While the British Standard (BS 3484-2:1994 Record inks—Part 2: Specification for permanent inks) is on the right track, testing must be conducted to identify which inks comply with the standard. (…"The ink shall show resistance to fading not less than the equivalent to that of blue wool number 5, grey scale number 4").

Short of legislation or internal policies that require the use of a standard ink, which would be difficult to enforce given constantly changing ink formulations, the simplest most immediate approach with broad impact is EDUCATION. By developing guidelines on choosing permanent inks, LAC should be able to significantly reduce the risk of inferior ink entering the collections by explaining how to choose quality, lightfast permanent ink, and/or providing an approved list.

A letter recently sent out by the Chief Librarian and Archivist of LAC to various federal government agencies asks for their cooperation in promoting the use of pens with lightfast pigmented ink. Corrections Canada, Statistics Canada, the Canadian Nuclear Safety Commission, and Public Works and Government Services Canada (PWGSC) are just a few of the departments that have responded positively. A list of recommended products advertised as pigmented inks is included at the end of the letter. The list is not intended to be exhaustive, and institutions are encouraged to consult product information to determine the nature of the ink colourant.

In the meantime, additional ink samples are being collected for a second phase of lightfastness tests that will be conducted shortly. Library and Archives Canada intends to share information on lightfast inks of high permanence on the LAC website, and through social media in the near future.

CONCLUSIONS

The storage cases and the display case each represent one part of a two part system. Together, they provide the necessary preservation, display, and security requirements to protect two of Canada's most important documents. Moreover, initial steps towards the establishment of national permanent ink guidelines demonstrate leadership in the archival community and a practical effort to encourage the use of lightfast, reliable products that will prolong the life of national archival holdings. The success of this collaborative project has opened doors to the possibility of creating more custom storage cases for LAC treasures and continued research into permanent ink products with continued collaboration with the Canadian Conservation Institute.

ACKNOWLEDGEMENTS

We sincerely thank several people who helped to make this project a success: Lisa Hennessey for her work managing the design process for the display case, and staff at Zone Display Cases for developing and manufacturing this unique outer enclosure. Jamie Louks for his role as security advisor for both projects, and Luc Voyer and Rick Cooke for advice during the planning phase.

MATERIAL NOTES

Cases based on the designs and technology discussed in this paper are available in various sizes worldwide from Zone Display Cases:

660 de l'Argon
Québec, QC
G2N 2G5
url: http://zonedisplaycases.com/
T: +1 418-841-4004

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The Coptic Bindings Collection at the Morgan Library & Museum: History, Conservation, and Access

ABSTRACT

The Morgan Library & Museum (ML&M) houses the largest single cache of Coptic manuscripts and bindings in the world. The manuscripts were discovered in a hidden well, intact, but in a deteriorated state, in the Faiyum Oasis near Hamouli, Egypt in 1910. This paper describes the discovery and purchase of the collection, the conservation and restoration of the manuscripts and their bindings at the Vatican, their eventual return to the Morgan Library, and the digitization and rehousing of the collection.

THE COPTIC BINDINGS COLLECTION

This discreet collection of volumes, known officially as The Morgan Library & Museum's Coptic Bindings Collection, is made up of over 50 volumes, 49 of which were part of a collection discovered at Hamouli, Egypt, in 1910. The village of Hamouli is in the desert oasis region of al-Faiyum. The governate of al-Faiyum is located along the River Nile, approximately 60 miles south of Cairo. These manuscripts were copied on parchment in the Sahidic dialect of Upper Egypt and bound during the 9th and 10th centuries. Paul Needham writes, "In 1910 the library of the ancient Coptic monastery of St Michael of the Desert was discovered in the southern Fayum, near the village of Hamuli. Nearly sixty parchment volumes were found in a stone cistern, many still in their original bindings; they compose the largest surviving group of intact Coptic codices coming from a single source." (P Needham, 1979, 12).

J. Pierpont Morgan purchased the collection of codices just over 100 years ago. This paper will focus on the story of the bindings themselves and will touch only briefly on the rebound manuscript text blocks, which also reside in the vaults at The Morgan Library & Museum. The bindings were separated from their text blocks shortly after being purchased in 1911, and since then, have remained almost entirely inaccessible. Due to their extreme delicacy and their historic importance, an appropriate re-housing plan had been difficult to determine. A great deal of research and a thorough review of the bindings' care was undertaken by Deborah Evetts, the long-term Head of Book Conservation at The Pierpont Morgan Library, after she began working with the collection in the early 1980s.

Though little has been officially published regarding the bindings or the text blocks, a photographic facsimile edition of the collection was completed in 1922 and has permitted its limited study and the addition of its contents to the field of Coptic and ancient Christian literature. The facsimile edition of the volumes was made at the Vatican Library and it photo-reproduced each of the manuscripts in its own, separate volume.

The discovery of the manuscripts in the desert in 1910 held the only evidence at that time of the existence of the monastery of the Archangel Michael, and the contents described a well-organized operation and active devotional life. Despite the Copts being a tolerated minority across both the Christian Byzantine and then Islamic Egyptian worlds, it is speculated that the monastery may have been destroyed or disbanded around the year 1000 in a spate of religious persecution, a belief supported by the span of colophons (823-914 CE) found in the Hamouli manuscripts. None of the colophons are later than 914 CE. At the time of purchase, "At least five of the codices had already strayed, and are now in the Coptic and Egyptian Museums in Cairo, and a number of fragments, broken up from whole codices after the find, were more widely dispersed. That the remainder was kept together was due especially to the efforts of Professors Emile Chassinat and Henry Hyvernat", both of whom are discussed below (Needham, 1979, 12).

Certainly familiar to manuscript researchers, Coptic scholars, and book historians, the collection is instantly recognized by its Gospels binding, from approximately 850 CE (fig. 1). The central design element details the delicate strips of vellum that the binder laced through a single piece of

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Fig. 1. Image of the upper cover of the Gospels binding MS M.569, ca. 850 CE, ML&M; Courtesy of Graham Haber.

Fig. 2. Detail of central design element on upper cover of the Gospels binding MS M.569, ca. 850 CE, ML&M; Courtesy of the authors.

cut red leather. The gilded leather is described as silver leaf and varnish followed with a colorant by Theodore Petersen in his unpublished *Coptic Bookbindings in the Pierpont Morgan Library* (fig. 2).

THE BINDINGS

These Hamouli manuscripts offer a wealth of information as a unit, and as such, help to build an accounting of the state of Coptic bookbinding from the region of northern Egypt in the 9th and 10th centuries. The educational power is displayed in the repeated examples of sewing structure, board attachment method, covering details, and decorative elements (figs. 3-5). These volumes carry forward the story of how bookmaking was changing, following on the heels of other studied manuscripts from the centuries previous like the collection of Nag Hammadi manuscripts from the 3rd and 4th centuries housed at the Coptic Museum in Cairo, and individual examples of 5th and 6th century wooden board Coptic bindings, such as the Freer Gospels at the Freer Gallery of Art, the Scheide Codex, in the collections of Princeton University, and the Glazier Codex, also in the collections of The Morgan Library & Museum. Unlike these tremendous finds, the Hamouli volumes make up virtually an entire monastic library, and show repeated examples of structural and decorative elements. Even detached from their text blocks, these covers tell a tremendous amount about the ongoing development of the Codex. The gap between the 5th and 6th century codices mentioned here and the 9th and 10th century Hamouli Manuscripts leaves a very long time between recorded examples of Coptic bookbinding structure, but many of the basic innovations developed in the earliest centuries of the Codex format remain largely unchanged through the 19th century, and continue even now in hand-bound art books and small fine press editions.

Emile Chassinat was a French Egyptologist and the Director of the French Institute for Oriental Archaeology in Cairo, and he was the first scholar to see and inspect the manuscripts following their discovery. Alerted to their existence, and encouraged by Chassinat's findings, Pierpont Morgan purchased the available manuscripts in late 1911 from the Parisian art dealer Arthur Sambon, following consultation with the Kalebdian Freres dealers based in Cairo and Paris, and had them shipped to New York. The force behind the acquisition was Belle da Costa Greene.

Belle Greene became Pierpont Morgan's personal librarian in 1905, leaving a new librarianship at Princeton. She was intelligent and savvy, and despite the fact that she was only in her early 20s when hired, she very quickly became the driving force behind the growing Library. Pierpont Morgan entrusted Greene with the funds and the autonomy to collect broadly and, for all intents and purposes, to run the library, which she officially did when she was named The Morgan Library's first Director when it became a public institution, welcoming visitors to the newly expanded Annex, in 1928. The combination of their skills, finances, and powerful personalities made Morgan and Greene a formidable collecting team. Belle was an extremely intelligent art collector, and with the backing of

Fig. 3. Binding detail, Coptic Bindings Collection, ML&M; Courtesy of the authors.

Fig. 4. Binding detail, Coptic Bindings Collection, ML&M; Courtesy of the authors.

Fig. 5. Binding detail, Coptic Bindings Collection, ML&M; Courtesy of the authors.

the great US financier, and then by his son, J.P. Morgan, Jr., over the next 43 years she built the core of the unparalleled collection of the Pierpont Morgan Library.

In 1910, with the discovery of the Coptic library, Greene put into motion the communication that led to its acquisition. She opened correspondence with Henry Hyvernat, a Coptologist and professor at Catholic University of America, in Washington, DC. Hyvernat became the scholar who shepherded, academically and physically, the Hamouli manuscripts through their next 25 tumultuous years, eventually passing the baton to his assistant, Theodore Petersen. Dr. Hyvernat and Belle Greene created a plan for the manuscripts, and set forward a 5-point contract addressing the needs of the newly acquired volumes. Hyvernat agreed, contractually, to 1. Collate and complete the collection, as possible. 2. Restore all of the manuscripts and the bindings. 3. Rebind all of the manuscripts in old or new bindings. 4. Produce 9 (a number that was later increased to 12) sets of a 56 volume facsimile collection to be distributed to prominent libraries and museums, and 5. Compile a complete catalogue of the collection. Following negotiations with the Prefects of the Vatican Library in Rome, Morgan and Greene decided to send his new manuscripts back to Europe to be restored in the well-respected Restoration Studio of the Vatican Library, and in 1912 the bindings re-cross the Atlantic, to be received in Italy by Henry Hyvernat.

The bindings were removed from the text blocks almost immediately upon arrival at the Vatican. "Unfortunately, the first step taken in restoring the books to health was the removal of all the bindings, an operation effected by Ehrle himself, with the aid of his desk scissors" (Needham, 1979, 13). In 2016, following decades of study of bookbinding structures and technical art history, the 1912 decision to cut the bindings from the manuscripts seems shocking. Yet, Vatican Prefect and medievalist Franz Ehrle was initiating the first step in preparing the volumes for the photography for the facsimile edition, while allowing more direct access to the contents. Regardless of historical context and hindsight, the bindings were separated from their parchment text blocks after 1000 years. They were wrapped in paper, labeled to indicate the manuscripts from which they were taken, and packed together in cartons, their needs to be addressed later, as stated in Hyvernat's contract with Pierpont Morgan.

Belle Greene was very protective of her role, and of Pierpont Morgan himself. In 1912, in her defense of their recent Coptic acquisition, Ms. Greene wrote to Morgan, saying freely:

> My dear Mr. Morgan:
> As you know me so well, it would be useless for me to disguise the fact that I am quite furious, and probably should wait until I calm down before I write you: but, also, as you know me so well, what is the use of that. It concerns the collection of Coptic manuscripts. The New York "World",

> which hates you personally, as you know, and will probably always do so, has published an article this morning, saying that the collection is not genuine; and I am writing to ask your permission, or rather your opinion as to the wisdom of my giving to the "New York Times" copies of the letters I have received from scholars all over the world, in which they state that this collection is of inestimable value and actually priceless. ……… I suppose you think I am crazy. I wrote you in the beginning that I am mad, and I am mad! I don't care what anybody says of me personally, but, if I had your permission, I would not allow the "World" to make such disgraceful misstatements unprotested.

To which Morgan replied via telegram "What World says unworthy your time or thought. Would ignore others. Will set straight. Love Going AIX Saturday." He signed it Flitch, his personal cable telegram sign off. Correspondence such as this letter and telegram from April of 1912 further indicate the closeness with which Pierpont Morgan and Belle Greene worked, as well as her confidence to speak with authority for the growing Morgan collection and decisions regarding acquisitions, even ones of this importance.

RESTORATION AT THE VATICAN

At the outset of the restoration, some of the covers were rife with wormholes, deteriorating leather, crumbling papyrus, and heavy losses, and were indeed in need of stabilization in the Vatican lab. The photographs taken of the bindings in the first stage of treatment evidence their varying states of preservation after spending centuries in the cistern that had safeguarded their existence. Their delicacy combined with their inaccessibility following removal from the text blocks meant that only a few people ever saw the actual bindings, either at the Vatican or following their return to the Morgan Library, and even Henry Hyvernat had produced a small-scale Photostat version to work from, as his contact with the materials was limited, as well. The treatment plan initiated between The Morgan Library and the restorers at the Vatican Library focused almost exclusively on the repairing and rebinding of the parchment manuscripts, which was carried out under the supervision of the head of the Restoration Studio, Augusto Castellani, the oversight of Prefect Ehrle, the project management of Professor Henry Hyvernat, and the watchful attention from New York, of Belle da Costa Greene.

Yet, as work got underway at the Vatican, World War I did as well, and the scheduled restoration and photography of the collection was gravely delayed. In the years that followed the arrival of the Coptic manuscripts in Rome, various new people became involved in the restoration project, further extending the schedule. In 1913, Pierpont Morgan passed away, leaving his collections and fortunes in the management of his son, J.P. Morgan, Jr, called Jack. As well, the head of the Vatican Restoration Studio, Augusto Castellani died, with the result that his brother began treating the volumes. Monsignor Ratti succeeded Franz Ehrle, the Vatican director at whose hands the text blocks had lost their original bindings. All of these changes, combined with the onset of the War, further tangled the already complicated thread of the project.

Fig. 6. Line drawing made at the Vatican Restoration Lab for proposed replica binding; Courtesy of Graham Haber.

Theodore Petersen, Henry Hyvernat's assistant and then successor at Catholic University of America, wrote later in his unpublished *Coptic Bookbindings in the Pierpont Morgan Library* "During the years 1919-1920 the covers had been treated. Their leather coverings had been oiled and waxed; many of their boards had gauze pasted over their papyrus faces and each binding had been packed between cotton in a separate cardboard box." In addition, exquisite line drawings were produced in the hope that exact replica bindings would be created for the restored text blocks (fig. 6). Yet the covers, stored away in cartons, suffered greatly in the ensuing years of European turmoil, incurring more insect damage before full eradication. Only in 1929 are they finally returned to New York, remanded by Greene.

In the years following the return of the manuscripts and their covers from Rome, Theodore Petersen researched the collection and its history, detailing the find even further. Dr. Petersen's unpublished manuscript became, and is still, the primary source of academic information about the collection, as the original bindings remained inaccessible. The remaining restored and resewn manuscript text blocks were also returned to New York in 1929.

REHOUSING

Rehousing the Coptic Bindings at The Morgan Library & Museum is not a new project at the Morgan. The rehousing was a high priority for Deborah Evetts, former Drue Heinz book conservator at the library. She, with the advice of book conservator Christopher Clarkson, had pursued numerous ideas to determine proper and safe housings for the bindings. In 1984, she discovered the bindings still in their crates shipped from the Vatican and immediately began a treatment and housing protocol. Her lecture and essay in the Bookbinding 2000 Conference detailing how she used Petersen's manuscript as a historical guide provide fascinating information on her efforts.

Deborah Evetts directed minor conservation interventions to a small number of the bindings, such as the consolidation of papyrus board edges, the use of thin skivers of alum-tawed skin to stabilize surface deterioration, and the bridging of precarious papyrus with Japanese paper to prevent loss. Additionally, she and Christopher Clarkson re-bound one of the manuscripts in quarter leather and wooden boards as a test to see if the entire collection should be re-bound. Eventually this idea was not pursued.

The bindings were housed in what were meant to be temporary folders made out of mat board, with each cover wrapped in glassine. The individual folders were then housed in Solander boxes. This was an effective housing method, but required several bindings to be housed on top of each other in one box. This was in part due to vault space limitations. Evetts continued to seek appropriate housing for the bindings. Housing prototypes through the years have included small scale mock up models of covers housed in deep matboard sink mats, non-adhesively sandwiched between Plexiglas with pressure tabs of mat board to keep the boards in place, and sandwiched between layers of shape-cut Plexi and placed in a frame for exhibition (fig. 7). These efforts tried to balance preservation, exhibition and minimal handling. All of these ideas and the concerns that led to their prototypes were part of the decision making process when this most recent housing campaign was undertaken.

The extreme delicacy of the bindings prevents any direct handling. The bindings, though consolidated, continue to deteriorate (fig. 8). Their age, importance, and condition led to the decision to house them non-adhesively, neither adhering anything physically to the objects nor securing them to a secondary support. Safe, inert housing material was required; something soft, non-pilling, and cohesive. Also needed was a housing construction that could allow visual access to the entire object, including its 3-dimensional details, without direct handling. The bindings need to be stored horizontally on shelves. Individual access is particularly important, allowing a single binding to be studied at a time, without adding the risks of moving multiple objects out of the vault with the goal of examining just one. High-resolution digital images were an essential step in the plan, updating the photographs taken in the first decades of the 20th century, and permitting detailed access to materials for researchers.

After a period of planning and scheduling, the results are very satisfying because the new housings provide the key element desired of rehousing projects-the ability to individually track collection material and safely house each Coptic binding. The T17 reinforced clamshell e-flute boxes (purchased from Talas) provide substantial support for the bindings. A cloth tab was added for easier opening of each box. The tabs were added after the boxes were constructed. Easier opening of the boxes means less movement for the bindings inside. The non-adhesive package in which each binding is housed consists of a top and bottom of 1/8" Artcare archival foam board and 4 layers of 1/4" Volara®, a closed cell

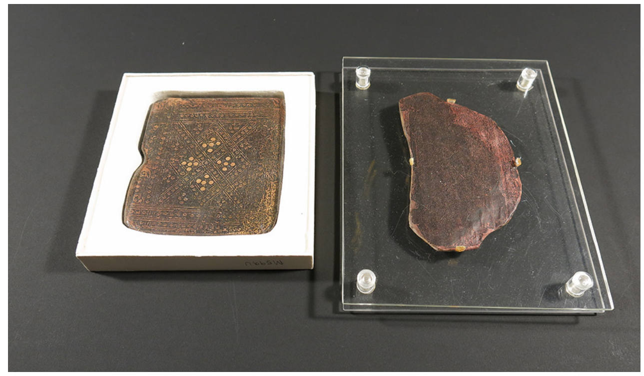

Fig. 7. Prototypes for Coptic Bindings protective enclosures; Courtesy of the authors.

Fig. 8. Deterioration of bindings makes handling difficult; Courtesy of Graham Haber.

Fig. 9. Binding in its "sandwich" of archival foam board, outer layer of Volara, and inner layer of laser cut Volara; Courtesy of the authors.

Fig. 10. Binding fragments rehoused; Courtesy of the authors.

Fig. 11. Large binding rehoused; Courtesy of the authors.

Fig. 12. Final individual housing; Courtesy of the authors.

polyethylene foam. The top and bottom layers of Volara are adhered to the sturdy foam board. The two inner layers house the bindings and are attached to each other and the outer layers of Volara with a system of punches and posts. The inner layers have a laser cut outline of the bindings that allow for the padded support of each binding (fig. 9). The inner layers of Volara accommodate the depth of the individual binding housed within. The University of the Arts in Philadelphia produced the layers of laser cut Volara. A detailed outline of each object and large fragment was drawn; this was turned into a vector drawing by a graphic designer using Illustrator software, which was in turn sent to the laser cutting lab at the University of the Arts. These inner layers have a perfectly cut outline of the binding, and serve as bumpers around the object without actually touching it. The binding rests on the uncut smooth layer of Volara, its recto and edges visible. The custom laser cut layers accommodates the binding depth. Each layer of Volara is held together with non-adhesive cut cylinders of foam to avoid any planar movement. This post, or sandwich, closed, can be gently inverted, and the Volara layers removed from the other side, revealing the verso of the binding, and all of its 3-dimensional details.

The large number of fragments associated with many bindings was a concern. It would have been too difficult to make so many small cutouts for the fragments and would have required more than one box per binding. Instead, fragments were housed in Mylar envelopes, barcoded with the parent binding information and housed in a single box with the other fragments (fig. 10). The housings were broken down into small, medium and large boxes to accommodate the different sizes of bindings and are stored in the Morgan vaults according to size (fig. 11). The bindings are now accessible to researchers in a safe housing (fig. 12). The images are currently in the process of being made available to the public on the Morgan Library & Museum website.

It has been a long journey from the Faiyum Oasis to the Morgan website for the Coptic Bindings Collection, but they are now fully and safely at home and await another century of discovery.

ACKNOWLEDGEMENTS

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The Recent Conservation Treatment of Portrait Miniatures at Library and Archives Canada

ABSTRACT

In many museums, the expertise for the treatment of portrait miniatures often resides in the objects or paintings conservation labs, while in archival related institutions, it often resides in one of the paper conservation labs. As with any specialty, the ability to maintain expertise over the long term requires a transfer of knowledge to other conservators. Since 2003, Library and Archives Canada (LAC) has invested in the development of in-house expertise for the conservation of portrait miniatures (Trojan-Bedynski et al., 2011). In 2015, a condition survey of LAC's portrait miniatures collection was conducted by conservators, with two main goals; to use as a tool in succession planning, to identify and address items requiring condition reports, conservation treatment, further monitoring or additional preservation care, such as re-housing or frame repair.

Portrait miniatures are subject to a wide variety of physical problems, often a result of inferior materials, poor handling or improper storage conditions. This paper will focus on the recent conservation treatment of several miniature portraits on ivory at LAC. Specific case studies will examine various conservation activities, including; documenting the condition of portrait miniatures, opening various types of encasements, cleaning and mould removal, consolidation of flaking paints, humidification and flattening of warped ivory, repair of cracked or broken ivory supports and the often lengthy process of acquiring and replacing a missing or broken cover glass.

INTRODUCTION

Early miniatures in Europe were painted with opaque colours on vellum. In 1705, Venetian artist Rosalba Carriera introduced ivory as a replacement for vellum. Artists recognized the translucent quality that an ivory support could lend to a miniature painting, which led to a rapid change from the use of opaque paints to more transparent watercolours. By 1720 ivory had replaced vellum as the most common support for portrait miniatures. (Aiken, 2000)

The portrait miniature collection at Library and Archives Canada consists of over 130 miniatures, which are part of a much larger portrait collection documenting the history of Canada. Though there are several early portraits as well, the majority of LAC's miniatures were created during the 19th century by European, American and Canadian artists, trained in French or English miniature painting methods. (Trojan-Bedynski et al. 2011) The majority of the collection is painted in watercolour on ivory, though the collection also contains enamel on copper, porcelain, card, vellum and glass supports.

SURVEYING AND CONDITION REPORTING

The recent condition survey of LAC's portrait miniatures collection, has allowed conservators the opportunity to assess and document the condition of each miniature and to transfer knowledge related to past treatments and history of the object. During the survey, photographs were taken of every item and a spread sheet was created specifically for conservation, which included the materials of each miniature and whether condition reporting, conservation treatment, monitoring or re-housing was required. (figure 1)

LAC conservators reviewed a variety of sample condition report forms from other institutions, which had been designed specifically for the documentation of portrait miniatures. A new, narrative condition report was created for LAC's miniatures, which allowed for the insertion of images and expandable fields of information. The 4 major components of each miniature; the paint layer, support, glass and frame components were described and assessed by grading their condition on a scale of 1-5. An overall condition rating for the object was then assigned and used to prioritize items most in need of conservation treatment. (figure 2) Condition reports were completed for all new items to the collection and included treatment proposals when conservation treatment was necessary. Conservation treatment of the miniatures

Presented at the Book and Paper Group Session, AIC's 44rd Annual Meeting, May 13–17, 2016, Montreal, Canada

			DRAWER 5				Page 2 of 2
Intellect. container label	photo	Title	Home loc. barcode #	Container barcode #	Media type	Mikan #	Content note
1984-119-1 MIN-070		Major John Norton, Teyoninhokarawen, the Mohawk Chief, painted by Mary Ann Knight, 1805	113402280005	2000792890	Watercolour, gouache and varnish on ivory	2836984	No treatment required. New frame created in 2013, foam opening in the storage box needs to be enlarged for better fit
1984-175-1 MIN-071		Actress Miss Jessie White Painted by Hugo Meisel, ca 1920	113402280005	2000792891	Watercolour on porcelaine, mounted on card	2837671	No treatment required. **Requires a frame and glazing.** Prepare specifications for a new frame
1984-118-1 MIN-072		Captain John Ross, R. N, painted by Mary F. Hamilton, ca. 1834	113402280005	2000792892	Watercolour on ivory in lg gold frame	2837341	Conditon report done: **Requires new frame and glazing** as current frame is damaged- Prepare specifications for a new frame
1984-168 MIN-073		Portrait Of Unknown Male (possibly a member of the Sise Family?)	113402280005	2000792893	Wax silhouette adhered to card, in a 2pc oval wooden frame	2939421	Condition report done: **Treatment required:** (Wax is cracked but still adhered to backing. Velvet from case interior is sticking to wax.)
1982-202-1 MIN-074		Admiral Sir Charles Ogle, Bart. Painted by Cornelius B. Durham in 1850.	113402280005	2000792894	Watercolour, (varnished), on ivory, adhered to 2 sheets of paper	2837556	Condition report and treatment proposal done. **Treatment required:** (Requires opening for cleaning of ormolu and treatment of the ivory)
1981-062-2 MIN-075		Madame Georgianne Chaussé, mother of the artist. Painted by Juliette de Lavoye, ca 1926	113402280005	2000792895	Watercolour on ivory with a 3pc hinged display case	2837558	no treatment required

Fig. 1. (LAC collection survey spreadsheet).

CONDITION AND TREATMENT REPORTS
MAPS & MANUSCRIPTS CONSERVATION LAB

Accession No.	0000-000 C-083509 MIN-028	Work order No.	NA
Mikan #	2939198	Bar code	2000792511
Examined by	Doris St-Jacques	Date of exam	May 11, 2015

DESCRIPTION OF OBJECT

Title	Simon Fraser, Master of Lovat, who raised the 78th Highland Regiment.	 Recto	
Artist	Unknown		
Date of Execution	ca. 1900-1910		
Object Materials	Parchment primary support (to be confirmed), card secondary support, push fit brass coloured oval frame with hanger, blank paper label on the verso, white paper oval spacer, oval convex glass		
Manufacturing Technique	Watercolour miniature portrait		
Object Medium	Watercolour, with flaked gold painted accents on the jacket.		
Inscriptions	On verso of the frame, 'Gen Simon Fraser 78th Reg'		
Primary support	Possibly parchment, to be confirmed after opening		
Secondary support	White card	Dimensions (cm H x W)	7.0 x 5.5cm
Frame/Encasement type	Push fit oval metal frame, with a hanger at top. Has been engraved on verso with 'K&co.' along bottom edge.		
Glass type	Oval, convex glass		

CONDITION

Surface layer	Relatively good condition, no evidence of surface dirt or mould.
Paint Layer	There are losses along the bottom edge, in the red area of the jacket, likely due to abrasion as the paint layer does not appear to be cracked or flaking.
Primary support	Slightly cockled, lifting from the secondary support at the bottom edge, though appears to be securely adhered overall otherwise.
Secondary support	White card is slightly cockled and has paint brush strokes around the miniature.
Frame/ Encasement	The bottom and left edge of the frame seem to have blood on the recto. There are several small, light scratches on the recto surface, while the verso has several, much deeper scratches overall. There are two holes in the metal of the frame back, likely where a stand was once attached, though has broken away at some point. The underside of the outer rim on the front of the frame is tarnished, as is the outer rim at the top of the frame. Scuff marks on the back surface have exposed the metal beneath the gold coloured finish. 

CONDITION AND TREATMENT REPORTS
MAPS & MANUSCRIPTS CONSERVATION LAB

Glass	The oval, convex glass contains pits and bubbles created during manufacturing of the glass
Previous repairs	None visible
Housing	Currently housed in a BS box with Japanese tissue covered Ethafoam.

Paint Layer Condition Rating	1	2	3	4	5
Support Condition Rating	1	2	3	4	5
Glass Condition Rating	1	2	3	4	5
Frame/Encasement Rating	1	2	3	4	5
Overall Condition Rating	1	2	3	4	5

RECOMMENDED TREATMENT		TIME
Open the frame, remove the miniature and clean the interior and exterior of the frame and glass. Examine and record the support material of the miniature. Seal (if possible) any exposed areas of the metal beneath the finish to slow future corrosion. Replace the current paper spacer with a properly cut spacer, made to fit the miniature. Re-assemble the miniature, spacer, glass and encasement.		
Documentation	Condition, recommended treatment and treatment reports Photo documentation BT, DT and AT	
Total		

APPROVAL FOR TREATMENT AS PROPOSED

Recommended by	Doris St-Jacques	Date	May 14, 2015
Approved by		Date	

Fig. 2. (New condition report created for LAC miniatures).

began with the items determined to be at the greatest risk, starting with any items containing mould. Miniatures were only opened if necessary and only if they were able to be treated at that time.

In 2011, the Journal of the Canadian Association for Conservation, published an article entitled '*A Portrait Miniature Project at Library and Archives Canada'*, by conservators Maria Bedynski of Library and Archives Canada, Carol Aiken, private conservator from Baltimore Maryland and Alan Derbyshire from the V&A museum. Tables in the article provide guidelines for the treatment of various repairs to miniatures on vellum or ivory and were a valuable resource for determining appropriate methodologies for recent portrait miniature treatments.

Case Study 1: Sir John Sparrow David (JSD) Thompson, Former Prime Minister of Canada

Our first case study is a 3.7 x 9 cm mourning brooch containing a portrait of Sir John Sparrow David Thompson by artist Bonne de Bock. (figure 4) Following Thompson's death, the brooch was presented to his wife, by their good friends Lord and Lady Aberdeen, the Governor General of Canada and his wife. The miniature is adorned on the recto with pearls and bull's eye agate stones. The pin clasp on the verso can be unscrewed and removed, allowing the locket to be attached to the accompanying bracelet and worn on the wrist.

Examination

Initial examination indicated the presence of mould, seen as a cloudiness on the underside of the glass. (Figure 5) The right side of the brooch containing the portrait, was filled with what appeared to be tiny wood fibres and dust. (Figure 6) An archivist at LAC had requested that the miniature be examined to determine the possibility of it being a painted photograph on ivory. Due to the presence of the mould and the dirt particles inside the locket, as well as the request from the archivist, it was necessary to open both sides of the locket to allow for proper cleaning and further examination.

The cover glass and portrait were held inside the locket by a pressure fit. It was possible to remove the materials from the locket by gently prying the metal bezel upward. The slightly deeper metal bezel on the right half of the locket, held the portrait and the cover glass together by means of metal prongs. (figure 7) These prongs required straightening to allow the portrait and the cover glass to be removed from the bezel. The cover glass was very slightly convex even though it was less than two millimeters in thickness, making it extremely delicate and impossible to replace if broken.

Once the bezel containing the portrait had been removed from the locket, it was evident that the support wasn't ivory as initially believed, but was white milk glass. Tin or Zinc oxide, lead arsenate and phosphates were among the most

Fig. 4. JSD Thompson mourning brooch, Before Treatment (LAC# R5240-28-1).

LEFT TO RIGHT

Fig. 5. Mould on the underside of the glass.

Fig. 6. Wood fibres and dust inside the portrait side of the brooch.

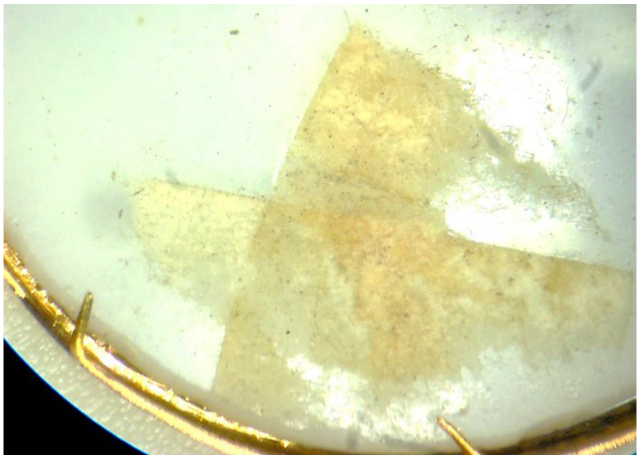


Fig. 7. Metal prongs on the verso of the bezel, holding the cover glass and portrait together.

Fig. 8. William Topley photograph of JSD Thompson (LAC # C-068645) on the left, and the portrait miniature (R5240-28-1) on the right.

Fig. 9. Images of the neck area of the miniature, viewed at different angles, showing several reflective grey areas in the portrait.

common ingredients used to produce white milk glass. In the Thompson miniature, the milk glass was a 'pot' or 'pot metal' glass, which is white throughout the thickness of the glass. (Whitman, 2007) The use of milk glass in painted portrait miniatures resulted in a similar luminescence to portraits painted on ivory and milk glass was a much less expensive alternative to ivory.

MILK GLASS AND OPALTYPES/OPALOTYPES

Further examination of the miniature was conducted by LAC conservators and photo conservator Greg Hill of the Canadian Conservation Institute, who agreed on the presence of a gelatin-based, positive photographic image under the paint layer.

The portrait was determined to be an opaltype, or opalotype, referring to the milk glass used as the support. The original opaltype technique was patented in 1857 by Glover and Bold of Liverpool, and involved wet collodion and silver gelatine. In general, opaltypes can be created using one of two basic techniques. Either a carbon print is transferred onto the milk glass, or a light-sensitive emulsion is coated on the glass surface, a negative image is exposed onto the surface and the emulsion is then processed. Analysis at the Canadian Conservation institute would be required to determine the exact photographic process used in this particular opaltype, as much of the image is heavily overpainted with an opaque bodycolour. Regardless of the exact *type* of photographic process beneath the overpainted image, only small areas of the miniature required conservation treatment. The consolidation of these areas would not inhibit further analysis of the miniature. The image used for this particular opaltype may possibly be a re-print of a photograph of Sir Thompson, by the famous Canadian photographer William Topley, taken in Ottawa in 1891, 3 years prior to Thompson's death. (figure 8) The Topley photograph is shown at the left, and the painted opaltype miniature is shown on the right.

These two images of the face and neck areas, have been photographed at slightly different angles to reveal the reflective qualities in some of the grey, yet unpainted areas of the miniature. (Figure 9) On the left, there are several grey areas around the mouth, the chin and the base of the neck. The image on the right shows those same grey areas as quite reflective, though the source of the reflectance cannot be attributed to the milk glass shining through, as these areas are grey in normal light, not white, as they would be if the milk glass was showing through. This is another indication of the presence of an emulsion layer.

An assessment of the condition of the paint layer revealed cracking and curling of the paint on the figure's lips, cheek and in the hair. (figure 10a-b)Tiny beads of gum Arabic had been applied around the edges of the lapel to simulate a satin trim on his jacket. (figure 11) A small area near the top left of the unpainted background was also flaking, though this area

Fig. 10a-b. Flaking paint in the hair, cheek and lips of the Thompson miniature

Fig. 11. Gum arabic on the lapel of the jacket, to simulate a satin trim.

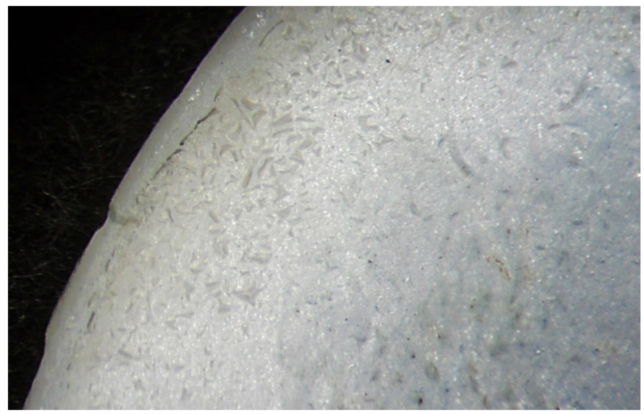
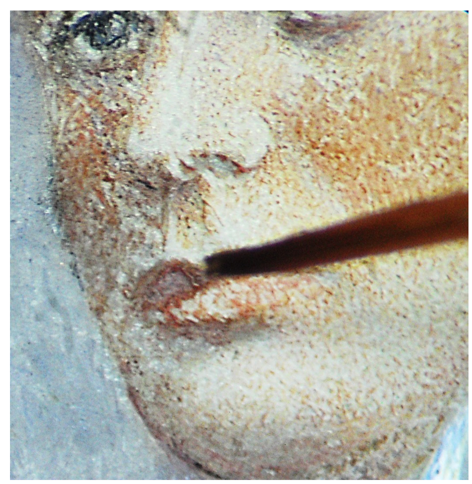


Fig. 12. An area of the unpainted, flaking background.



LEFT TO RIGHT

Fig. 13. Hand inscribed name of A Moreau and the date of 1895 inside the brooch.

Fig. 14. Cleaning the underside of the metal bezels.

Fig. 15. Application of a 1% gelatine consolidant to areas of flaking paint.

was unpainted, so the flaking was further indication of the presence of an emulsion layer on the glass. (figure 12)

CLEANING AND CONSOLIDATION

Following the removal of the contents of the brooch, two inscriptions of the name A. Moreau were revealed; they were scratched into the metal, along with the date of 1895, the year the locket was presented to Mrs. Thompson. (figure 13) The significance of the Moreau name remains unknown. The inner edge of the bracelet is stamped with the 'Birks' jeweller's name, indicating that the bracelet may have been fabricated at a later date than the locket, which does not bear the 'Birks' name.

The filigree wire around the hair strand in the left side of the locket was carefully cleaned with a fine bristled brush to remove green copper based corrosion products from between the twisted strands of wire. The cloth behind the hair was also cleaned to remove loose copper corrosion particles which had been transferred from the filigree wire. The undersides of both metal bezels were cleaned with a lightly dampened swab and soft brush to remove the loosened residue. (figure 14) The cover glasses were each immersed in water for several minutes to soften any surface dirt, and then cleaned with a non-abrasive glass polishing cloth.

Following testing of various adhesives, gelatine was selected as the consolidant using a 1% solution of 200 bloom Type B gelatin in reverse osmosis (RO) water. The cracked paint layer in the lip and cheek areas were consolidated by brush application, and the flaking emulsion layer in the background near the top of the miniature, was also consolidated with a 1% gelatin solution, applied with a Becker Ultrasonic mister. (figure 15) A fine application tip was used for the application, along with a Mylar mask, to confine the consolidant to the flaking area. The miniature was allowed to dry thoroughly.

The verso of the milk glass was cleaned using a lightly dampened swab to remove loose surface dirt and the remnants of a water soluble paper tape. A soft brush was used to clean the recto of the locket between the edges of the bezel and the stones. As both methods of consolidation were successful in closing the gaps in the cracked paint, no in-painting was necessary. The components of the locket were then re-assembled.

CASE STUDY 2: ETHEL AND ROBERT MCKENZIE

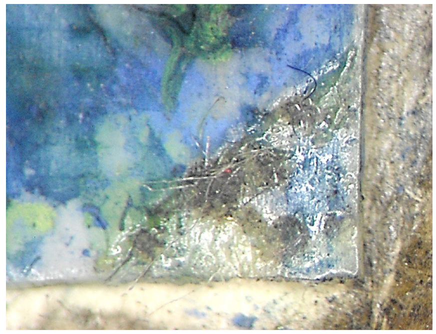
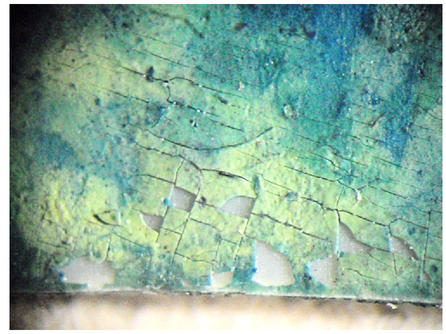
Our second case study includes the portrait miniatures of Mrs. Ethel McKenzie and her husband Robert Tait McKenzie, painted by Russian born artist Leo Dubson, in 1927. (figure 16) Dubson lived in Paris for many years, eventually working in the United States. The miniatures are 9.5 x 13 cm and both are painted in watercolour and heavily applied gouache bodycolour on very thin sheets of tangentially cut ivory. Leo Dubson used a stippling effect to create fine detail, combined with a scratching technique using fine needles to create highlights and texture in the paint layer. (figure 17)

Fig. 16. Portrait miniatures of Robert and Ethel McKenzie.

Fig. 17. Scratching technique used to create highlights and add texture.

CONDITION

On each of the two miniatures, an acidic wood pulp paper backing has been adhered at the corners with a proteinaceous adhesive, causing the backing paper to cockle as a result. The cockling of the paper caused distortion of the thin sheets of

LEFT TO RIGHT

Fig. 18. Each miniature was warped as a result of the paper backing adhered to the verso.

Fig. 19. Gummy adhesive on the recto of the McKenzie portraits.

Fig. 20. Cracking and flaking paint has resulted in many losses.

ivory. Each miniature was out of plane and warped along both axes. (figure 18)

Paper fibers were embedded in a gummy adhesive residue on the corners of the recto of both miniatures. Conservators were able to remove most of the adhesive mechanically with tweezers, though it was necessary to apply a small amount of 75% ethanol: water on a nearly dry brush, in order to sufficiently soften and remove the remaining adhesive without disturbing the paint layer. A thick layer of glossy adhesive was also present along the left edge of the recto of the Ethel McKenzie miniature, though it was water soluble. (figure 19) The thick adhesive was locally reduced with the use of lightly dampened swabs, without disturbing the paint layer beneath. Several areas in the paint layer on both miniatures were cracked, flaking and often they were no longer in contact with the ivory. (figure 20) There were many losses in the paint layer which was cracked and flaking, and the bare ivory was exposed in several areas. The areas containing green and yellow paint were badly cracked, while most of the blue painted areas were quite powdery and easily damaged.

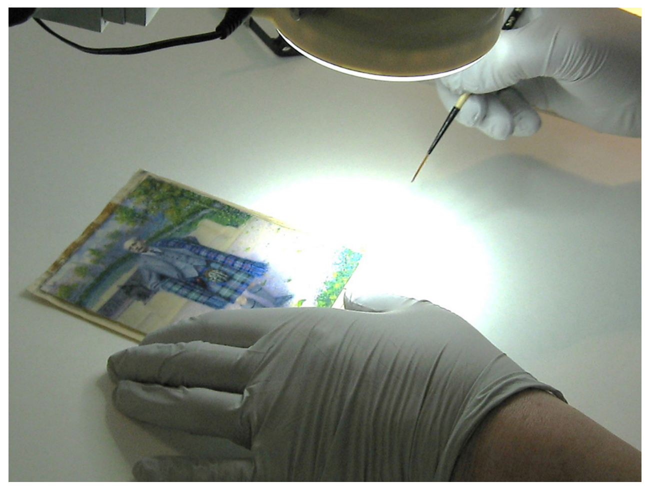


Fig. 21. Consolidation of the cracked and lifting paint, using methylcellulose adhesive.

PAINT CONSOLIDATION AND REMOVAL OF THE BACKING PAPER

Various adhesives were tested to find one which would not alter surface gloss, would be sufficient in strength to secure the flaking areas and would not alter the colour or solubilize the media. A 2% methylcellulose solution was selected as the consolidant for brush application to the cracked and flaking paints, coaxing them back into contact with the ivory. (figure 21) The blue powdery pigments were treated with a single application of 1.5% methylcellulose, applied with a Becker ultrasonic mister. Loss areas were not in-painted.

To reduce the humidity required for the removal of the backing paper, the paper was removed dry, leaving some paper fibres and the adhesive remaining on the corners of the ivory support. To protect the ivory from the application of too

Fig. 22. A mylar mask was created to protect the ivory during removal of the residual adhesive on the verso.

much moisture during the removal of the adhesive, a Mylar mask was created to protect the ivory, exposing only the areas where the paper fibres and adhesive remained. (figure 22) Squares of a rigid 3% gellan gum were applied to the corners exposed by the mask, allowing conservators to monitor the progress through the clear gel. After approximately 5 minutes, the gellan gum was removed, lifting the paper and much of the residual adhesive with it. (figure 23) The remaining adhesive was quickly removed from the ivory with swabs. This process was also repeated for both miniatures.

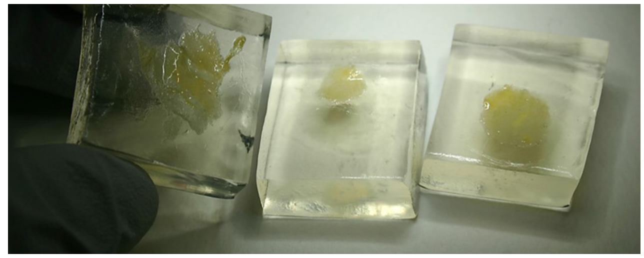
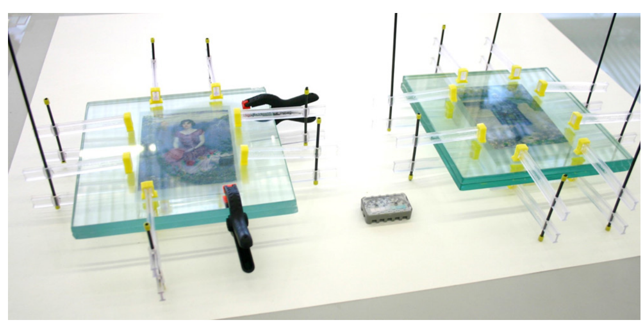


Fig. 23. When the gellan gum squares were removed, the paper and much of the adhesive was stuck to the gellan gum.

HUMIDIFICATION AND FLATTENING OF THE IVORY

The miniature of Ethel was placed in a tent over humidified Goretex, but the thin sheet of ivory began to react too quickly, so the miniature was quickly moved to a sealable plastic container, containing a bed of loose, non-decrepitating silica gel, conditioned to approximately 10% over the ambient RH. A plastic grate, covered with Reemay had been placed at the bottom of the container, to elevate the miniature off the surface of the silica gel. (figure 24) The container was sealed and the miniatures were turned every 30 minutes until the ivory relaxed easily when flipped over.

To dry a humidified ivory miniature, Alan Derbyshire of the V&A museum recommends the use of a silicone-coated paper on either side of the humidified miniature, placed between two sheets of glass and clamped during drying. As LAC conservators were unable to locate a source of silicone-coated paper, a trial was conducted using a silicone-coated Mylar against the recto of the miniature, with a layer of absorbent blotter beneath the miniature to prevent the retention of too much humidity against the ivory. Rare earth magnets were used to secure the layers together onto a metal plate beneath the ivory and blotter. (figure 25) Unfortunately, the strength of the magnets required to hold the layers together risked sudden movement of the magnets toward each other during the setup. As a result, the drying system was modified, placing the miniature between two sheets of silicone-coated Mylar and glass, clamping the edges of the glass to keep the ivory flat during drying. (figure 26) Once dry, the McKenzie miniatures were placed into sealed micro environments to reduce the possibility of future warping of the thin ivory. The sealed miniatures were then returned to their original frames.



TOP TO BOTTOM

Fig. 24. Humidification of the ivory using a sealed chamber with non-decrepitating silica gel.

Fig. 25. The use of rare earth magnets to dry the miniatures was deemed too risky, as the magnets could shift suddenly.

Fig. 26. The miniatures were clamped between silicone coated Mylar and glass to dry and flatten the ivory.

CASE STUDY 3: PORTRAIT OF GENERAL JAMES WOLFE

This last case study is a portrait of General James Wolfe, who is one of the most frequently painted figures in LAC's miniatures collection. The miniature is painted by an unknown artist, in watercolour with gum Arabic, onto a 9.2 x 11.8cm sheet of tangentially cut ivory. The portrait is a copy of a painting also by an unknown artist, which is part of the collection of the National Portrait Gallery in London. The frame is a pinned, ornate two piece metal frame, with a convex, rectangular glass. The verso of the frame contains the inscription: 'General James Wolfe, Born 1727, Died 1759'. (figure 27) An insignia and the date of 1927 had been painted into the miniature along the right edge.

CONDITION

The ivory sheet contained four full breaks, which extended from the top to the bottom edge, three partial breaks, which were also vertical in nature. The edges of the ivory pieces had begun to curl upward and there was evidence of previous retouching along the breaks. Darker paint colours contained a larger proportion of gum Arabic, and were therefore quite glossy in appearance. Some areas of the paint layer contained a scratch technique to create texture and highlights, though other areas in the paint layer had simply been damaged by abrasion. The miniature had shifted inside the frame and was in contact with the glass which, though chipped around the edges, was still intact. As several areas of mould and fungal growth had been identified on the underside of the glass, it was necessary to open the miniature to remove the mould. (figure 28)

OPENING THE PINNED FRAME

The metal frame was a two piece frame, (figure 29) held together with pins, though several pins were missing and those that remained did not have any head, so they could not be pulled out. The pins would need to be drilled or pushed inward. As drilling the pins inward could potentially damage the metal around the pin holes, conservators opted for pushing the pins inward, just far enough to allow the top layer of the frame to slip past the tips of the pins. Some pins moved much more easily than others, which was further explained once the frame was separated. Some pins, which were not original, were tapered, and could only be pushed in a short distance. (figure 30) Once the frame was opened, the exposed

Fig. 27. The inscription on the verso of the Wolfe miniature.

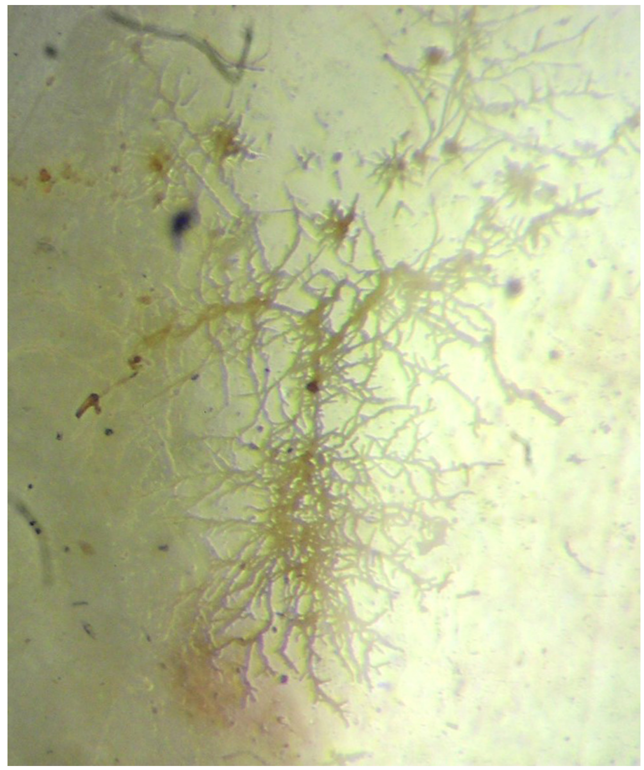
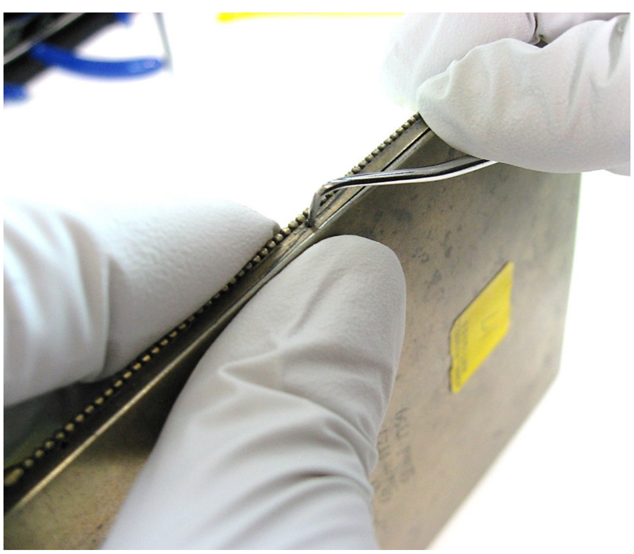
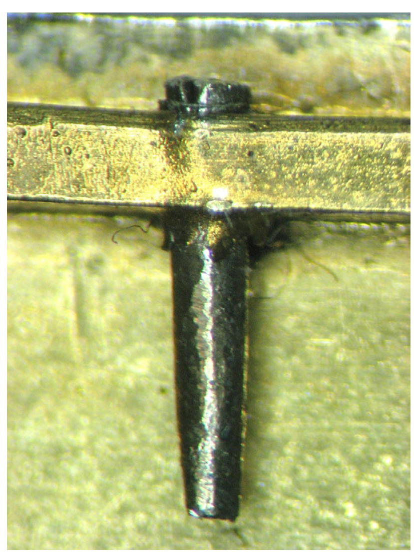


Fig. 28. Mould and fungus on the interior of the glass.





LEFT TO RIGHT

Fig. 29. The two-piece, pinned metal frame of the Wolfe miniature.

Fig. 30. A close-up of the tapered pins which complicated the opening of the frame.

Fig. 31. Separating the two card layers with a long, single-edged blade.

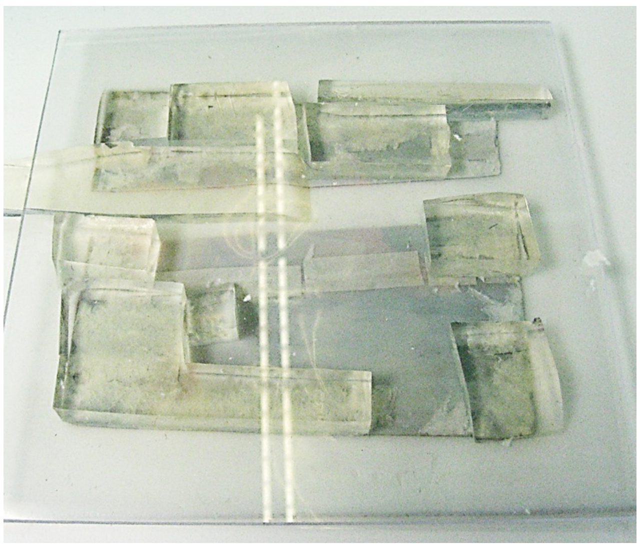


Fig. 32. The white paper tape on the verso of the break edges, was removed with a 3% gellan gum.

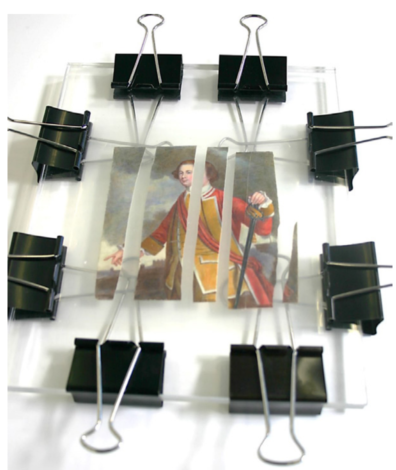
foil edge was carefully pried outward to allow for the removal of the miniature.

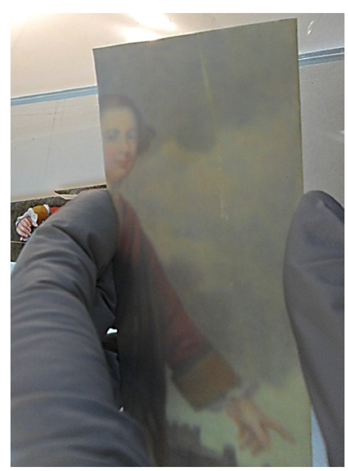
REMOVAL OF THE SECONDARY SUPPORT

The ivory support was adhered to two layers of card. The adhesive between these layers was dry and the cards had already partially separated. With the help of a long, flat, single edged blade, the two layers of card were completely separated, turning the miniature while using the blade to gently cut between the cards. (figure 31) The white, 2-ply card remained adhered to the verso of the miniature but since the adhesive between the miniature and the card was also quite brittle, the majority of the card was able to be removed dry, revealing a white, paper-based tape on the ivory, which had been used to repair the breaks in the support before it was mounted to the cards. (figure 32) A rigid 3% Gellan gum was used to soften the remaining adhesive and the tape, removing the residue with swabs.

HUMIDIFICATION, FLATTENING AND REPAIR OF THE IVORY

Immediately following the removal of the card layers and the adhesive, the miniature pieces were placed in the sealed humidity chamber, (figure 33) flipping the pieces every 30 minutes, over several hours, until evenly humidified. The pieces were then placed between silicone-coated Mylar and glass, clamping the edges until dry. (figure 34) The miniature was allowed to remain between the layers for several weeks while other treatments were completed. Breaks in the ivory were repaired from the center outward, beginning with the break along the right edge of the face. (figure 35) The miniature was held in the conservator's hand, applying gentle pressure to the break edges while applying small dots of cyanoacrylate adhesive to the verso along the break.





LEFT TO RIGHT

Fig. 33. Humidification of the ivory pieces, over pre-conditioned silica gel.

Fig. 34. Drying the humidified pieces between silicone-coated Mylar and glass.

Fig. 35. Repairing the miniature from the center of the ivory outward, using hand applied pressure.

LEFT TO RIGHT

Fig. 36. The repaired miniature, viewed from the verso in transmitted light.

Fig. 37. Each repaired break was reinforced from the verso with Japanese tissue.

Fig. 38. The repaired and in-painted portrait of General James Wolfe.

The miniature was kept almost vertical during this process to prevent the adhesive from seeping between the breaks and onto the image side of the miniature. Repairs continued in this manner, until all sections had been re-assembled. (figure 36) The miniature was then clamped between silicone Mylar and Plexiglas until dry.

The break edges were then reinforced on the verso using Japanese tissue and a very dry wheat starch paste, (figure 37) placing the miniature immediately back between Plexi to keep it flat during drying. The edges of the tissue were trimmed and the recto of the miniature was then retouched using Gamblin conservation colours. (figure 38) General Wolfe was then returned to his frame, using the same tapered pins to close the two piece frame.

GLASS REPLACEMENT FOR MINIATURES

The component of a portrait miniature which often poses the greatest difficulty is the cover glass. Miniatures can often contain several pieces of both coloured and clear glass within the same item. (figure 39) Convex glass replacement for small items presents several additional challenges. The metal bezel that the glass rests in is often so thin and so precisely fit to the glass, that once the convex glass is removed from the metal bezel, it is often impossible to fit them back together. If that precisely fit cover glass would ever require replacement, it would be absolutely necessary to provide that metal bezel to the glass maker to ensure a proper fit.

Past attempts to replace missing or damaged cover glasses for miniatures, have led LAC conservators from high tech optics companies, to blown-glass artists and watchmakers in various countries. At the moment we do not have access to a manufacturer of convex glass within Canada, so to have a very precise fitting cover glass made, it would be necessary to ship the metal bezel which surrounds the glass, to a glass maker outside of Canada, allowing them to customize the glass to fit the bezel. This is problematic, as a result

Fig. 39. Miniatures may contain several layers of glass, which can be challenging to replace.

of the Canadian Cultural Property Export and Import Act, which restricts the movement of cultural property out of the country. As a result, we are in need of a convex glass supplier within Canada and we are always happy to receive new contact information for glassmakers.

CONCLUSION

The recent survey and the development of a new, narrative condition report at Library and Archives Canada, have provided conservators with the opportunity and necessary materials to record the condition of portrait miniatures in greater detail and to use that information to identify miniatures which are at the greatest risk of damage. The ability for conservators to conduct conservation treatments on portrait miniatures in their collections, not only assures that miniatures in their collections will remain accessible, but could also provide institutions with a more detailed description of the materials present in the miniature and the techniques used in its creation. Ongoing work with miniature collections assures further contribution to the body of knowledge available on these unique materials and to the development and continuance of the expertise for those responsible for portrait miniature collections.

MATERIAL NOTES

- *Non-decrepitating silica gel:* A loose silica gel used to control the RH of the humidity chamber, as the gel does not readily disintegrate upon direct application of water.
- *Gellan gum:* A high molecular weight exopolysaccharide, used as a gelling agent in food, biomedicine and the pharmaceutical industry. When mixed with water and heated, it forms a gel upon cooling. Gellan gum is used at low concentrations (1-4%) for various conservation treatments, including washing of paper and stain removal, though deacidification and bleaching agents can be incorporated into the gel for use in paper conservation.
- *Opaltype or Opalotype:* Also known as a milk glass positive. This is a positive photographic image formed by carbon transfer, or by the application of a light sensitive emulsion onto opal glass /milk glass, onto which a negative image is exposed. The exposed emulsion is then processed. Opaltypes were never extremely popular and were no longer being created by the 1930's. (Osterman 2007)
- *Milk glass:* Also known as opal glass. A translucent white glass, which can be either 'pot' or 'pot metal' glass, meaning it is solid white, or 'flash coated', which coats a layer of white glass over the surface of clear glass. (Whitman 2007)

BIOGRAPHICAL INFORMATION ABOUT THE PEOPLE BEHIND THE PORTRAITS

Sir John Sparrow David (JSD) Thompson 1845-1894

Over the span of his career, Sir John Sparrow David Thompson served as a court reporter, a lawyer, alderman, attorney general of Nova Scotia, member of the Supreme Court of Nova Scotia, Premier of Nova Scotia and Canadian Minister of Justice, spearheading the revision of the Criminal Code in Canada. He served as Canada's fourth Prime Minister for only two years, when he suffered a heart attack at Windsor Castle, only minutes after Queen Victoria had sworn him in as a member of the Imperial Privy Council. Out of respect, the queen held an elaborate funeral for him and the ship HMS Blenheim, which later transported his body back to Canada, was painted black for the solemn occasion.

Robert and Ethel McKenzie

Robert was a metal sculptor with over 200 works located worldwide. Among his extensive work history, he was an educator, a surgeon in the First World War and is known as the father of modern day physiotherapy. Prior to marrying, he was the physician to Canada's Governor General Aberdeen and his wife, who later served as attendants in the McKenzies' wedding party. Robert's wife, Ethel (O'Neil) McKenzie was a poet, a musician and an educator, and together the couple lived in both Canada and the United States. They eventually returned to Canada to purchase the Mill of Kintail in Almonte, Ontario, which they restored and is now a well-known conservation area.

General James Wolfe (1727-1759)

General Wolfe was a British army officer, commander of the expedition that took Quebec in 1759. He died from his wounds during battle, on the Plains of Abraham.

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Post-Flood Development of Mass Treatments at the National Library of Florence: The Roots of Library Conservation

INTRODUCTION

November 4, 2016 marks the 50th anniversary of the most devastating flood in Florence since 1333. The average person has never heard about it, even though at the time students and their professors the world over, flocked to Florence to help in the initial rescue and clean-up. But those of us who were there and lived through the following months have indelible memories. (Figs. 1 & 2)

It is widely recognized that the vital and respected profession of book and paper conservation has its origins in the philosophy and treatments developed in the aftermath of the flood, in response to the immense challenge of dealing with so much damage to hundreds of thousands of rare books and documents in the libraries of Florence. I am a calligraphic designer, not a conservator, but I was there, and have first-hand knowledge of how the huge Restoration System was set up in the National Library, the Biblioteca Nazionale Centrale di Firenze (the "BNCF"), during 1967. It is important for the profession to know its history so the story needs to be told before it dies, along with those who experienced it.

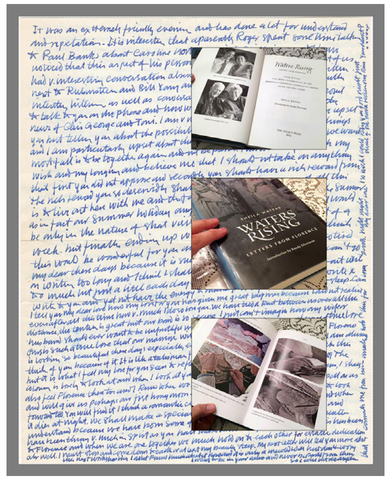
My late husband was the bookbinder and library conservator Peter Waters, who died in 2003. This is largely his story and that of his team members, who played a vital part in the restoration operations in the BNCF following the flood. In this talk I will describe the setting up of that massive Restoration System. It is impossible to cover this story adequately in a short talk, but it is covered in great detail in my new book called *Waters Rising: Letters from Florence* published this April 2016 by Cathleen Baker of The Legacy Press. (Fig. 3)

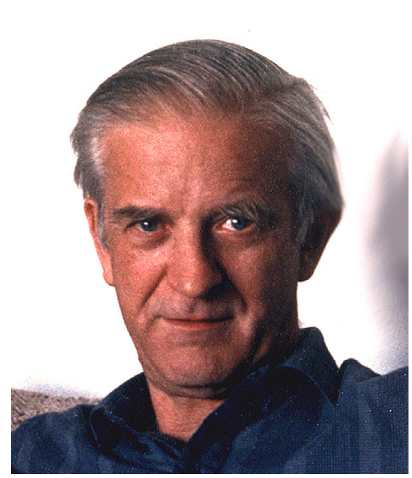
For giving information about past events, personal letters and eye witness accounts have powerful authenticity. In nearly 500 pages my book contains all the letters Peter and I wrote to each other during the months following the flood. Peter's letters, almost fifty of them, were his chief diary. After his death, for easy reference, I extracted all the relevant technical information from his letters and notes for a Narrative-Diary section. There are over 280 photos, mostly taken by Peter, of damaged books and treatments devised for them, and also

Presented at the Book and Paper Group Session, AIC's 44rd Annual Meeting, May 13–17, 2016, Montreal, Canada

Fig. 1. Book "mono prints" on the ceiling.

Fig. 2. BNCF November 1966, BNCF basement.





LEFT TO RIGHT

Fig. 3. Peter, 36, on leave from Florence at home with Sheila, Spring 1967.

Fig. 4. From Waters Rising: the book and one of Peter's letters.

Fig. 5. Peter Waters when at the Library of Congress.

included is a section of some of Peter's student bookbindings, and later commissioned and exhibition bindings, that he made before the flood. I am very grateful to Cathleen Baker for the huge amount of time she has so enthusiastically given to this project, and to our eldest son Julian Waters, her co-designer, and for his immense help in preparing visuals for this talk. I am also indebted to Randy Silverman for introducing us to Cathleen, and for his masterful introduction about Peter's life, work and impact on the library field, naming him Father of Preventive Conservation. This presentation is but a microcosm of the much bigger story told in the book. *Waters Rising* comes with a remastered DVD of the 40 minute film about the Restoration System made by Roger Hill and Peter in 1968. (Fig. 4)

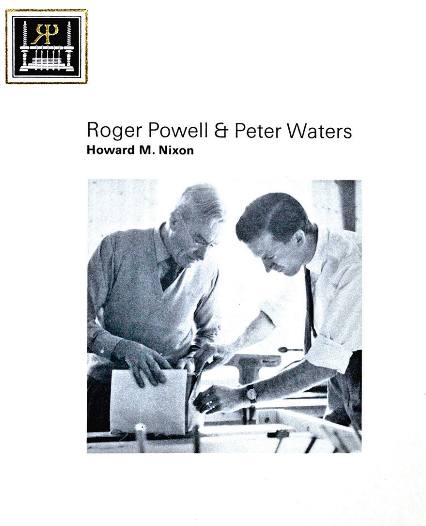
I will use many of Peter's own words, taken, not from his letters but from his article in the 1969 edition of The Penrose Annual (a British annual review of the graphic arts since 1895), because his own descriptions of the fully-developed sections of the Restoration System are so succinct that I cannot hope to improve on them. I quoted the same extracts in two previous overview talks, the first time was in 2006 in New York University's 40th anniversary symposium in Florence. Those proceedings were published by Archetype Publications, entitled Conservation Legacies of the Florence Flood of 1966, where more technical information can be found in the talks by Tony Cains and Chris Clarkson. The second time was in the National Gallery of Art in Washington, DC for the 45th anniversary. The Franco Zeffirelli film, *Florence: Days of Destruction,* was shown on both occasions.

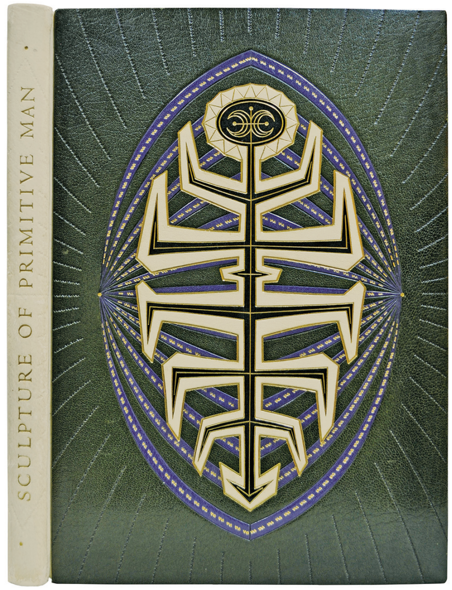
As a direct result of his pioneering work in Florence, Peter served as Chief of Conservation at the Library of Congress in Washington DC from 1971 to his retirement in 1995. He was Technical Director of the setting up of the BNCF's vast Restoration System from the end of November 1966 to October 1967. I became directly involved myself and spent a total of three months working with Peter in the BNCF during 1967. (Fig. 5)

WHY WAS PETER CHOSEN TO PLAY A LEADING ROLE?

Peter's work in England before he was forty is not as well-known as his time in the Library of Congress, so I will give a little of his background to explain why he was chosen to lead the British team. He had no experience of dealing with damaged books on such a massive scale—who had?—but he had a reputation as an innovative designer-bookbinder and manuscript restorer, in partnership with Roger Powell (who had restored and rebound the Book of Kells in 1953). (Fig. 6)

Peter and I met while we were masters-degree students at the Royal College of Art, London (the RCA), in 1949. He specialized in fine bookbinding, lettering and typography and I in calligraphy, lettering and typography, and Roger Powell was our bookbinding tutor. Peter had previously spent four years from the age of fourteen studying bookbinding with William Matthews at Guildford College of Art. We married in 1953 and ran our own businesses of commissions and part-time teaching. In 1957 we moved from Woking, Surrey to Froxfield, Hampshire for Peter to become Roger's full partner. From college days Peter and I collaborated on all our commissions, actively or with design critique and I designed illustrations that were used on many of his and Roger's bindings. (Figs. 7 & 8)





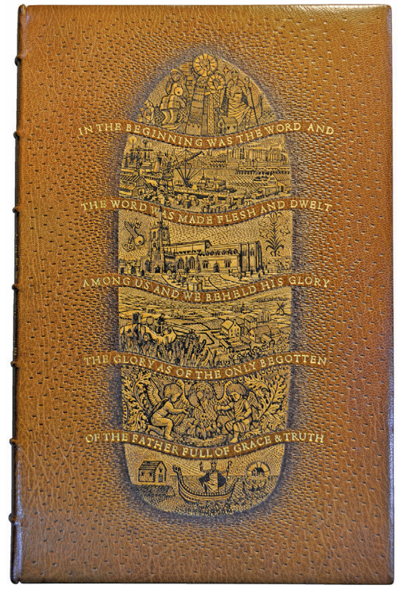


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Fig. 6. Peter with his partner Roger Powell.

Fig. 7. Binding "Sculpture of Primitive Man".

Fig. 8. Binding of Book of Donors for Chelmsford Cathedral, UK.

THE CALL FOR HELP

On Friday afternoon, November 25, 1966, Peter was phoned by Howard Nixon, Keeper of Printed Books at the British Museum. Nixon had been contacted by Dr. Casamassima, Director of the BNCF, who needed advice on restoring at least 110,000 badly damaged rare 16th and 17th century printed volumes. These included 90,000 of the Palatina and Magliabechiana collections, a primary source for western scholarship and the nucleus of the library. Howard Nixon knew Peter's work well. When Peter was only 21 and still at the RCA, he was commissioned by Nixon to design a binding for Le Livre Anglais exhibition in Paris in 1951. Peter revived the tradition of pre-1500 blind-stamped binding and Nixon bought the book for the British Library's permanent collections. So Nixon had confidence in Peter's ability to assess the unusual and desperate situation at the BNCF and make recommendations. (Fig. 9)

Fig. 9. Dr. Casamassima with Sandy Cockerell.

Nixon asked Peter to choose two colleagues and fly to Florence the very next day! Tony Cains, a skilled private binder and Dorothy Cumpstey, an expert teacher of binding, were able to drop everything to go with him. The three arrived in Florence, complete with gum boots, without any clear mandate and were set to work in the Forte di Belvedere to look for mold on dried books. These were arriving by the truckload every day from grain and tobacco drying facilities in Italy. Wet, muddied books had been dried en masse and inevitably many had suffered further damage from the heat. In the Forte working conditions were uncomfortable with no heat and little water and students were busy scraping dried mud off books. Meanwhile, student volunteers were still digging books out of the BNCF basement, wiping off excess mud with wet sponges and scattering sawdust over them to absorb some water. In the three weeks after the flood over 400 truckloads had already gone to drying plants. (Figs. 10 & 11)

Peter describes the state of the dried books in his Penrose Annual article:

LEFT TO RIGHT

Fig. 10. Tony Cains, Unknown, Peter, Dorothy Cumpstey.

Fig. 11. Student volunteer Mud Angels loading trucks outside the BNCF.

LEFT TO RIGHT, TOP ROW THEN BOTTOM ROW

Figs. 12-16. Examples of damaged books.

> Despite good superficial cleaning before drying and the wise rule by the Director at the beginning, that none of the books should be opened before arrival at the dryers, many of them, arriving at the Forte, resembled abstract sculptural forms. Vellum and leather covers were distorted and shrunken. Book stacks in the library have characteristic openings at each end and vellum bindings stored originally at the ends of the stacks had rotted where the water had run through these shapes, combining with the vellum to form a glutinous mass. Other covers were defaced with a combination of mud, sawdust, oil and mold and edges were badly stuck with gelatin, mud and sawdust. (Figs. 12, 13, 14, 15 and 16) The books had been stood upright to dry in the heated dryers, allowing water and gelatin to drain. The concentration of gelatin was greatest in the openings between the sections, leaving them brittle. Covers that had been too hurriedly ripped off had dragged the sewing through the backs of the sections. The water, combined with excessive gluing of the spine when originally bound, had accelerated the damage to the backs of the sections. Early 16th century spines suffered least because they had been pasted with starch paste rather than hide glue. The leaves of books bound in limp vellum withstood the flood better than most.

This was a very important finding because it led to the later development of non-adhesive and limp vellum binding techniques.

PETER'S VISION

Only four days after the team's arrival, a high level meeting showed that there was no plan at all for the future, beyond dry-cleaning, wrapping and storing the often very badly distorted books. In that state they would be unusable by readers, maybe indefinitely. Peter questioned this policy and suggested an outrageous idea: to set up a colossal dry cleaning, washing, drying and pressing plant to save and store the majority of the collections, wrapped, but flat, to await mending and rebinding. The effect of this idea on Director Casamassima was dynamic and from that moment he supported the team and the implementation of Peter's plan, no matter any opposition. In fact, he cut though enough red-tape to warrant a prison sentence in normal times.

It was decided that the whole series of operations would eventually be carried out in the BNCF itself. The Power Station had a large number of sinks and plenty of hot water and during November 100 untrained students were working around the clock in 8 hour shifts. They were washing large books, causing even more damage by separating their leaves while wet, a technique normally requiring immense skill. The British pointed this out so were asked to take over and train them in their new system of washing, not from the wet state but after dried books had had their sections separated ("pulled") by the students working in the Forte. Tony Cains took charge at the Forte and Chris Clarkson joined them to direct the Power Station Students. (Fig. 17)

The original briefing had called for an advisory visit to Florence by Peter, Tony and Dorothy, but from November through April Peter stayed there for most of the time. At home I became the liaison between binders and restorers going out to help and the British Italian Art and Archives Rescue Fund. Peter describes that expansion of the team and the funding supplied.

> It became clear that a great deal of additional help was needed and we appealed for more British restorers and binders, particularly those with teaching ability. In the following months over forty people worked for periods of from two weeks to several months developing the system and training volunteers. The team included members of the British Museum Stationery Office Bindery and the most distinguished private restorers, binders, and teachers of binding in Britain. This flow of help was organized by Howard Nixon and supported by the British Italian Art and Archives Rescue Fund, whose major effort in Florence became concentrated on the BNCF. From time to time the team was joined by restorers from many other countries. Guidance on chemical problems was given to the team by the British Museum Research Laboratory in collaboration with the Istituto di Patologia del Libro in Rome. (Figs. 18 & 19)

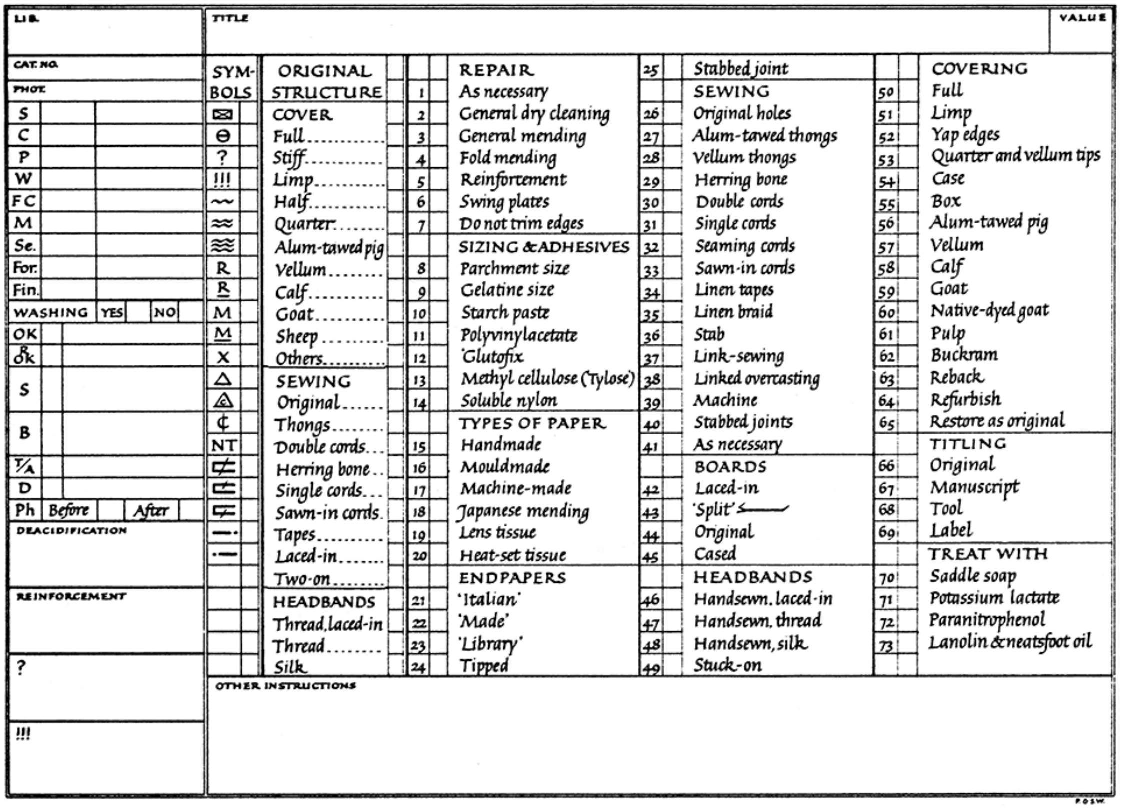
PREPARATIONS TO MOVE THE WHOLE SYSTEM TO THE BNCF

Peter then describes the preparations made, from December through March, for the move to the BNCF. Very early it was clear that expert careful selection for appropriate treatment would be needed for each book, on its journey through the system, and at Peter's request, Roger Powell, then 70 years old, arrived in early December to concentrate on this skilled

Fig. 17. Students washing books at the Power Station in the revised system.

Fig. 18. Peter, Tony, Elizabeth Greenhill, Sally Lou Smith, Stella Patri, Charles and Pamela Gott (nee Fowler).

Fig. 19. Peter's photo of team members in May 1967.



LIB. | TITLE | VALUE

CAT. NO.
PHOT.
S
C
P
W
FC
M
Se.
For.
Fin.
WASHING YES NO
OK
S
B
D
Ph Before After
DEACIDIFICATION
REINFORCEMENT
?
!!!

SYM-BOLS

ORIGINAL STRUCTURE
COVER
Full
Stiff
Limp
Half
Quarter
Alum-tawed pig
Vellum
Calf
Goat
Sheep
Others
SEWING
Original
Thongs
Double cords
Herring bone
Single cords
Sawn-in cords
Tapes
Laced-in
Two-on
HEADBANDS
Thread, laced-in
Thread
Silk

REPAIR
1 As necessary
2 General dry cleaning
3 General mending
4 Fold mending
5 Reinforcement
6 Swing plates
7 Do not trim edges
SIZING & ADHESIVES
8 Parchment size
9 Gelatine size
10 Starch paste
11 Polyvinylacetate
12 'Glutofix'
13 Methyl cellulose (Tylose)
14 Soluble nylon
TYPES OF PAPER
15 Handmade
16 Mouldmade
17 Machine-made
18 Japanese mending
19 Lens tissue
20 Heat-set tissue
ENDPAPERS
21 'Italian'
22 'Made'
23 'Library'
24 Tipped

25 Stabbed joint
SEWING
26 Original holes
27 Alum-tawed thongs
28 Vellum thongs
29 Herring bone
30 Double cords
31 Single cords
32 Seaming cords
33 Sawn-in cords
34 Linen tapes
35 Linen braid
36 Stab
37 Link-sewing
38 Linked overcasting
39 Machine
40 Stabbed joints
41 As necessary
BOARDS
42 Laced-in
43 'Split'
44 Original
45 Cased
HEADBANDS
46 Handsewn, laced-in
47 Handsewn, thread
48 Handsewn, silk
49 Stuck-on

COVERING
50 Full
51 Limp
52 Yap edges
53 Quarter and vellum tips
54 Case
55 Box
56 Alum-tawed pig
57 Vellum
58 Calf
59 Goat
60 Native-dyed goat
61 Pulp
62 Buckram
63 Reback
64 Refurbish
65 Restore as original
TITLING
66 Original
67 Manuscript
68 Tool
69 Label
TREAT WITH
70 Saddle soap
71 Potassium lactate
72 Paranitrophenol
73 Lanolin & neatsfoot oil

OTHER INSTRUCTIONS

Fig. 20. Record card for each book.

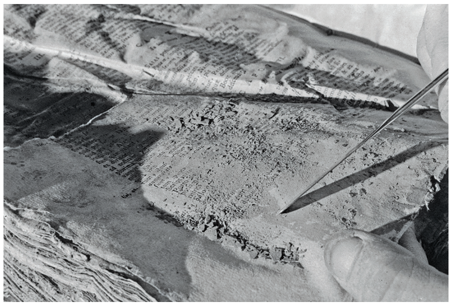
work and to train more experts in selection. Peter describes this process.

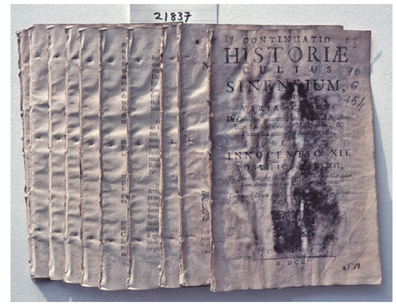
> Before a book enters the restoration system, it has to be classified according to its value and the treatment it requires, and details of historical interest are recorded. Symbols were devised during our first week at the Forte to make international interpretation easier and designed to warn a student or worker of the state of the book and how it should be handled. For instance, OK indicated that a student could handle a book, whereas the international road 'stop' sign showed that it was particularly valuable and should be reserved for specialist treatment. In the beginning, these signs were written on a slip of paper, but now a detailed printed restoration card and photographs of the original binding and any significant pages, accompany each book with classification and directions for treatment. The card also indicated the history of the original structure by means of an enlarged symbol system with other relevant details.

He closes that paragraph with a very important sentence: "These symbols guard against the temptation to make the system more important than the books that are fed into it".

Fig. 21.Peter and Sheila working on the record card originals.

To add a personal note here, during the month of May 1967, while working with Peter, I designed these cards, drew the symbols and wrote all the wording in plain, legible hand lettering, camera-ready for printing by the thousands, one card in English, the other in Italian. (Figs. 20 & 21)





LEFT TO RIGHT

Fig. 22. Mud being scraped from a dried book at the Forte.

Fig. 23. Students pulling books.

Fig. 24. A pulled book.

On his Sundays off, Peter photographed several hundred damaged books, his personal collection of slides finally numbering 1100, and insisted that every book should be photographed before treatment. In less than two years, over 50,000 volumes were photographed to preserve their history.

DESCRIPTIONS OF PROCEDURES FOR TREATMENT

CLEANING AND PULLING

Next Peter describes the actual procedures of treatment in the present tense. The first was cleaning and pulling.

> As much caked mud as possible is removed dry by flexing the edges of the leaves and the remainder is flaked off with spatulas and sharp blades. Then the book is collated and the sections are separated by careful cutting of the sewing from the spine. Covers, headbands, cords, threads, fragments and the record card etc. are placed in envelopes and catalogued. The sections are prepared for washing by interleaving with wet strength paper at frequent intervals. Hand-colored prints are protected where necessary with a 3% solution of soluble nylon in alcohol. (Figs. 22-24)

WASHING AND DRYING

> Each leaf is supported on a floating wooden board and washed individually by soft brushing in warm water containing a saturated solution of Topane (2hydroxydiphenol). This is followed by gentle squeezing of the whole book which is then pressed to remove excess liquid. Bleaching, de-acidifcation and re-sizing are done where necessary. At the Power Station the washing was done in rusty sinks covered in polyethylene sheeting. In the library, there are multiple stainless steel sink units totaling forty compartments, and all are water-jacketed and thermostatically controlled. Random pH measurements are being taken with a Pye flat-head electrode pH meter before and after washing. (Fig. 25) At the Power Station, sections were hung to dry on terylene lines, but in the library they are laid flat on racked trolleys in purpose-made, electrically-warmed, automatically-controlled drying cabinets. A final collation is made by a librarian and the book is then wrapped for storage. (Figs. 26 & 27)

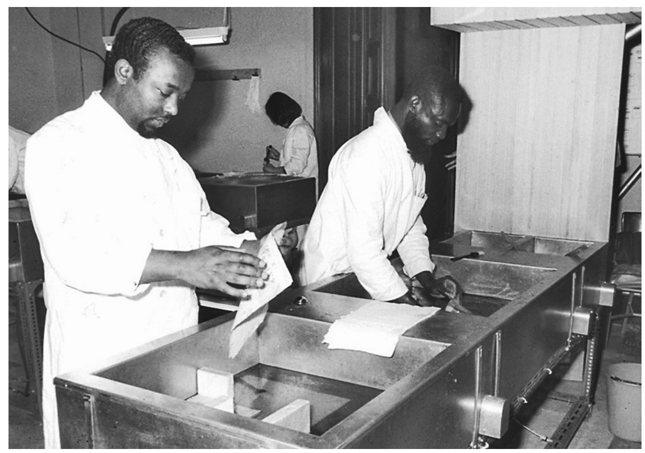


Fig. 25. Washing books in the new water-jacketed sinks

I must add here that Sandy Cockerell, an engineer as well as a well-known private binder and manuscript restorer, was the prime advisor in the design and fabricating of these large drying cabinets, trolleys and racks, and worked closely with Peter during several visits. (Fig. 28)

MENDING OF TEARS AND LACUNAE

Peter's article continues with descriptions of the new mending and binding areas set up in the main reading room. This was unprecedented in a country's national library!

> Although the original intention was to send the prepared books to binderies throughout the world for mending and binding, by April1967 it was apparent that this would be impracticable, mainly because of the wide diversity of standards and the

Fig. 26. A trolley being loaded with trays.

Fig. 27. A loaded trolley being pushed into a drying cabinet.

Fig. 28. Sandy Cockerell stretching olive netting for a drying tray.

Fig. 29. The mending area in the converted main reading room.

Fig. 30. Japanese tissue mending: cutting with a ruling pen.

Fig. 31. Heat-set tissue: mending tears with a tacking iron.

impossibility of maintaining proper controls. It was therefore decided that mending, the most time-consuming operation of all, should be done in the library and that binding should follow. A mending department was designed for thirty workers (the maximum number for whom space and wages could be found), to be housed in the main reading room for at least a year or so. This was ready in August 1967, when the training of about five unskilled workers per week was undertaken until the room came into full operation.(Fig. 29)

Mending methods had to be devised suitable for the scale of the operation and the condition of the paper. Long-fibered Japanese tissue paper is used to form patches, with adhesive designed to spread through to the area around the mend and remain flexible. A lens tissue is specially treated and used principally for the mending of tears. Many of the books have been reduced almost to single leaves and, on average, every section has at least two folds needing repair. (Figs. 30 & 31)

When I worked in Florence for five weeks in late spring of 1967 Peter designed the mending stations, and I drew plans and elevations for their construction. Each unit had a small light box inserted in the desktop and plenty of storage space on either side. In the summer we were in Florence for nine weeks and I had the immense pleasure of watching the desks being carried in and installed in the reading room. We left our youngest son Chris in the care of our mothers but took Julian 10 and Michael 7 with us. They reveled in exploring the entire library and made special friends with the electrician they nicknamed Sparks.

THE FINAL STAGE OF REBINDING

Peter wrote:

> A bindery was started in September 1967. Many of the smaller books will be rebound in limp vellum. A study is being made of the early Italian limp vellum structures as so many of the library's books are bound in this way. When the structure is sound, it is a long-lasting binding, strong and pleasant to handle and fairly quick to make. A limp vellum style, unique to the library, is being evolved, as, compared with the work of the 16th and 17th centuries, limp vellum binding of today has become decadent. (Figs. 32 & 33)

In the DVD that comes with *Waters Rising*, Chris Clarkson, who has become recognized for his expertise on vellum structures, makes a limp vellum binding from start to finish. Peter makes a leather binding. You see only their hands and arms and no faces.

PRINT RESTORATION

A print restoration department, with on-the-spot chemical analysis, was set up adjacent to the reading room by William Boustead, Chief Conservator to the National Art Gallery in Sydney, funded by the Australian government, and he trained a nucleus of workers in print restoration. It was later looked after by the chemist Joe Nkrumah who stayed on for seven years.

THE RESTORATION SYSTEM POST–1967

After October 1967 Peter left the technical direction of the Restoration System to Tony Cains, the operation being funded for a further three years by the American Committee to Rescue Italian Art (CRIA). Mostly back in England, Peter resumed working with Roger Powell, teaching part-time at the RCA and joined as co-director with James Lewis, in a three-year program of back-up research for the BNCF, overseen jointly by the Imperial College of Science and Technology and the RCA, funded by the American Council on Library Resources.

During 1967 the student labor force at the BNCF was gradually replaced by about 100 Italian workers, the restoration estimated to take about 25 years, though it still continues today, fifty years later. The whole system was

Fig. 32. Richard Young and Stella Patri teaching sewing.

Fig. 33. Rebound books.

Fig. 34. Limp vellum bindings.

TOP TO BOTTOM, LEFT TO RIGHT
Figs. 35-38. Before and after treatment.

Fig. 39. Peter (retired) with one of the encased U.S. Charters of Freedom, c.2000.

gradually moved to basement rooms so the reading rooms could be reclaimed. Through the years the workforce dwindled through lack of financial support, and now it is down to about seven people, in a lab outside the BNCF, under the direction of Alessandro Sidoti.

INTERNATIONAL TRAINING: THE FUTURE

The dream of setting up an international training center at the BNCF never materialized because of insufficient funding and too few expert restorers available to continue training. Even so, the legacies of the BNCF experience gave impetus to the new profession of library conservation, with the Library of Congress leading the way. Peter was given the task of designing its large comprehensive department from scratch, and from 1969 to 1971 he "commuted" from England ten times to the Library of Congress until our family immigrated to the USA in 1971. During the following two years he was able to persuade the curators to think more broadly in terms of what Peter called "phased conservation" (now termed "preventive conservation"), instead of merely sending single items for repair to the library's bindery. Since then, conservation laboratories have been set up throughout the world, many of them directed and staffed by conservators trained at the Library of Congress, and later at other centers too. (Fig. 39)

SUMMARY

Tragedies and disasters often bring out the best in people involved, and the great Florence flood certainly did that. So much good has come from its aftermath in the world of book and paper conservation. All who labored there will never forget the experience and many of them have since taught and influenced countless others. Tragically Peter died in 2003 at only 73 from mesothelioma, through exposure to asbestos in his twenties. I wish he could have been here to talk to you himself. He brought the skills of a designer-craftsman to the wider world of library conservation, and used what he called "sideways thinking" to solve problems. He also felt that some treatments can cause more harm than good. I feel honored to have played a small part in the effort myself, as a support to Peter. By sharing these first-hand memories I hope I have given you a feel for that momentous time after the flood and an appreciation of why the Florence experience was so pivotal.

SHEILA WATERS
Fairfield, PA
Waters_sheila@yahoo.com

Push Pins, Staples, Daylight, Glazing and Barrier Free: Are Conservation Standards Becoming Too Relaxed?

Using past and recent case studies this presentation will discuss the preparation, presentation, installation and storage of oversized contemporary art on paper in the context of past and current challenges. These include artist and curator expectations, the impact of tightening health and safety standard, increasing framing and material costs, storage challenges, loan processes, budgets and longer exposure periods. How are these pressures, if at all, impacting and shaping the future direction of conservation decision making and enforcement of standards?

JOAN WEIR
Conservator, Works on Paper
Art Gallery of Ontario
Ontario, Canada
joan_weir@ago.net

Presented at the Book and Paper Group Session, AIC's 44rd Annual Meeting, May 13–17, 2016, Montreal, Canada

ANDREA KNOWLTON AND DAWN MANKOWSKI
DISCUSSION GROUP CO-CHAIRS

Archives Conservation Discussion Group 2016
Innovative Approaches to Disaster Response: Real-Life Tips and Tricks

ABSTRACT

The session presentations highlighted panelists' experiences with disaster planning and salvage of archival and related materials after natural or man-made disasters. Many institutions need to address issues that arise during significant disasters with resources that are immediately available, and the panelists shared new, adaptive, and practical approaches. Their presentations and the discussion that followed are summarized below.

SUMMARY OF PRESENTATIONS

MARTA O'NEILL
USING NEW APPROACHES TO AN OLD PROBLEM: STILL LEARNING FROM THE ST. LOUIS FIRE OF 1973

The National Archives and Records Administration (NARA) facility in St. Louis houses the Preservation program, the National Archives at St. Louis, and the National Personnel Records Center in a new building, opened in 2011. The records housed in the facility have very high usage by veterans, their next of kin, federal agencies, and the general public.

The original building, commissioned by the Department of Defense and built by the Army Corps of Engineers, was opened in 1956. This building had no fire walls and no sprinklers, except in the areas where Navy records were held. In the early hours of July 12, 1973, a fire broke out in the building, and burned for three days, with flare-ups continuing for weeks afterward.

This open discussion took place on May 17, 2016, during the joint CAC/AIC Annual Meeting, held May 14–May 17, 2016, in Montreal, Canada. The moderators organized and led the discussion and recorded notes. Readers are reminded that the moderators do not necessarily endorse all the comments recorded, and that although every effort was made to record proceedings accurately, further evaluation or research is advised before putting treatment observations into practice.

In the areas of the worst damage, the building and records inside suffered both from the fire itself and from water-damage and saturation. After the fire, records that could be recovered were either air-dried, or vacuum-freeze-dried by McDonnell-Douglas in what were then experimental chambers used for the NASA space program. Approximately 6.5 billion records were recovered, but an estimated 16-18 million records were lost in the fire.

Despite damage from the fire and water, recovered records continue to be used by federal agencies, reference staff, and researchers in the reading rooms. The condition of records that survived the fire can vary dramatically, but records may be burned and charred, distorted, browned, brittle, blocked, fused, mold-damaged, or have surface debris, water damage, or tears.

For current use, Preservation staff review all of the records that have been requested each day. Records with only minor damage, such as light discoloration or planar distortion, can be released to the reading room without intervention. Some documents are photocopied or sleeved to facilitate use. Other materials may receive light treatment, such as surface cleaning to remove debris, or more significant treatment to stabilize the documents. A few records are considered too damaged to handle, and so they are completely withheld. Of nearly 50,000 records reviewed in 2015, approximately 2% were treated in some way, and less than 1% of those records were completely withheld for any use.

Fused records pose a major challenge to Preservation staff. These records became fused as a result of surface sizings or coatings interacting with heat and water during the fire. Some records are only fused in small areas, while others are fused across the entire surface. In some cases only a few documents have become fused. In other cases, there may be a blocked stack of records up to an inch thick.

In 2014, NARA Preservation staff consulted with Hal Erickson, previously associated with the Preservation and Conservation Studies program at the University of Texas at Austin. At his suggestion, experiments were undertaken to release fused coated papers using acetic acid, followed by the introduction of an alkaline reserve. Initial results were promising. Documents separated easily, with little loss. Additional testing and trials will be undertaken to determine the short-term and long-term effects of this treatment.

Preservation staff has also experimented with the use of imaging to provide better access to damaged records, especially those that are so damaged that any handling could result in further loss or destruction. Many of these documents are heavily charred, but ink may be visible on the surface of the paper. The imaging and enhancement of these documents has allowed for information previously thought lost to be revealed.

A pilot project was begun in 2015 to digitize and process images for burned or charred records. Preservation staff developed standards which allowed rapid capture with a single camera, and standardization of the capture process in order to achieve efficiency in the workflow. Records to be imaged were selected according to pre-established criteria, such as significant charring, but lacking fusing or mold-damage.

A number of imaging techniques were considered, including multi-spectral imaging, ultraviolet-induced visible fluorescence, and reflectance transformation imaging. Tests were conducted to determine if changes in contrast in a conventional color image could improve legibility. Although some areas of the documents had some improvement, text could not be universally revealed in this way. In addition, this required lighting adjustments and image enhancements to be made individually for each image, which dramatically slowed the process.

Ultimately, infrared photography was selected. This method provided more successful results. Preservation staff used a 16MP Phase One camera from Digital Transitions, which allows dual spectrum capture. As a result, visible and infrared images could be shot consecutively with the removal or addition of a filter. Images were further enhanced with Adobe Photoshop to increase legibility. Figure 1 shows an example of these results. On the left is the digital image of the original document in visible light, and the enhanced infrared image is on the right. Traditional digital images remain an important component of the imaging process, since some markings, including annotations in red pen, can drop out in infrared light. Infrared filters can be used on a wide variety of cameras, so this imaging process can continue even if additional or different cameras are purchased in the future.

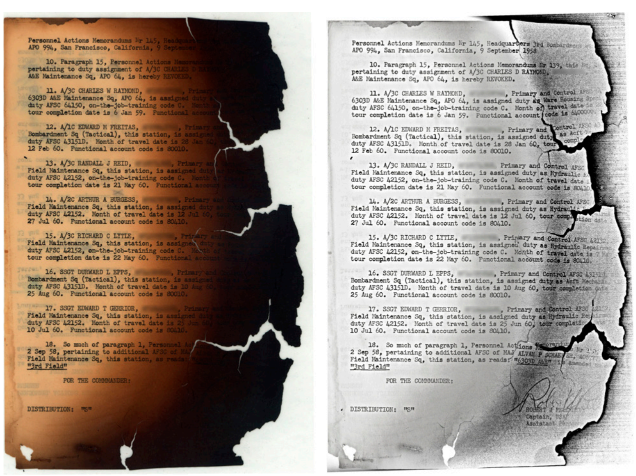


Fig. 1. Before and after image of digitized burned document using infrared photography and Photoshop enhancement. Photo courtesy of Lenin Hurtado, Reformatting Lab, Preservation Programs at St. Louis.

Preservation staff in St. Louis are working with conservators and scientists from NARA in College Park, Maryland, to continue efforts to increase access to these fire-damaged records. They hope to develop a testing protocol for the use of acetic acid baths to separate fused documents. Infrared imaging of damaged documents has also been incorporated into standard workflows at the Center. Images of burned records that are too fragile to release to the reading room can instead be delivered in a digital format.

Marta O'Neill, National Archives and Records Administration, St. Louis

WHITNEY BAKER
DISASTER RESPONSE: THE HUMAN ELEMENT

In 2012, the University of Kansas (KU) Libraries experienced a major disaster when a water main broke on a hillside above the below-grade art and architecture library. In the preceding years, Kansas had a number of very cold winters with heavy snowfall, followed by extreme drought in the summers. These conditions led to pavement shifting and water main breaks, which released a large amount of water very quickly. The art and architecture library is located in the basement of the Spencer Museum of Art on the University of Kansas campus. During the 2012 incident, water rushed into the 14,000 square foot space. Half of the space had water coming in from the ceiling, and the entire area had several inches of water on the floor.

Approximately 80% percent of the affected materials were art books. Two freezer trucks containing about 17,000 items were sent to a disaster recovery vendor for vacuum-freeze-drying. The collections space was damaged to such a degree that much of it needed to be reconstructed. Flooring, carpeting, wallboard, and library shelving had to be removed prior to beginning repair. This meant moving an additional 26,000 volumes not affected by the flood to the library's off-site shelving facility.

Thanks to recent training and an up-to-date disaster plan, the emergency response team was able to recover more than 97% of the materials that were damaged in this flood. After the recovery effort, the team members discussed the disaster with hopes of making improvements to the process.

Tip #1: Use reflective construction vests and Tyvek wristbands to better identify team leaders and members in a disaster zone. The library had hundreds of volunteers assisting with the salvage, some of whom were paid by the university. This meant that the university was interested in tracking the hours of these staff members, as well as securing access to the site.

Some of the workers, such as building staff or security, were clearly identifiable. However, volunteers from the library, the museum, the art history department, and other campus departments also aided in the recovery. Shift leaders were given reflective safety vests, and Tyvek wristbands were used to distinguish volunteer workers. Though name tags or lanyards were also considered, the wristbands worked best because they were inexpensive, recyclable, and didn't require someone to be in charge of collecting them at the end of a shift.

Tip #2: Use a large piece of paper for a sign in/sign out sheet. It was necessary to track the hours that staff and volunteers spent in the recovery effort, either for budgeting purposes, insurance, or overtime pay. This detail might not always be incorporated into disaster training but is extremely important. The strategy that worked best in this instance was placing a large sheet of paper near the entrance. Using this system allowed for tracking information that the university administration would need, but also gave a higher rate of sign-in compliance and an accurate hour count.

Tip #3: Provide short training sessions for volunteers at the beginning of each shift. Volunteer training also played an important role in the success of this recovery effort. The library utilized groups of twenty volunteers at a time, and short training sessions were provided for volunteers at the beginning of each shift. The training covered potential kinds of damage and condition problems, as well as the jobs that would be assigned to each volunteer.

In this case, a two-hour recovery shift was sufficient. Working conditions prohibited longer shifts, because there was no HVAC system, and the outside temperature was 107 degrees. There was also no plumbing, so no bathrooms were available in the building. While volunteers may be enthusiastic and want to help, shorter shifts are preferable under these conditions.

The salvage effort was divided into three main tasks. The majority of volunteers were part of a human chain, because the compact shelving used in the space considerably slowed down the recovery. Others assembled or packed boxes for shipment.

Tip #4: Establish a central, networked location for all disaster photographs. Disaster recovery literature states that it is advisable to have a person in charge of communication, and to document the effects of the disaster. The university wanted to remain in control of reporting about the flood until it had a real sense of the extent and scope of the damage. While social media is a great tool with regard to the conservation field, it can complicate situations like this when the institution wants to remain in control of the message. Though one of the disaster recovery team members was assigned to document the salvage, most volunteers also had cell phone cameras. The library did not want to discourage volunteers from taking photographs that might ultimately be helpful, so staff decided to designate a place on a networked drive where volunteers could put photos taken during the recovery effort. This allowed volunteers to feel like they were helping, but also better controlled how the pictures would be used.

Whitney Baker, University of Kansas Libraries

DEBRA CUOCO

SUSTAINED RECOVERY: HOW TO SURVIVE A DISASTER AFTER THE INITIAL RESPONSE IS COMPLETE

While salvage efforts at cultural institutions are frequently discussed, what happens after the first 48 hours can often be overlooked. A case study from the Weissman Preservation Center at Harvard University provides the opportunity to examine the full arc of recovery efforts, from initial salvage to sustained treatment, with insight into the challenges faced at each stage of the process.

The weather forecast for Saturday, March 8, 2008 called for heavy rain. At approximately 7:45 p.m., a drainage pipe burst, sending over 500 gallons of water into the Harvard Theatre collection of Houghton Library. The water poured onto four sets of metal flat files, soaking the oversized textile-lined posters and painted canvas backdrops that were stored on top of the flat files. The water then travelled down a flight of stairs and landed on the Emily Dickinson Family Library Collection, also a part of Houghton Library.

Harvard Operations was alerted and called the Library Collections Emergency Team (LCET) to notify team members that collections were potentially at risk. The LCET team is made up of conservators and preservation librarians at Harvard Library, who in turn train staff on all aspects of salvage and preparedness. As part of their duties, team members trade off carrying a cell phone and responding to calls regarding collections emergencies.

Within ten minutes, the on-call LCET conservator was at the library assessing the situation. The flat files contained unique set and costume designs executed in potentially vulnerable media. Because of the quantity and types of materials affected, additional assistance was required. Within an hour, four paper conservators, the senior book conservator, and Houghton Library staff and Operations were on the scene. A decision was made to salvage the materials in-house, as the objects in question were special collections and space was available in the building to recover *in situ*.

Tip #1: Document Salvage Efforts. In the flurry of activity and adrenaline, the team failed to document this disaster with photographs. After the incident, disposable cameras were added to emergency supply kits. Currently, the LCET cell phone or digital cameras are used to document collections emergencies.

Items in the flat files had varying degrees of wetness. The flat files had small holes drilled inside the drawers that allowed for air-flow, but which also allowed water to travel into the drawers. As a result, every drawer had pools of water. Drawer covers (which conservation staff had asked the library to remove, because the black dye in the cover was water soluble) actually helped to protect the tops of the piles from moisture. The dye bled on the folders, but not on the objects themselves. Items in the bottoms of the piles, on the other hand, were very wet. A quick tip for drying out drawers: take a full roll of paper towels and use it as a sponge. This is not really environmentally sustainable, but works well in a hurry, and full rolls of paper towels are often readily available.

Items were removed from folders, with identifying information torn from the folder. The objects were laid out on tables, floors, or hallways on brown kraft paper. The kraft paper allowed the team to easily write notes to each other or put borders between certain items. This process allowed the team to keep track of the collections and maintain intellectual control of the material.

At 3:00 a.m., movers arrived to help the LCET team roll out the heavy oversized materials. All told, over 1100 paper items and 500 books were recovered. The salvage was a great success; relatively few items needed treatment after drying, and the entire operation was an example of a truly collaborative effort between multiple departments.

Tip #2: Don't forget to take breaks. Responders forgot to hydrate and eventually ate dinner at 2:00 a.m. Rather than trading off duties and taking breaks, everyone worked long into the night.

After the success of this initial salvage response, the longer-term recovery efforts proved more difficult. Communication issues and patience proved to be the biggest challenges. The excitement over what had been achieved the past weekend started to fade, and staff grew impatient to return to normal operations. During the first week, curatorial staff began the process of relabeling and re-foldering materials to gain intellectual control of the collections. The LCET team debriefed everyone who participated in the salvage efforts and made sure the event was fully documented, including opportunities for improvements.

Tip #3: Make sure you debrief as soon as possible after the event with all staff that were involved. Everyone has a different piece of the story, and it's easy to lose information if it isn't recorded quickly.

One outcome of this post-disaster conversation was the addition of a metal ramp with an attached drain pipe above the flat files. This was intended to divert water leaks from flowing directly into or onto the cases. Water-diverting ramps have been added to storage areas in other parts of the library as a tool to protect collections.

By mid-week, library and operations staff was understandably eager to reopen spaces to patrons. There was a push to open areas not connected to Houghton Library. This required the movement of many materials that were still drying, particularly designs executed on boards which took longer to dry.

The most challenging collections were the painted backdrops and textile-lined posters, because these materials took considerable time to dry completely. To facilitate the process, the backdrops were re-rolled, flipped, and unrolled daily. Due to their size, this required several people working together. After the first days, finding enthusiastic volunteers to help was often difficult, particularly among staff outside of the preservation department. Examination of the backdrops also revealed some damage that required consultation with a paintings conservator, creating an additional delay.

Before re-rolling the backdrops, a plan was needed for permanent storage, as they could not be returned to the top of the flat files. The backdrops were rolled onto lined tubes and wrapped for storage within the stacks. This was completed within three weeks of the flood. Within a month, all spaces, including the Theatre Collection, were reopened. While this might seem like a relatively short period of time, the library was unprepared for the delay of services to patrons.

In addition to the need to reopen the library as soon as possible, insurance claims needed quick processing. An initial claim had to be submitted within days. Assessments of all affected items and treatment estimates were required by the third week. Excel spreadsheets and supplementary documentation were submitted, and then staff had to wait. Three months later, proposals were requested to justify the claims for a small number of items selected for treatment. And then more waiting. Once this step was complete, treatment began. However, the process was slow, as these treatments had to be integrated with other ongoing projects. Ultimately, it took eighteen months from the time of the initial incident until the hiring of two project conservators to treat the flood damaged materials.

In hindsight, what could have been done differently? LCET, local emergency teams, and Harvard libraries often participate in mock emergency exercises. Discussion includes different kinds of disasters that may occur, how to salvage particular materials, and whether a vendor is needed to aid in the response. Rarely do discussions include what happens after the initial salvage efforts. How much space is needed, and for how long? How will this affect public spaces and services? Is there appropriate in-house expertise for the kinds of objects affected? Are there items that are particularly vulnerable? Each library space and collection is different, and within each there are new challenges. This discussion of details through the entire timeline and how long the recovery would take was missing from previous exercises. The recovery was frustrating both to conservators, who were emotionally invested in the project, and to curatorial staff, who wanted to get the collections back in order and available to patrons as soon as possible. If the full picture of an emergency event had been covered within a mock exercise, expectations may have been more realistic.

In all, the salvage of these collections was successful, and the lessons learned were beneficial to better prepare the emergency team.

Debra Cuoco, Weissman Preservation Center,
Harvard University Library

OLIVIA PRIMANIS

TRY THIS: AN ALTERNATIVE TECHNIQUE FOR AIR-DRYING WET BOOKS

When a relatively small number of books are affected by an emergency such as a water leak, conservators frequently air-dry the materials in-house. Often, this means that books are set up on their ends and fanned open to dry. Unfortunately, this can result in distortion of both the text block and the binding, with problems such as curling at the bottom of the text block. Occasionally, the text block will fall out of the binding, or the cloth will separate from the cover because the adhesive has failed.

After the 1986 fire at the Los Angeles Public Library, books were air-dried using a process described as dehumidification drying in a chamber conditioned to 100-110 degrees Fahrenheit and 20-30% relative humidity. The books were dried open in crates as quickly as possible to prevent mold growth. Once dry, many of the book covers and text blocks were distorted. One solution was to press the books. The covers of the books were wrapped in damp paper towels and plastic wrap to re-hydrate the boards. Then the books were placed closed and spine down in a crate and compressed using a wooden dowel. As the covers relaxed with the dampness, the distortion in the book was reduced.

Another option that results in less distortion is to first set up the books to encourage the covers to dry flat, and then air-dry the text blocks. To do this, the book can be placed on the edge of a crate. The crate permits air circulation around the covers and text block. One board hangs down, while the other board is lifted or held open with crumpled newsprint or other material. This should allow the boards to dry in 6-8 hours if they are very wet, or even in just a few hours if they are damp. Drying the boards in this manner allows the cloth covering material and endpapers to readhere and set firmly in place, if a water-soluble adhesive was used. The book can then be set up on end and fanned open to air dry with less distortion of both the binding and the text block.

Olivia Primanis, the Harry Ransom Center,
University of Texas at Austin

DAN PATERSON, *with* ALAN HALEY, YASMEEN KHAN & ANDREW ROBB

LARGE-SCALE RESPONSE TO WET BOOKS AT THE LIBRARY OF CONGRESS: TRIED AND TRUE TECHNIQUES

Over the past few years, the staff who serve on the Preservation Emergency Response Team at the Library of Congress have developed a number of approaches and techniques that have improved response and recovery efforts.

Tip #1: Clear signage in the stacks is essential, especially in a large institution. Staff members who are most likely to see a water intrusion in the stacks may not be familiar with the institution's disaster response plan. Since the team added simple signage with clear instructions throughout library stacks, the time in which water leaks are reported and response is initiated has been significantly reduced.

Tip #2: The team has learned that taking the time to do an initial triage increases efficiency in the response process. A first step is to segregate materials based on a few set criteria, such as degree of wetness or type of paper. Over time, the team has noticed surprising differences that influence these criteria. For example, acidic papers often dry faster than alkaline papers or papers that have undergone mass deacidification. Coated papers are also segregated at this stage and sent for freezing so that no additional time is expended on them. Separating materials into groups allows the team to manage the drying process better.

Tip #3: Different binding styles or materials react differently to moisture, and understanding those differences can speed recovery efforts. Library bindings, for example, retain a great deal of water, even when the text block is relatively dry. When library bindings are affected, the team may choose to remove the book from the binding entirely. Although the book must be sent out for rebinding, this action ultimately protects the text block and saves resources by allowing the books to dry more quickly.

Tip #4: When rare materials are affected, curators should be involved in the decision-making process as soon as possible. Curatorial knowledge and input can be critical in prioritizing recovery efforts and resources. In one example, the binding of a 1522 Aldine imprint was wet after a disaster, and the curator advised conservators to focus attention on quickly drying the text block, with an understanding that the volume would have to be treated and rebound at a later date. This decision was made based on the curator's knowledge that several other copies of the same imprint in the collection were unaffected, and that recovery of other wet materials was a greater priority in this context.

Tip #5: For large-scale recovery involving a significant number of books, the recovery team air-dries books directly on book trucks. The books are placed on the truck with precut fluted board positioned between the text block and the cover. Volumes are separated by additional pieces of fluted

Fig. 2. A full shelf of books interleaved with fluted board on a cart. Photo courtesy of Richard Herbert, Library of Congress.

board. Figure 2 shows a full shelf of interleaved books on a cart. Using carts allows more books to be set up for air-drying in the available space. Trucks can also be rotated and moved easily, such as for positioning them in front of fans at varying intervals.

The team has found that the flutes in the board can be intentionally oriented to speed drying. For books that are wet near the joint or spine, the flutes are placed perpendicular to the spine. When the truck is placed in front of fans, this encourages airflow towards the gutter. If the text block is wet, airflow can be directed across the text block by placing the flutes parallel to the spine. The book is then positioned on its spine on the truck, which allows the air from the fans to move through the flutes. Drying the books on trucks also provides some restraint, which limits distortion of the text blocks and bindings. It is important to note that books may need to be fanned out for initial drying, especially during triage, before they are ready to be moved to the trucks.

Tip #6: In a very few cases when a text block is wet but the binding is dry, the recovery team has experimented with wetting out books *in situ*. A mixture of approximately 90% deionized water and 10% ethanol is brushed out on leaves one at a time to reduce tidelines. As leaves are wet out, the text block is interleaved with Tek-Wipe between every fourth or fifth page. After 30-40 pages are treated and interleaved, the book is placed in the press. The process is repeated over multiple days as the conservator works through the book. This process has resulted in significant reduction of tidelines. It must be emphasized that this is an experimental technique that is time-consuming and labor-intensive, but in the right circumstances, it can be effective.

Tip #7: For large-scale events, stabilize materials first, and then deal with registration and statistics. This works well at the Library of Congress, in part because the recovery space is a locked room controlled by key card. Access to the materials is limited to conservation staff and others who are escorted in, so collection security is maintained. Since recovery may continue for hours or days, materials may arrive in multiple batches over time, potentially leading to confusion in registration. By counting all of the materials at the end of the recovery effort, the team can maintain intellectual control and prevent double-counting as collections move through the space.

Dan Paterson, The Library of Congress

DAISHI YOSHIHARA & MASASHI AMANO

GRASSROOTS CITIZEN VOLUNTEERS AS A SOLUTION FOR DISASTER PREPAREDNESS

Translation assistance by Kazuko Hioki

Shiryo-Net is a Japanese volunteer organization, established in 1995, working to preserve historical materials affected by natural disasters. Large-scale natural disasters, such as earthquakes, floods, and mudslides, are frequent occurrences in Japan. Because many locally significant historical documents are in private hands, it is difficult to salvage all of these materials using expert conservators. To combat the effects of these disasters on a local level, regional Shiryo-Net groups have been established throughout the nation. There are 24 Shiryo-Net groups in all. The most recent is the Kumamoto Shiryo-Net, which was formed in the aftermath of the Kumamoto earthquake in 2016.

Shiryo-Net's core membership is composed of historians, but membership is open to anyone. The organization is funded through dues and donations. For example, the Kobe Shiryo-Net consists of 15 staff and 300 members who are students, historians, or archivists.

One of the goals of Shiryo-Net is to increase the number of skilled volunteers to salvage historical documents in the aftermath of a disaster. To this end, it has given many successful recovery workshops throughout Japan. Members are often not experienced in recovery of fragile collections, so the organization works with conservators to teach salvage with materials that are easily accessible. This training is provided by Shiryo-Net members and is open to the public. For example, volunteers are taught to dry documents with paper towels or other materials that can be purchased at a local grocery store. The motto is "anyone, anywhere, easily."

The salvage effort of historical documents after the 2011 Tohoku earthquake and tsunami involved one of these workshops. One of the challenges of training volunteers is that many had never seen or handled damaged materials before. Shiryo-Net members instructed volunteers to recognize the historical significance, component materials, and original format of these records, as well as the risks involved in cleaning them. One of the ways that members approached this was to have the volunteers make historical book models and conduct a mock salvage operation. The book models were buried in the mud and recovered using the techniques taught in the workshop.

Since 2011, five thousand volunteers have joined the operation in the Miyagi Prefecture alone, and have recovered 20,000 manuscripts damaged during the 2011 tsunami.

Daishi Yoshihara, National Research Institute for Cultural Properties, Tokyo

Masashi Amano, International Research Institute of Disaster Science, Tohoku University

DISCUSSION

Commenter: Hi, I'm coming to this from more of a library/archives perspective, rather than a conservation perspective, but how much does rarity and value factor into triage decisions?

Dan Paterson: Both are factors at the Library of Congress. That's why we try to get the curators involved as quickly as possible after a disaster. For example, there was an incident where we had three first editions of *Ulysses* in the recovery room that we consulted with a curator about. As it turned out, one of them was Joyce's copy, one of them was the copy that was used in the lawsuit as a piece of evidence in order to get the book published, and then one was just generally rare. It was important to find out which one was which during triage. Fortunately, none of them were damaged; it was just their housings that got damp. We really feel like we need curatorial input, because sometimes it's too far outside our area of expertise to be able to make those decisions.

Marta O'Neill: I'd like to respond to that in an archival sense. Part of our emergency plan has a list of priority documents and what we'd try to salvage first in a disaster. It really helps to work with the archivists to identify and prioritize those resources when making an emergency plan. Then in the event of a disaster, you can respond according to that list.

Debra Cuoco: At Harvard, we do something similar with our Library Collections Emergency Team (LCET). We try to have those conversations with curators and librarians. We also go on tours, which are helpful for having face-to-face communication and familiarity with collections spaces. Even if the particular collection does not have a formal emergency plan with designated recovery priorities, we are able to get a sense from the curators which materials are important or might be considered a salvage priority.

However, in the incident I mentioned, we were unable to locate the curator of the Theatre Collection that night. In the end, I think it actually helped us because we knew we had to salvage everything without curator input, and we just systematically went through the flat files in order. Also, I'd just finished surveying this particular collection the week before, so I had both an idea of which materials were important and an emotional investment in the recovery. I actually worked in a different area and helped once things were out of the flat files. I think if I had been directly involved in pulling the materials out of drawers, I might have advocated for saving particular collections first. In this case, we knew we had to recover everything, so we just made everything equally important. Certainly in other cases, in other libraries, we try to do the same and get those priorities ahead of time.

Commenter: My question is about Shiryo-Net. Does your membership include the institutions or people that own the historical documents? How do you decide when and where to send your volunteers after an event? Do the owners of the documents contact you in some other way?

Kazuko Hioki (translating): Shiryo-Net members do a lot of outreach so they can get to know the owners and locations of locally important historical materials. They work to identify and catalog these materials before a disaster happens. Then, in a disaster situation, if the owner is unable to contact Shiryo-Net, the organization's members will know the locations of significant materials in that village. They can then send out volunteers and plan the recovery effort. Sometimes the collections' owners contact Shiryo-Net, but the most important thing is building and maintaining that long-term relationship over time.

Commenter: Also regarding Shiryo-Net and disaster response in general in Japan. Is there an equivalent of AIC or a professional organization of conservators upon whom you can call for expertise?

Kazuko Hioki (translating): Yes there is an equivalent society in Japan, but it is much smaller. They have one thousand members, but the organization doesn't have full time staff.

Commenter: How do you encourage volunteers or members to join Shiryo-Net? Do they find out that your organization exists and ask to volunteer?

Kazuko Hioki (translating): Shiryo-Net is a volunteer organization primarily for historians, so new membership is promoted through outreach by current members. Local volunteers also hear about the organization through word of mouth or from the regional Shiryo-Net group.

Commenter: My question specifically is about the barcodes that are used by Library of Congress. Are those associated with the books in the interest of preparedness or are they associated after a disaster occurs to catalog or inventory affected items? What kind of information do the barcodes have?

Dan Paterson: We actually do not use the barcodes on books for tracking purposes because of the way barcoding has been implemented at the Library of Congress. We've found that using those barcodes is not the most efficient way for us to keep an inventory in a disaster response. However, there have been times when we've created our own barcodes and put them on flags during an incident.

Whitney Baker: It can be useful for inventory purposes if the institution is already using barcodes as part of the cataloging system for books. Then you can scan each barcode into a document and look up the cataloging information later. This is if you have sufficient time to do this, of course.

Dan Paterson: Exactly. I think that's been our experience. In theory, we've tried to incorporate it, but it's never been as fruitful as the amount of effort that we've had to put into it.

Commenter: It sometimes happens on a large team dealing with disaster recovery, even with volunteers taking short rotations, that one person refuses to stop. Have you encountered this problem and how did you deal with it?

Debra Cuoco: We find that it happens a lot. It's very hard to get people to stop. We knew this was a problem, and I mentioned that we forgot to take breaks and drink water. Sometimes it's difficult for people to get out of the groove of what they are doing. What we had to do is make everyone stop and take a break together.

Now we are trying to set up a system with a spreadsheet for longer incidents, because we still have people that work too many hours. Also, it makes sense to stagger expertise during a longer recovery. If you have all of your experts there at the same time, you don't then want to have a period of time where there's no expert present on whatever particular material is being salvaged. The next time we have a large incident, we're going to attempt to get this going.

Whitney Baker: For the disaster I discussed, we just told everyone that shifts were two hours, and that was decided by the library administration. That helped set expectations for how long volunteers would be there. A lot of times, disaster situations are such that two hours may be long enough, especially if there are not great working conditions. I would set the tone ahead of time.

Olivia Primanis: I think in my experience at Los Angeles Public Library, we had the opposite problem, which was that you would walk into an area and find no volunteers working. It made me think it was very important to have one person that was completely in charge, so they could guide volunteers to areas that needed assistance.

Marta O'Neill: We have a situation where we have a lot of records, so we have a lot of people, which is a good thing. We established teams with a team leader and a particular number of people on a team. The teams rotate with one team relieving another, similar to a shift change. We found that people have gotten into the habit that when their shift is over, the next team comes in.

Dan Paterson: I would say that we do something fairly similar to that. There is one person in charge of recovery, and then Conservation will put out a call for volunteers with set time shifts. So there's a defined beginning and ending period for the shift.

Commenter: Dan, I have a question for you about drying on the book trucks. Once you have the books positioned with the fluted board, do you feel that it is sufficient for them to be there in that position until they're dry? Do you have to go back and shift the board and continue adjusting until they're done?

Dan Paterson: We do check on them frequently, depending on the degree of wetness. A lot of times, we'll check them twice in the first 24 hour period and change the fluted board out. Sometimes there will be more interleaving in there also. Many times we'll use newsprint in addition to the fluted board because the acidic paper wicks the water out well, and it's inexpensive. Or, we may use Tek-Wipe. But we'll check them at least once a day over the course of the recovery effort.

Commenter: To follow up on that, do you pre-cut the boards?

Dan Paterson: We use scrap board from our box making machine cut into various sizes. We also cut newsprint and the Tek-Wipe into various sizes as well. We have a dedicated recovery room where these supplies are stored, so they are accessible during a disaster.

Commenter: Is there a threshold where a book is too wet to interleave with board and dry on the truck? Are the saturated books separated out prior to this process?

Dan Paterson: We find this works well for the vast majority of things that we get. The book might be put in the press to get the excess moisture out. Or it might be frozen, which we'd likely do if the book was very saturated.

Olivia Primanis: After a fire, you have a bit more time to dry a book than after just a water event, especially a water event where sewage is involved. In a fire, the heat of the fire kills a lot of the mold spores.

In our instance, some of the large bound periodicals were in the stacks for two weeks, wet, before they were removed and frozen. We found that if we could dry them in about 1-2 weeks after the fire, we didn't have a mold problem. I don't want to say you don't have to move fast after an event, but I think if fire is involved, you have a bit more time. Sometimes that's lucky, because you might not have access to the building.

ACKNOWLEDGEMENTS

The co-chairs of ACDG would like to thank Book and Paper Group Program Chair Angela Campbell for her assistance in planning and organizing this session. They also wish to express their gratitude to the panelists for sharing their experiences, and to the audience members who participated in the discussion.

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Art on Paper Discussion Group 2016: Paper is Part of the Picture: Connoisseurship and Conservation Practice

ABSTRACT

Paper Conservators have long relied on a variety of bathing and bleaching methods to reduce discoloration and stains in works of art on paper. Justifications for aqueous treatment, however, are steeped in subjective interpretation, shaped by historic, cultural, and institutional contexts. In her opening presentation, "Paper is Part of the Picture," Peggy Ellis examined the way in which our sensitivity to the subtle characteristics of historic papers is necessarily limited by our modern experience of what paper is.

Cleaning treatments may significantly alter chromatic and tonal values or remove indicators of artistic practice or historical use, potentially changing the authentic presentation of the work to meet the expectations of the viewing audience. Marian Dirda explored the complex decision-making process behind deciding on a treatment designed to reduce paper staining, and the importance of openly engaging with curatorial colleagues to evaluate the impact of treatment in "Connoisseurship and Conservation Practice: Dialogue between the Conservator and Curator."

The notion of authenticity in art, and understanding what is meant by artistic intent are central to discussions of treatment, particularly as we increasingly strive to integrate our field with those of curators and other scholars. Kristi Dahm illustrates the importance of closely examining many works in an artist's oeuvre to understand an artist's choices and how those aesthetic goals may have been altered over time in "Casting Far and Wide: Winslow Homer's Engagement with the Materiality of Paper".

Lastly, Amy Hughes presented innovative approaches to minimizing the impact of stain reduction treatments to preserve overall paper tone and other characteristics, in her talk "Fine-Tuned: Adjusting Wash Water Using Conductivity as a Variable".

This open discussion took place on May 17, 2016, during the joint CAC/AIC Annual Meeting, held May 14–May 17, 2016, in Montreal, Canada. The moderators organized and led the discussion and recorded notes. Readers are reminded that the moderators do not necessarily endorse all the comments recorded, and that although every effort was made to record proceedings accurately, further evaluation or research is advised before putting treatment observations into practice.

INTRODUCTION

Following in the tradition of the two prior Art on Paper Discussion Group sessions which presented discussions on media terminology and the ethics and practice of inpainting, the third Art on Paper Discussion Group sought to continue the essential dialogue around how we describe materials alongside an examination of a complex aesthetic issue in the conservation of works of art on paper, specifically how do we look at, describe, and consider paper tone relative to artist's intent, historical context, and approaches to conservation treatment both traditional and new. The four presentations were followed by a question and answer period and a guided discussion.

PRESENTATION SUMMARIES

MARGARET (PEGGY) HOLBEN ELLIS
PAPER IS PART OF THE PICTURE

Peggy began by observing the discrepancy between the significant aesthetic and physical role of paper in prints and drawings and the paucity of descriptive information about the paper support of prints and drawings that appears in the literature of art. The lack of truly informative and evocative paper descriptions specifically in museum catalogue entries, collection data systems, and gallery wall labels has been noted. The 2014 *Guidelines for Descriptive Terminology for Works on Paper* pointed out this deficiency.[1] In order to fully understand the role of paper as part of the picture, it is important that paper terminology be consistent and meaningful to everyone.

If the support is included in the description of a work of art on paper, it might include its color (ivory, cream, buff), structure (laid, wove), texture (oatmeal, pebbled), or function (cartridge, butcher, plate). Unfortunately, terms such as these are vague, as well as historically archaic, culturally biased, or industry-specific. Also, the persons responsible for identifying and describing the paper supports of prints and drawings, i.e., members of the museum community, are far removed from a paper's manufacture and subsequent selection and fabrication into a work of art. Artists were not unaware of these characteristics and consciously sought out papers having specific physical and aesthetic properties. Once entered into a collection and ensconced in mats and frames, prints and drawings are not generally handled directly, further distancing the cataloger from the paper's physical attributes and minimizing its critical role as carrier of marks. Finally, the properties of paper are, and always have been, difficult to qualify and quantify, even for those whose livelihoods depend upon doing so, i.e., paper manufacturers and publishers.

It is also very apparent that all five senses are required to evaluate and accurately assess a paper's properties—paper is sensed—not just seen. The speaker provided examples of how sight, smell, touch, hearing, and even taste were employed in the past to ascertain paper's characteristics. Two options for becoming fluent in the language of paper were suggested: to define and incorporate technical terms as used by industry; or to invent a universal, culturally and historically neutral vocabulary that can be easily understood by the layperson.

Margaret (Peggy) Holben Ellis, Eugene Thaw Professor of Paper Conservation; New York University Director, Thaw Conservation Center, The Morgan Library and Museum, New York, NY

MARIAN DIRDA
CONNOISSEURSHIP AND CONSERVATION PRACTICE: DIALOGUE BETWEEN THE CONSERVATOR AND CURATOR

Marian Dirda spoke about the need for dialogue between conservators and custodians in planning conservation treatment. The conservator benefits from the guidance of the curator, and in turn conveys the possibilities and risks of conservation treatment. She noted that curators at the National Gallery of Art are generally restrained in considering wet treatment for prints and drawings since it can effect changes in paper texture, tonal relationships, or embossing. As an example, Marian described the treatment of a 1540s engraving, *Massacre of the Innocents* by Nicolaus Beatrizet. The curator felt that the yellow paper tone reduced the volume of figures that was the very essence of the print. He wanted the print to be brighter, yet retain some of the paper tone. To ensure only moderate lightening, the conservator gently washed the print on a screen in cold water, followed by brief immersion, and the curator was happy with the result.

Local spot reduction may be more appropriate than overall washing. Marian described the treatment of *River Landscape with Buildings, Boats and Figures* by Eugène Boudin, 1858, in which large foxing spots had overpowered the delicate white clouds in the image. Conservators feared that overall wetting, even screen or blotter washing, would cause a loss of graphite and white gouache media. The spots were washed locally on the suction disc with dilute ammoniated water and dilute hydrogen peroxide, rinsed well locally afterward. Marian pointed out that local treatment, particularly, requires the conservator to be restrained and cautious, as local treatment may cause tidelines and chemical change in paper that could become visible over time. On the positive side, local treatment preserves the overall paper tone.

Marian stressed the importance of learning about an artist's work before proposing treatment. Seeking examples of comparable works in excellent condition allows one to judge the original paper tone and understand the artist's intent. She described the prints of Mary Cassatt as an example of the way in which alterations in paper tone can change the aesthetic effect. Two impressions of the artist's color aquatint, *Woman Bathing*, c. 1891 (Figure 1), could not be exhibited because the paper had darkened and significantly altered the color balance in the print.[2] Marian showed how areas of unprinted paper, which Cassatt had held in reserve to establish white stripes in the skirt and a horizontal band at the waist, were intended to function as the brightest value in the work. Over time, however, as the hue in the stripes and waistband shifted and darkened, the brightest values in the print had been replaced by areas printed in light-toned inks. Marian described a similar color shift in two impressions of another aquatint by Cassatt entitled *The Letter*, c. 1891 (Figure 2). These examples underscored her earlier point that conservators should closely examine numerous impressions to understand the artist's intent before proposing treatment.

Marian gave a thoughtful account of the value of open, informed dialogue between curator and conservator, particularly when there are conflicting priorities. She described a request to treat a drawing scheduled for exhibition. The graphite drawing, *Study for Mary Cassatt at the Louvre: The Etruscan Gallery*, c.1879, had been used by Edgar Degas to make two related soft-ground etchings: *Mary Cassatt at the Louvre: The Etruscan Gallery and Mary Cassatt at the Louvre: The Painting Gallery* (Figure 3). In preparing the plates, Degas had used two different colors of softgrounds, which had transferred to the back of the drawing as he traced portions of the design. The curator had requested treatment to lighten the paper, which was moderately light-struck and yellowed, but the conservator feared alteration to the graphite lines if the drawing were washed overall, and also thought the weak paper might crack if treated locally. Ultimately, in strong raking light, the conservator noticed faint, shiny scratches on the front of the drawing that corresponded to the soft-ground lines on the back (Figure 4). She theorized that Degas had used a blind stylus to transfer the design to the plates. The discovery of these subtle lines turned the consensus against aqueous treatment, which would have destroyed the marks, so integral to understanding

Fig. 1.

LEFT TO RIGHT

a. Mary Cassatt (American, 1844-1926), *Woman Bathing*, 1890-1891, Color drypoint and aquatint on discolored laid paper with watermark "ED&Cie", Mathews and Shapiro 1989, no. 10, State iv/iv, plate: 36.51 × 26.67 cm, sheet: 46.67 × 31.12 cm, Rosenwald Collection, National Gallery of Art 1946.21.92.

b. Mary Cassatt (American, 1844-1926), *Woman Bathing*, 1890-1891, Color drypoint and aquatint on discolored laid paper with watermark "ED&Cie", Mathews and Shapiro 1989, no. 10, State iv/iv, plate: 36.5 x 26.6 cm; sheet: 47.9 x 31.2 cm, Gift of Mrs. Lessing J. Rosenwald, National Gallery of Art 1989.28.5. Compare the darkened waistband with the printed colors of the back and jug

c. Mary Cassatt (American, 1844-1926), *Woman Bathing*, 1890-1891, Color drypoint and aquatint on white paper without watermark, Mathews and Shapiro 1989, no. 10, State iv/iv, plate: 36.4 x 26.7 cm; sheet: 43.2 x 29.8 cm, Chester Dale Collection, National Gallery of Art 1963.1.253. The waistband and stripes retain their original, brilliant paper tone.

Fig. 2.

LEFT TO RIGHT

a. Mary Cassatt (American, 1844-1926), *The Letter c.1891,* Drypoint, softground etching and aquatint in color on discolored laid paper with watermark "PL BAS", Mathews and Shapiro 1989, no. 8, State iv/iv, image: 34.61 x 22.54 cm; sheet: 47.94 x 31.12 cm, Gift of Jane C. Carey as an addition to the Addie Burr Clark Memorial Collection, National Gallery of Art 1959.12.5. The unprinted paper of the letter is nearly as dark as the hands.

b. Mary Cassatt (American, 1844-1926), *The Letter c.1891,* Drypoint, softground etching and aquatint in color on white paper without watermark, Mathews and Shapiro 1989, no. 8, State iv/iv, plate: 34.6 x 22.8 cm; sheet: 43.6 x 30.0 cm, Chester Dale Collection, National Gallery of Art 1963.10.251. When the paper is bright white, and not yellowed, the letter is the focal point of the print.

Fig. 3. Edgar Degas (French, 1834-1917), *Study for "Mary Cassatt at the Louvre: The Etruscan Gallery"* [recto], c.1879, Graphite with blind stylus on wove paper (National Gallery of Art, 1995.47.36.a) and *Study for "Mary Cassatt at the Louvre: The Etruscan Gallery"* [verso], c.1879, Carbon and softground wax transfer on wove paper (1995.47.36.b), overall: 32.3 x 24.5 cm, Collection of Mr. and Mrs. Paul Mellon.

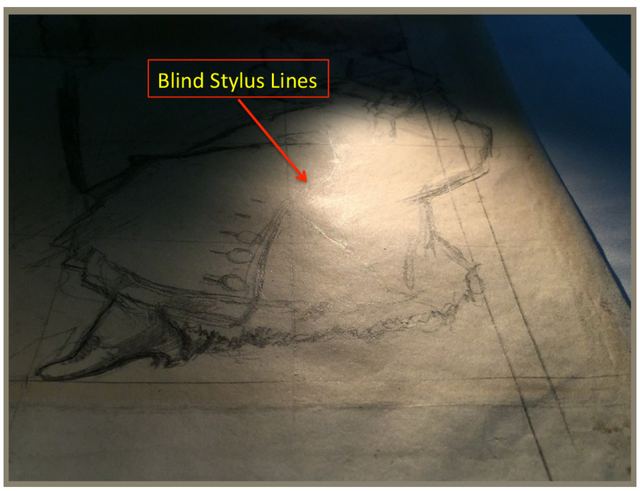

Fig. 4. Edgar Degas (French, 1834-1917), *Study for "Mary Cassatt at the Louvre: The Etruscan Gallery"* [recto], c.1879, Graphite with blind stylus on wove paper, National Gallery of Art, 1995.47.36.a. Detail of stylus lines visible with specular illumination.

the artist's technique. The conservator and curator ultimately agreed to forgo treatment to preserve it as it was.

The last point of the talk addressed the particular vulnerability of modern papers to oxidative attack and yellowing. Marian cited the example of Michael Heizer, who had created a suite of six oversize prints, titled *Scrap Metal Drypoint*, in 1978. The prints exhibited overall yellowing and brown edge stains that had probably been caused by storage in wooden drawers. She noted that the 1960s and early 1970s were a low point for production of artists' papers; even 'good' artists' papers were extremely vulnerable to light damage and stains. While national and international standards for stable, permanent papers were introduced in the 1980s, no standards currently govern the lightfastness of artists' papers.

Marion Dirda, Senior Paper Conservator, National Gallery of Art, Washington, D.C.

KRISTI DAHM

CASTING FAR AND WIDE: WINSLOW HOMER'S ENGAGEMENT WITH THE MATERIALITY OF PAPER

Kristi spoke about Winslow Homer's (1836-1910) use of paper throughout his graphic oeuvre. The diversity of papers under consideration demonstrates that Homer was acutely attuned to such varied physical characteristics as tone, color, texture, surface sheen, opacity, translucency, thickness, and degree of sizing. Homer used these properties to his aesthetic and expressive advantage with different media.

Kristi observed that Homer's choice of gray and tan papers for graphite drawings from the early 1870's onward reflects aesthetic strategies he developed as an illustrator for wood engravings reproduced in the popular press. Over more than a decade, Homer trained his eye and hand to see and draw strong lines and broad, flat areas of tone, in order to effectively translate his drawings into the linear medium of wood engraving. In *Children Sitting on a Fence*, 1874 (The Art Institute of Chicago, 1927.3522), Kristi noted that Homer chose a gray paper to create a middle value in reserve against dark graphite lines and white watercolor highlights. She also noted that Homer chose to draw on the smooth felt side of a soft, medium thick, wove paper.

Homer's earliest opaque watercolors from the 1870's are on similar papers, but reveal the artist's preference for green and blue supports, in addition to gray.[3] Kristi pointed out that Homer was an experienced oil painter by this date, albeit self-taught. He seems to have selected paper colors that functioned like a preparatory colored ground, analogous to his work in oil, in order to more intuitively learn to paint in an aqueous medium.[4] For example, in *Apple Picking*, 1878 (Terra Foundation for American Art, 1992.7) he used both dense and dilute washes of opaque watercolor to allow the paper tone to show through and lend substance to elements in the scene.

Kristi pointed out that many of the papers Homer used for opaque watercolors, including *Apple Picking*, have darkened to warm brown, altering the color balance. She theorized that an alum rosin sizing agent may have contributed to their darkening. The original, green paper color can only be observed through microscope examination.

Kristi described how some of Homer's papers could be linked to a specific time and place. In England, between 1881 and 1882, Homer consistently used large sheets of tan, highly textured, laid paper (46 x 62 cm) for his drawings in graphite and opaque white watercolor. All sheets are watermarked "Saint Mars" through the horizontal center, on the right side, with a countermark "JV" on the left portion of the sheet. Slight magnification reveals red, blue and black fibers mixed into the tan furnish.

Homer showed transparent watercolor to greatest effect by using authentic watercolor paper, which had specific physical properties that facilitated the active manipulation of brilliant colored washes on the surface. Watermark evidence confirms that Homer exclusively used thick, bright white, heavily textured English watercolor paper by J. Whatman. Hand-made from linen fibers and tub-sized with gelatin, Whatman papers were durable and slow absorbing, allowing Homer to work aggressively with additive, wet into wet methods, and to employ subtractive techniques such as blotting, wiping and scraping, exemplified in *Adirondack's Guide*, 1892 (Art Institute of Chicago, 1933.1234).

Kristi also discussed Homer's extensive use of watercolor blocks. Residues of brown adhesive and gauze used to bind the sheets together into a block are evident along the edges of Homer's watercolors executed over several decades (Figure 5). In some, a fragment of paper from an overlying sheet has remained along an edge, or a ghost of its former presence is visible as a white void at the edge of a painting, where it had formed a barrier to Homer's brush.

Homer used paper with deep, diagonal furrows on the wire side for two trips to the Bahamas and Bermuda in 1898 and 1899.[5] This particular paper is not used for any other works.[6] Homer alternated between the heavily textured side and the smoother felt side depending upon the effect he aimed to achieve.

In Kristi's survey of Homer's etchings at The Art Institute, she found impressions on laid Whatman paper, parchment, and Japanese vellum. Japanese vellum is a smooth, thick, and dense calendered Japanese paper with a lustrous surface.[7] Transmitted light reveals a mottled appearance caused by clumps of long fibers, characteristic for these papers. (Figure 6) These long fibers reflect specular light in all directions, creating a surface that can only be described as lustrous. (Figure 7) Homer's choice of support speaks to his ambition to offer deluxe impressions. Kristi identified both lifetime and posthumous prints on Japanese vellum and suggested that a survey of Homer's etchings might be instructive to clarify the supports used in lifetime and posthumous impressions.

Kristi Dahm, Associate Paper Conservator, The Art Institute of Chicago, Chicago, IL

Fig. 5. Winslow Homer (American, 1836-1910), *Sunshine and Shadow, Prout's Neck*, 1894. Watercolor, with rewetting and blotting, over graphite, on thick, rough-textured, ivory wove paper. 38.5 x 54.6 cm, The Art Institute of Chicago, 1933.1253. Detail of right edge showing gauze string and adhesive residue from the watercolor block.

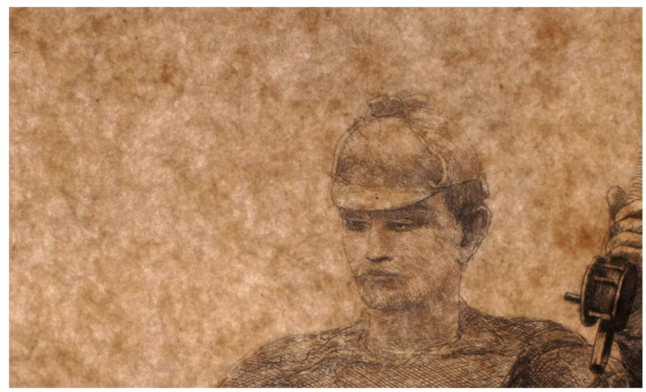

Fig. 6. Winslow Homer (American, 1836-1910), *Fly Fishing, Saranac Lake*, 1889, Etching and aquatint with lavis, stopping-out, scraping, and burnishing, on moderately thick, smooth, cream Japanese vellum. 35.8 x 51.8 cm, The Art Institute of Chicago, 2007.12. Transmitted light detail revealing a mottled appearance caused by clumps of long fibers characteristic of this paper.

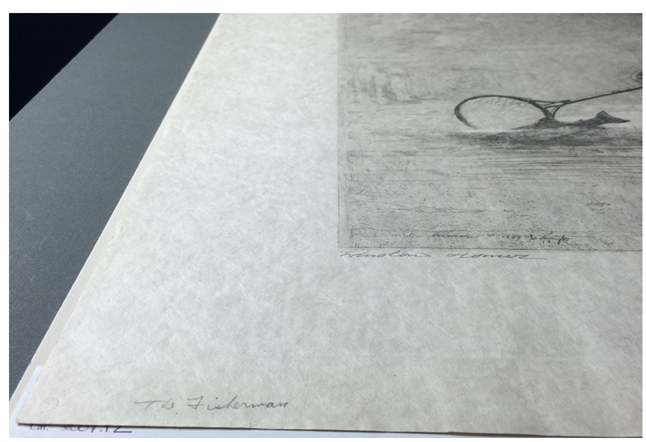

Fig. 7. Winslow Homer (American, 1836-1910), *Fly Fishing, Saranac Lake*, 1889, Etching and aquatint with lavis, stopping-out, scraping, and burnishing, on moderately thick, smooth, cream Japanese vellum. Image: 35.8 x 51.8 cm; Plate: 44.0 x 56.5 cm; Sheet: 50.5 x 70.0 cm. The Art Institute of Chicago, 2007.12. Specular light detail showing light reflecting in multiple directions off the Japanese vellum surface.

AMY HUGHES

FINE-TUNED: ADJUSTING WASH WATER USING CONDUCTIVITY AS A VARIABLE

Amy presented treatment case studies illustrating the use of pH-and conductivity-adjusted waters for aqueous stain reduction. She proposed that conservators, with an awareness of the properties of conductivity in solution, would be able to design aqueous treatments that are more sensitive to the needs of unique objects. The manipulation of conductivity as part of aqueous treatment practice holds promise as a technique for sensitively removing stains and brightening paper tone while minimizing swelling and disruption to the surface of paper during treatment. The aqueous solutions she described in the talk were adopted from those taught as part of the Getty's Cleaning of Acrylic Painted Surfaces (CAPS) workshops and were introduced to her by Daria Keynan in 2012.

The representative case study was a watercolor sketch by Zacharie Astruc (French, 1833–1907) drawn on a moisture sensitive paper (Figure 8). The watercolor was presented to Amy for treatment requiring reduction of the tidelines at the upper half of the sheet (Figure 9). Aside from the tidelines, conservators and curators agreed that the sheet possessed a desirable tone overall. The paper, a page cut from a blank book, was machine-made wove containing a generous amount of non-fibrous filler and was heavily calendared. Areas with severe water damage had already suffered partial loss of the compacted surface, appearing more matte and fluffy in raking light. The hope for the treatment was to reduce the tidelines locally to return visual integrity to the object while retaining the aged, slightly yellowed paper tone as well as the sheen of the paper.

Fig. 8. Zacharie Astruc (French, 1835–1907), *Two Roses*, ca. 1884–1904, Watercolor, 17.78 x 12.065 cm, The Metropolitan Museum of Art, Gift of Gregoire Tarnopol, 1971.253.3.

Fig. 9. Zacharie Astruc (French, 1835–1907), *Two Roses*, ca. 1884–1904, Watercolor, 17.78 x 12.065 cm, The Metropolitan Museum of Art, Gift of Gregoire Tarnopol, 1971.253.3. Before treatment, detail.

The speaker described testing methods and results. These included discreet tests on the tidelines over the suction platen using a variety of aqueous solutions, both with and without added ethanol, including warm and cool alkaline water and a selection of chelators in water. None reduced the stains satisfactorily while leaving the surface texture of the paper intact. Amy commented that the difficulty of reducing the stains was likely a result of having been present in the paper for at least 45 years since the work's acquisition. She then discussed the choice to employ a solution of pH- and conductivity-adjusted water, tailor-made to match the stained areas of the paper, to minimize the swelling of the paper surface while still efficiently removing the discoloration products. The goal was to create an isotonic aqueous environment for local stain reduction.

Amy explained that to achieve near isotonicity, she measured the surface pH and conductivity of the stained areas of the artwork using agarose gel plugs as a vehicle (paper pH 6.1 and conductivity 940μS/m), and then made a solution of moderately concentrated ammonium acetate in deionized water to match the measured values of the artwork (solution pH 6.0 and conductivity 1,000μS/m). The pH- and conductivity-adjusted ammonium acetate solution was formulated by reacting acetic acid and ammonium hydroxide in deionized water. According to Amy, these solutions do not strictly follow a recipe because the reaction of the acid with the base to form the salt is non-linear and the volume of the base is dependent on the strength of the particular bottle of ammonium hydroxide, which tends to lose saturation over time. It is therefore necessary to make up the solutions using frequent pH and conductivity measurements as guides throughout the process.

The tidelines on the watercolor were treated locally over the suction table using both an airbrush and a small paintbrush

Fig. 10. Zacharie Astruc (French, 1835–1907), *Two Roses*, ca. 1884–1904, Watercolor, 17.78 x 12.065 cm, The Metropolitan Museum of Art, Gift of Gregoire Tarnopol, 1971.253.3. During treatment with adjusted water, detail.

Fig. 11. Zacharie Astruc (French, 1835–1907), *Two Roses*, ca. 1884–1904, Watercolor, 17.78 x 12.065 cm, The Metropolitan Museum of Art, Gift of Gregoire Tarnopol, 1971.253.3. After treatment, detail.

to deliver the tailored solution. After several applications, the majority of the discoloration was washed out of the paper despite the tenacity of the stains (Figure 10). The paper texture and sheen were unaltered during treatment, however, the tidelines remained somewhat visible and distracting. After further discussion within the department, it was determined that if possible, the stains should be reduced further using a bleaching agent. After preliminary testing, solutions of sodium borohydride (a salt with high conductivity) were applied selectively by brush—just enough to break up some of the darker lines. The sodium borohydride worked effectively on the remaining discoloration, but dulled or greyed the surface of the paper when pushed too far, so bleaching was stopped and the treated areas were rinsed with the same solution of adjusted water used for washing (Figure 11).

In Amy's experience, pH- and conductivity-adjusted waters are particularly useful for papers prone to fiber disruption and undesired swelling during aqueous treatment. They have proven to be a good choice for treatments where controlled moisture delivery is key, including damp swab cleaning, cleaning over the suction platen, and cleaning using rigid polysaccharide gels. She views these so-called "adjusted waters" as a sensitive tool for aqueous treatment; to be employed when the conservator would like to subtly diminish stains and discoloration while leaving texture and overall paper tone intact.

Amy Hughes, Andrew W. Mellon Fellow in Paper Conservation, The Metropolitan Museum of Art, New York, NY

SUMMARY OF DISCUSSION

At the close of the presentations, the moderators opened the floor for discussion. Responses from the audience were enthusiastic about the content presented, and appreciation for bringing back a focus on connoisseurship into the professional dialogue about conservation was expressed.

The first question pertained to the usefulness of the "The Print Council of America Paper Sample Book," a reference guide used by many conservators and curators to describe paper characteristics by way of visual comparison with provided samples. Peggy Ellis commented that, although the reference is good, and is currently all that we have in our field, the descriptive language has become outdated and no longer holds meaning for audience members. A suggestion was made to translate the paper tone colors to L*a*b* values. Another participant suggested that conservators consult with paper historians in evaluating paper characteristics and their significance.

The conversation continued with a focus on treatment and maintaining the characteristics of paper outlined in Ellis's talk. Audience members were interested in learning more about how to perform treatments with gels and whether it was possible to self-educate in the area of conductivity treatments. It was noted that FAIC workshops were being planned for 2016 and 2017 in Washington, D.C. and Fort Worth, Texas.

Questions about bleaching techniques relative to paper tone led to a discussion about the usefulness of working in labs with colleagues of different generations and the benefit of reading older treatment documentation. In addition to presenting practical tips for bleaching, such as protecting areas from over-bleaching with Marvelseal® during light bleaching, or applying chemical bleaches with an airbrush, audience members also discussed the usefulness of relying on presentation techniques, such as over-matting, using low light levels, and careful selection of mat color or wall paint color. Presentation methods were thought to be particularly helpful when a series of prints on papers of different tones due to differential aging are displayed side-by-side.

One panelist cited the importance of documenting the thought process that goes into a treatment, such as testing results and discussions with curatorial colleagues. Members of the panel also cited dialogues with conservation scientists on bleaching, and how awareness of the work of Margaret Hey and others can contribute to our evaluations of bleaching treatments. It was also stressed, however, that conservators must evaluate such contributions using their own judgment, gained with an appreciation for historical paper and an awareness of the aesthetic impact of bleaching treatments.

The discussion closed with return to the topic of paper tone and the lessons that can be learned from examination of dated papers of known manufacture and a reference to the usefulness of Historic Paper Sample Collection at the National Gallery of Art, Washington D.C.

ACKNOWLEDGEMENTS

The co-chairs wish to thank the audience members who participated in the discussion following the presentations. Kristi Dahm, Marian Dirda, Margaret (Peggy) Holben Ellis, and Amy Hughes were wonderful collaborators and generous in sharing their insights and expertise. Their efforts made the session a success. Finally, Angela Campbell, BPG Program Chair, offered support and advice during the planning for the discussion.

NOTES

1. Ash, N., S. Homolka, and S. Lussier. 2014. Descriptive Terminology for Works of Art on Paper: Guidelines for the Accurate and Consistent Description of the Materials and Techniques of Drawings, Prints, and Collages. Philadelphia Museum of Art. http://www.philamuseum.org/conservation/22.html

2. The NGA has five impressions of Woman Bathing, c. 1891, by Mary Cassatt, including 3 impressions of the 4th and final state. Two impressions in which the paper had darkened were made on paper with the watermark 'ED&Cie', the sign of Emile Desloye and Company in Plancher-Bas, France. X-ray fluorescence confirmed the presence of a large amount of iron in the paper.

3. These are likely French papers. A 'MONTGOLFIER' watermark is found along the right edge of *The Green Hill*, 1878, The National Gallery of Art, 1994.59.25.

4. Hoermann, Christine. "A Hand Formed to Use the Brush", in Mark Simpson, Winslow Homer Paintings of the Civil War, The Fine Arts Museums of San Francisco, 1988, pp. 108-109.

5. Tedeschi 2008, p. 180. For Sargent's use of the same paper see Annette Manick and Antoinette Owen, *Bringing Back Something* Fine, in John Singer Sargent Watercolors, Ed. Erica E. Hirshler and Teresa A. Carbone, Museum of Fine Arts Boston, 2013, p. 207.

6. Conversation with Judith Walsh, January 2006.

7. For more on Japanese vellums see: Antoinette Dwan, *A Method for Examining and Classifying Japanese Papers Used by Artists in the Late Nineteenth Century: The Prints of James Abbott McNeil Whistler*, "Conservation Research", National Gallery of Art, Washington, 1993, pp. 112–113. Also see Penny Jenkins, *Vexed by Vellums*, "The Paper Conservator" Volume 16, 1992, pp. 63–64.

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Nicolaus Beatrizet (French, 1515-1565), *The Massacre of the Innocents*, 1540s (?), Engraving on laid paper, Bartsch, no. 21. Copy A, State ii/ii (or of iii?), 31.1 x 41.3 cm, Aisla Mellon Bruce Fund, Purchased as the Gift of Robert B. Loper and Samuel H. Kress Foundation Funds, National Gallery of Art, Washington D.C. (2014.57.1)

Eugène Boudin (French, 1824-1898), *Landscape with Buildings, Boats, and Figures*, c. 1858, Graphite with watercolor and white gouache on wove paper, size: 24 x 40 cm, Collection of Mr. and Mrs. Paul Mellon, National Gallery of Art, Washington D.C. (1980.25.6)

Michael Heizer (American, born 1944), *Scrap Metal Drypoint #6*, published 1978, Drypoint in sepia on uncalendered Arches 88 paper, 89.2 x 212.4 cm, Gift of Gemini G.E.L and the Artist, National Gallery of Art, Washington D.C. (1981.5.179)

Winslow Homer (American, 1836-1910), *Children Sitting on a Fence*, 1874, Various graphites, heightened with opaque white watercolor, on medium weight, slightly textured gray wove paper, 19.3 x 23.9 cm, The Charles Deering Collection, The Art Institute of Chicago, (1927.3522)

Winslow Homer (American, 1836-1910), *Apple Picking*, 1878, Opaque watercolor over graphite on medium weight, slightly textured, gray-green wove paper, altered to brown, laid down on board, 17.8 x 21.3 cm, Daniel J. Terra Collection, Terra Foundation for American Art, (1992.7), on long-term loan to The Art Institute of Chicago, (152.2005)

Winslow Homer (American, 1836-1910), *Adriondacks Guide*, 1892, Transparent watercolor with touches of opaque watercolor, rewetting, blotting and scraping, over traces of graphite, on thick, moderately textured, ivory wove paper (top edge trimmed), 32.9 x 54.5 cm, Mr. and Mrs. Martin A Ryerson Collection, The Art Institute of Chicago, (1933.1234)

FURTHER READING

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Keynan, D. and A. Hughes. 2013. Testing the Waters: New Technical Applications for the Cleaning of Acrylic Paint Films and Paper Supports. Book and Paper Group Annual, volume 32. http://www.cool.conservation-us.org/coolaic/sg/bpg/annual/v32/bp32-08.pdf

Fairbanks Harris, T. and S. Wilcox, eds., 2006. Papermaking and the Art of Watercolor in Eighteenth-Century Britain: Paul Sandby and the Whatman Paper Mill. Yale University Press, New Haven and London.

Schenck, Kimberly. *Degas and Cassatt: A comparison of drawings for soft-ground etchings*, in Facture, Volume 3, to be published 2017 by the National Gallery of Art, Washington.

Tedeschi, M. and K. Dahm, 2008. Watercolors by Winslow Homer: The Color of Light, Yale University Press. (electronic version forthcoming, fall 2016, Yale University Press).

Mathews, Nancy M., and Barbara S. Shapiro, Mary Cassatt: The Color Prints, Harry Abrams, New York, 1989. For discussion of Mary Cassatt's printing plates.

Sarah Bertalan, *Cassatt's Paper: Finding the Right Sheet*, in Mary Cassatt, Prints and Drawings from the Collection of Ambroise Vollard, M. Rosen and S.Pinsky, Adelson Galleries and Marc Rosen Fine Art, 2008.

Hey, Margaret. 1979. The washing and aqueous deacidification of paper. *The Paper Conservator* 4: 66–80.

For a brief history of standards for permanent papers see The Library of Congress Preservation Division, Resources / Collection Care / Permanent Papers at http://www.loc.gov/preservation/resources/rt/perm/pp_5.html

For a discussion of lightfastness standards of artists' materials see: ASTM International, Subcommittee D01.57 on Artist Paints and Related Materials at http://www.astm.org/COMMIT/SUBCOMMIT/D0157.htm

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Tip: How to Resew a Book in Situ Using Beading Wire, Floss Threaders, and Alligator Forceps

Fig. 1. Resewing Tools.

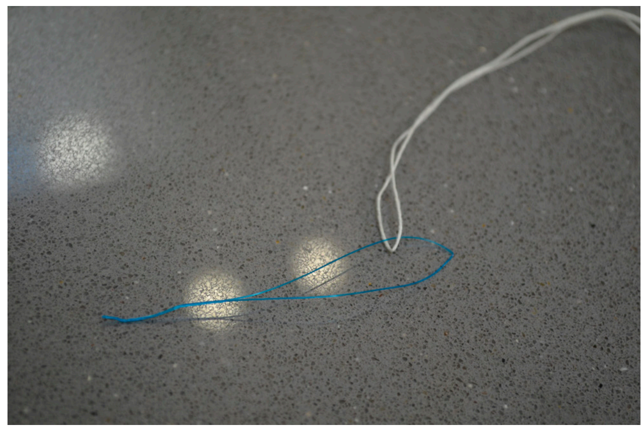

Fig. 2. Sewing thread passed through loop in floss threader.

The tools used in this unique resewing in situ of an entire textblock were 7 strand beading wire, GUM Eez-Thru Floss Threaders, and a pair of alligator forceps (figure 1). Short lengths of the beading wire were bent in half to create a "V" shape and the sewing thread was looped around the bend to assist it in staying put during the sewing process. The straight end of the floss threader was cut at an angle to assist it in passing through sewing holes; as the straight end became bent through use, damaged parts could be cut off to extend usage. The sewing thread was passed through the open loop in the floss threader allowing it to carry the thread to the desired destination (figure 2).

The sewing thread was introduced into the center of the signature to be sewn through a kettle stitch and each support was then sewn successively. The thread was moved from the outside of the textblock to the inside of the signature using the bead wire while the floss threader was used to move the thread from the interior of the signature to the exterior of the textblock as well as to navigate around the sewing supports in between the exterior of the spine of the textblock and the interior of the spine of the binding. This division of labor was established due to the ability of the beading wire to withstand the inaccuracy of attempting to find the sewing hole from the "hidden" exterior of the textblock and the ability of the floss threader to carry the sewing thread through the sewing hole via the loop and then bend around the sewing supports in very close quarters. (figures 3-6)

Presented at the Book and Paper Group's Lunchtime Tip Session, AIC's 44rd Annual Meeting, May 13–17, 2016, Montreal, Canada

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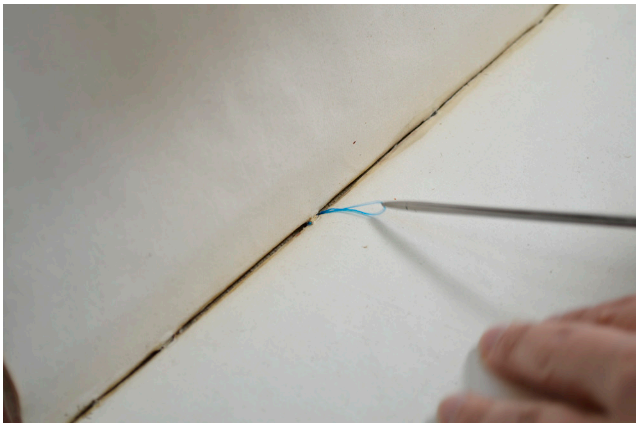

Fig. 3. Pulling floss threader through sewing hole from the exterior of signature in preparation for maneuvering it around sewing support.

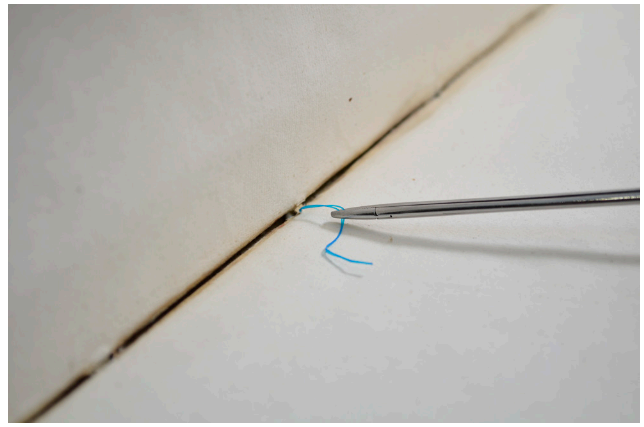

Fig. 4. Pulling floss threader behind sewing support back to exterior of signature before transitioning to bead wire.

Fig. 5. Using alligator forceps to find floss threader in space between exterior of textblock and interior of spine of binding.

Fig. 6. Pulling thread taut inside signature using bead wire.

SETH IRWIN

Tip: The Adaption of the Video Slider into a 'Microscope Bridge' as a Practical Alternative for Using a Stereomicroscope to Examine and Treat Oversize Paper Artifacts

ABSTRACT

One of the most regularly used instruments in most conservation labs is the stereomicroscope. In many ways it has become the 'workhorse' of many labs. While there are many types of stereomicroscopes available on the market, the ability to use a microscope on oversize materials can present a challenging problem. This is primarily due to the limitations of currently available designs for microscope stands that allow for a microscope to reach into the middle of a large artifact such as an oversize map or print where the viewing area desired is beyond the reach of a typical stereomicroscope stand. At present, currently available stereomicroscope stand designs are primarily limited to either an articulating arm, a boom stand, or a floor stand, all of which have limitations when an extended reach is required. These limitations can become apparent in the form of vibration issues, the inability to clamp the stand to a table, the danger of damage to the microscope due if the stand tips over, the need to access an area beyond the reach of the stand, and finally the weight of the microscope head itself.

The solution for this problem has often been to employ an alternative microscope stand design that operates in gantry or bridge style. The use of the 'bridge' design has been available for conservation for many years, but as yet this design has only been available in a custom built set-up by a few select manufacturers. These custom built 'bridge' set-ups are often very expensive and custom built to a specific location.

The video sliding track is a device that has been used by both professional and amateur videographers for decades. It allows for the attachment of a device to a glider that can then glide smoothly along a track of varying lengths. Video sliding tracks are often very inexpensive and very lightweight. They are designed to be easily dismantled and packed away for travel, and video sliding tracks can also be purchase with both a motorized slider or manually operated. In addition, a video slider can be set directly on a surface without the need for additional clamping or a heavy base plate.

This paper will show how to easily and inexpensively adapt a video sliding track to a stereomicroscope focusing mechanism. This stand will accept most standard stereomicroscopes and will allow for a conservator to reach desired viewing areas that are beyond the reach of most microscope stands. This will hopefully allow for a practical and economical method of using a stereomicroscope on oversize material.

INTRODUCTION

At the University of Hawaii Hamilton Library Preservation Department, the Paper Conservation Lab is frequently asked to work on large paper objects from many of the various departments and collections throughout the library. The large object can often reach sizes of four by six feet. In 2013 when an attempt was made to bring the lab's Leica MZ7s stereomicroscope out of storage and back into working order it was discovered that the only stand that was purchased for the microscope was a dissection stand. While this type of stand would have worked well for many other types of laboratories, it was unsuitable for virtually everything that the Paper Lab was asked to work on. It was also determined that due to lack of funding it would not be possible to purchase a better suited stereomicroscope stand for basic treatment work.

After assessing the need to get the lab's stereomicroscope back to operation status, combined with no funding to purchase a new stand, a plan was put into place to use the rack and pinion part from the existing focusing stand and adapt it to a retrofitted 'bridge style' stand constructed out of available materials and spare parts from around the lab (fig. 1). After the retrofit and many months of use it was determined that this design was ideal for active day to day treatments, but due to the extensive amount of work needed to build it, as well as the likely expense of the materials used, the author decided to attempt to find an easier and more cost effective method of making a bridge style stand that would accommodate most stereomicroscopes. The goal for this project was to devise

Presented at the Book and Paper Group's Lunchtime Tip Session, AIC's 44rd Annual Meeting, May 13–17, 2016, Montreal, Canada

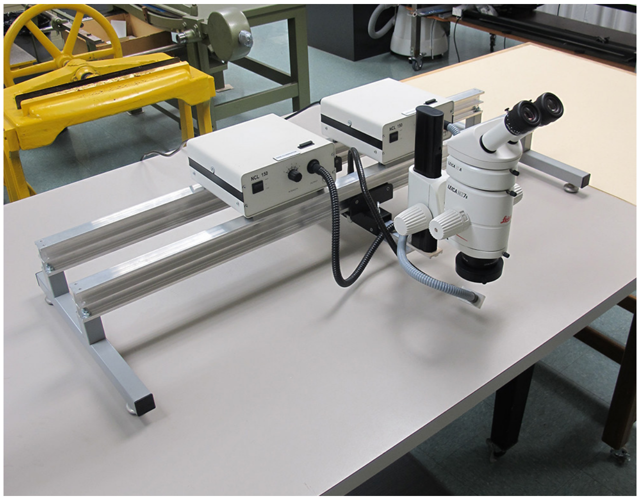

Fig. 1. Leica® Mz75 stereomicroscope in custom built bridge stand at the University of Hawaii Preservation Department Paper Lab.

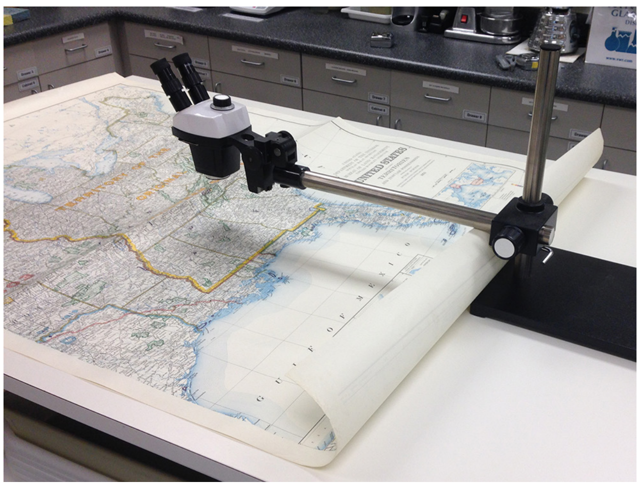

Fig. 2. Attempting to get a stereomicroscope, on a boom stand, into the middle of a large map. This required that the map be rolled at one end under the boom arm.

Fig. 3. Leica® S6D on a Unitron® Articulating (Flex Arm).

a way to take the benefits and functionality of the retrofitted bridge system and give the design greater practicality by removing it deficiencies such as weight, size, and cost. The design also had to be easily adaptable without requiring the use of the metal shop equipment that the retrofitted version required to make.

AN OVERVIEW OF STEREOMICROSCOPE STANDS

One of the benefits to purchasing a stereomicroscope body manufactured in the last thirty or so years is it adaptability to many components made by other microscope companies. A modern stereomicroscope head made by one company would generally be able to be used in a focus mechanism by a different company, and that focus mechanism could then in-turn be used on a stand from a third company. This flexibility between companies allows for many options and customizations to suit the needs of the users. While there is no doubt of the usefulness of the stereomicroscope in conducting daily treatment work in a paper lab, the currently available stand options present some functionality problems in doing treatment work on many paper objects.

Currently there are two main types of stands offered on the market for using table-based stereo microscopes and each one has both benefits and deficiencies. For reference purposes it should be noted that the following observations were made by the author based on usage of actual microscopes in various stands. It should also be noted that while floor stands are available and have many advantages and disadvantages they were not considered for this project due to their high cost and portability issues.

BOOM STANDS

This is the most common stand available and most of the companies manufacture a version of their own that might vary slightly from company to company. This style usually comes in either a table clamp or a heavy base plate. A boom stand provides the greatest stability to eliminate vibration, and is generally not too expensive. The boom style does have several obvious limitations in paper lab bench top treatment work, the greatest being its very limited extension abilities. Often boom arms have limited extensions. This can present difficulties when trying to get your microscope to access the center of large paper objects. Other limitations include the portability of an often heavy base plate. For boom stands that use the table clamp option, extension limitation still exists and the user can gain the advantage of portability without the heavy base plate, but for the safety of the microscope and to reduce vibration, a very sturdy table is needed that usually needs to be at least 1” inch thick. A heavy weight tabletop is not always possible. (fig. 2)

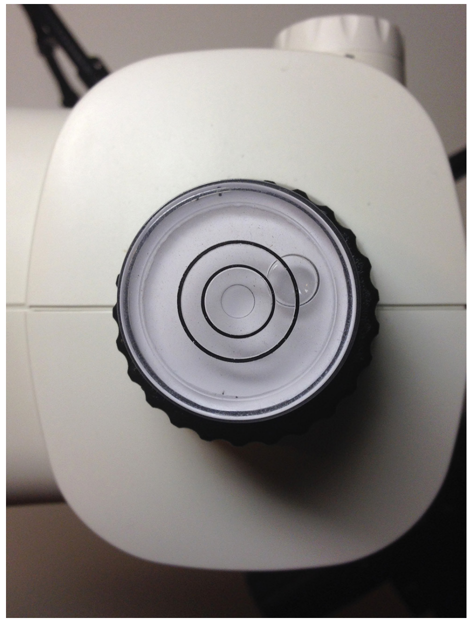

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Fig. 4. Images shows bubble level on top of microscope at shortest extension.

Fig. 5. Images shows bubble level on top of microscope at full extension.

ARTICULATING ARM STANDS

This style has become more common on the market and most of the microscope companies also offer a version of this style. This type of stand, like boom style stands, is also available in either a base-plate design or a table clamp design. Articulating arms offer greater flexibility for positioning as well as a greater length of extension (fig. 3). Articulating arm stands do have some disadvantages. What the stand gains in increased extension it loses in stability. The microscope is prone to a greater increase of vibration problems when the arm is fully extended. Weight of the microscope also becomes a factor that can result in problems such as drift in the stand as well as causing a leveling issue of the microscope in relation to the surface when the arm is fully extended, thus requiring the user to constantly re-level the microscope head (figs. 4-5). In addition, while this design can come in a base plate option, it is often necessary to use additional weights on the plate to prevent tipping of the scope, an issue that is compounded with the more weight that is added to the microscope. The articulating arm style does share many of the same functionality problems that the boom style has when it comes to benchtop treatment work.

BRIDGE OR GANTRY STAND

This style of microscope stand is not generally available on the microscope market and is usually built to a specific location. It is generally considered to have no mobility other than that of the tables or benches they are installed on. Often the microscopes adapted to these custom built systems are not designed to be removed from the system either. There are many benefits to the bridge design that allow for it to potentially be a more functionally useful stand then both the boom stand and articulating arm.

Observation of the University of Hawaii library paper lab bridge stand found it to be more stable then mounting the microscope on either a boom-stand or an articulating arm due to its four-point or two-point contact with the table surface. The bridge design also allowed for greater access of the microscope to the difficult to reach areas of large paper objects, and it did this without sacrificing stability. The bridge stand could also work on any flat surface without a heavy base plate, and while also not requiring the need to clamp the stand to a table for added stability.

The design goal was to have a stand that would have equal or greater stability then a boom or articulating arm stand at any point along its track while also preserving its alignment to the surface. The stand would also need to be portable, relatively inexpensive, and also accept most common stereomicroscope heads.

In order to do this the idea was very simple. Find an already available table-top track system and then find a way to attach a focus mechanism to it. Due to the interchangeability of most stereomicroscopes to almost any focus mechanism for any stereomicroscope would work.

THE CAMERA TRACK SLIDER AND FOCUS MECHANISM

After extensive research on currently available track systems, the style of system that showed the most promise is a family of products designed for professional and hobbyist videographers called camera track sliders. These systems are designed to allow videographers to do smooth panning shots


LEFT TO RIGHT
Fig. 6. Glide Gear® DEV 470 Camera Track Slider 47”. *Image Retrieved from Amazon©

Fig. 7. The bottom of a used Nikon® vertical post and focus block that was used for this paper.

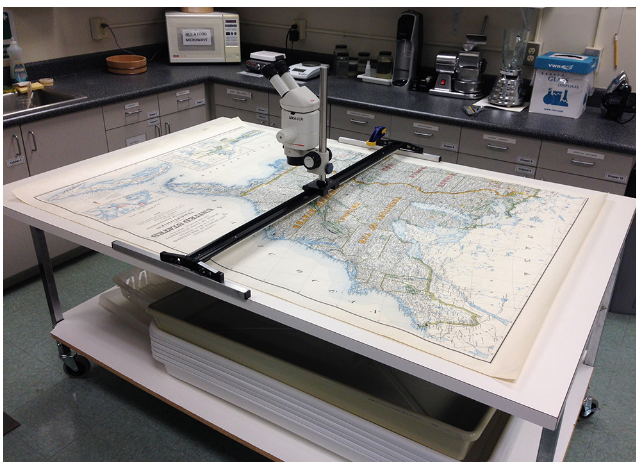


Fig. 8. Leica® Mz7s stereomicroscope mounted on adapted Glide Gear® Camera Slider with a used Nikon® focus mechanism.

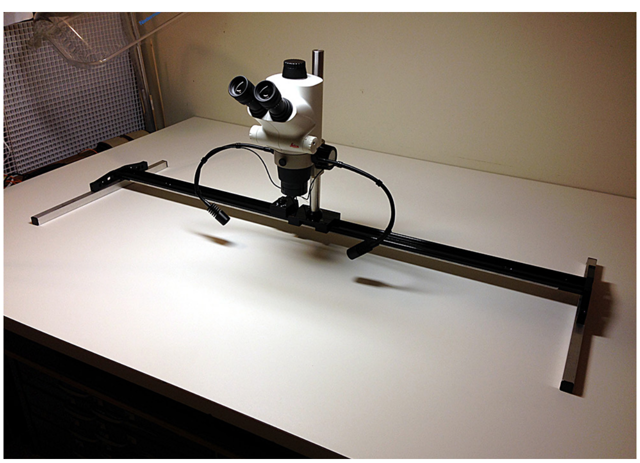


Fig. 9. Leica® S6D stereomicroscope mounted on adapted Glide Gear® Camera Slider with a used Nikon® focus mechanism.

Fig. 10. Sled for Glide Gear® Camera Slider.

by sliding their cameras on a sled that rides a track. The most common specifications to consider when looking at which one to purchase are the maximum weight load the track will allow and the length of the track. These systems generally will also be offered in either a motorized or manual option. The system is available with either smooth Teflon guides or ball bearings. For this project it was determined that a manual operating track was sufficient for most treatment work. In addition, since most of the work tables in the UH Paper Lab are 4’ x 6’ feet, the most usable length to start with for testing purposes would be a 47” track. For this project the camera track slider that was chosen is a 47” Glide Gear Camera DEV 470 Track Slider (fig. 6). It was purchased on Amazon for approximately $150.

For the focusing mechanism, the focus block that was chosen was a standard focus mechanism or pole stand with a 32mm diameter vertical post and a focus block with a 76mm diameter ring. A pole stand would ordinarily consists of a focus block that slides on a single metal vertical post that would be attached to a base, usually by a single screw or bolt (fig. 7). By removing the vertical post from the base of the microscope and attaching it to the sliding plate on the camera track slider most modern stereomicroscope heads can be safely placed anywhere on the track pointing directly down at the artifact. (figs. 8-9). The sled on the camera track also contains a built in bubble level to allow for easy to read leveling of the track, as well as lock knob to lock the sled (fig. 10).

ADAPTING A CAMERA SLIDER, WHAT YOU WILL NEED...

A STEREOMICROSCOPE POLE STAND ASSEMBLE AND FOCUS MECHANISM

The most important part when choosing a pole stand is how the pole is mounted to a base. For this to attach easily the

LEFT TO RIGHT

Fig. 11. 32mm stainless steel vertical post. *Image courtesy of Terrald Knorr from Martin Microscope®

Fig. 12. Unitron® focus block for a 32mm vertical post. *Image courtesy of Unitron®

stand needs to have a single screw or bolt which will generally be a 3/8" diameter thread. When purchasing a focus mechanism make sure that the diameter of the focus mount ring for your stereomicroscope matches with the focus mount you are purchasing. The focus mount is the part of the stereomicroscope head that sits into the ring on the focus block. For most modern stereomicroscope heads this diameter is 76mm. There are several companies that make versions of this where the entire stand needs to be purchased, but after extensive research the easiest, most cost effective, and best quality way of doing this is just to purchase the individual parts. The best source for this is Martin Microscopes®. A 12" long vertical post with a 3/8" threaded mounting hole at the bottom (fig. 11), a Unitron® Focus Block with a 76mm ring (fig. 12), and a safety collar will cost approximately $340 before shipping. There are less expensive focus blocks, but the savings is negligible and there is a significant loss in quality, which will greatly impact user experience when using the microscope.

A CAMERA TRACK SLIDER

There are many companies that manufacture these tracks. For this project the Glide Gear® DEV 470 Camera Track Slider was used. Be aware of the cumulative weight of your microscope head when choosing which one to purchase. The weight of a stereomicroscope head can add up very quickly once you consider the added weight of a potential camera and any illuminators, as well as any other accessories. The heavier your microscope head is the thicker the metal support that will need to be added to the bottom of the track to increase the weight capacity of the track.
(Can be purchased at most camera suppliers)

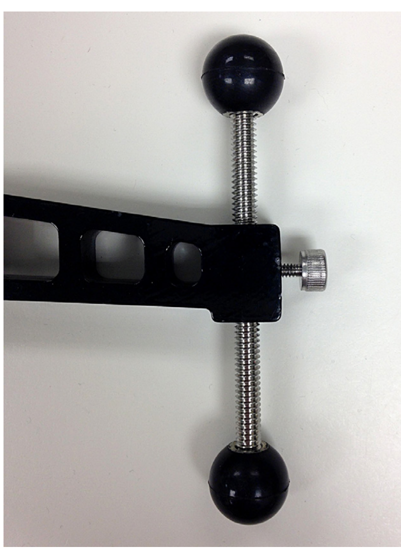
- A 36" Section of ¾" aluminum square tubing (Can be found at most hardware stores)
- A 43.5" Section of ¼" x 1.5" thick aluminum or steel Bar. If your microscope is very heavy, a thicker bar might be required. (Can be found at most hardware stores)
- 7 - ¼" Diameter x ½" long screws and appropriate washers. (Can be found at most hardware stores)

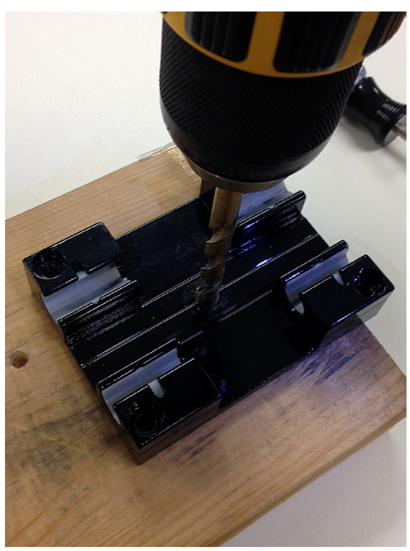
STEP 1: PREPARING THE MATERIALS

Remove the adjustable leveling legs by first unscrewing the lock screw, followed by unscrewing one of the balls from the threaded rod, and finally completely unscrewing the threaded rod from the leg. (fig. 13)

STEP 2: MOUNTING THE VERTICAL POST

Remove the 'sled' from the track by unscrewing and removing the end sections. Using a drill, expand the center mounting hole in the sled from ¼" to a 5/16" hole to accommodate the larger screw for the vertical post. Insert the mounting screw into the sled and slide the sled back onto the track. Depending





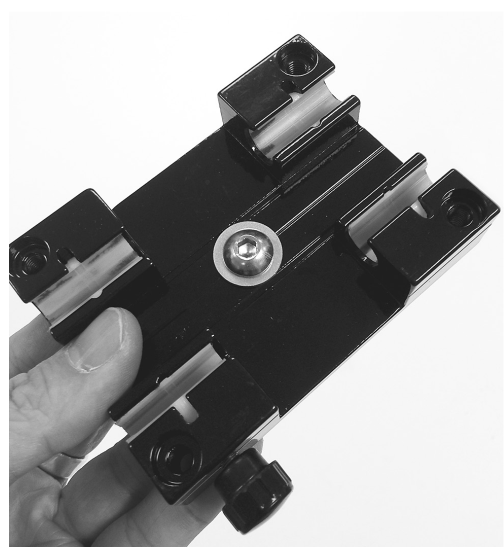


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Fig. 13. Adjustable threaded leveling leg.

Figs. 14-15. Expand the mounting hole in the sled from ¼" to 3/8" using a drill and insert the new 3/8" mounting screw for the post.

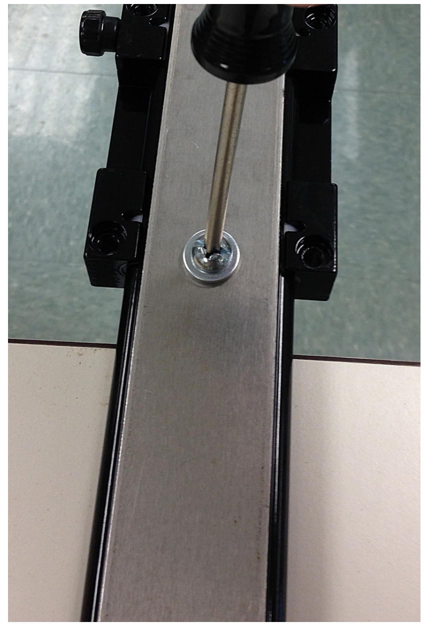

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Fig. 16. Bottom of the track on the left and ¼” aluminum bar on the left.

Fig. 17. Drilling ¼” hole that lines up with threaded hole in the track.

Fig. 18. Mount additional ¼” bar to the bottom of the track using ¼” screws.

Fig. 19. Bottom of track with additional bar screwed in.

on the size of the original mounting screw it might be necessary to replace it with one with a smaller head in order to allow it to fit between the bottom of the sled and the track. The vertical post screw can now be inserted into the sled from below, the sled put back onto the track. (figs. 14-15)

STEP 3: BRACING THE TRACK

To increase the weight load of the track it will need additional bracing. Attach the aluminum or steel bar to the bottom of the track by first drilling holes that line up with the smaller threaded holes in the track, and then screw the additional bar to the bottom of the track using the ¼” screws. (figs. 16-19)

Fig. 20. Detachable legs with additional aluminum tubing for extension.

STEP 4: EXTENDING THE FEET

The Glide Gear ® Slider is designed to have the center of gravity directly over the track, but when a heavy microscope is added it offsets the center of gravity. Without compensating for this it could cause the track to tip forward or throw the leveling of the microscope off. In order to prevent this the removable legs need to be extended past the microscope. This can be easily and cheaply done using the ¾” aluminum square tubing. First cut the 36” tubing in half to give two give two 18” sections and then drill two holes in each of section that align with the threaded holes where the adjustable feet were. A second larger hole can be drilled in the bottom to accommodate the head of the screws. The aluminum tubing

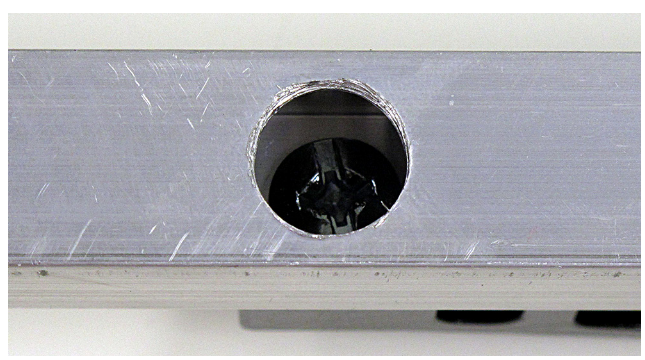

Fig. 21. Close up of the bottom of the aluminum tubing after mounting holes are drilled for screws.

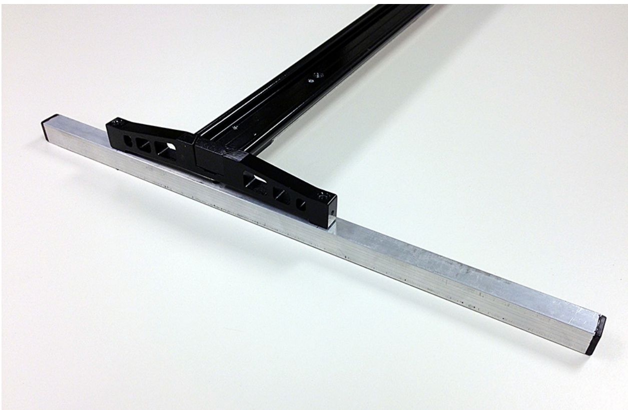

Fig. 22. Aluminum tubing mounted into the bottom of the detachable legs and installed back onto the track.

can then be screwed into the removable feet from the bottom using four of the ¼” screws. (figs. 20-22)

SUMMARY

The stereomicroscope is one of the most important tools in a conservation studio, allowing conservators to do treatments and examinations. While the microscope’s functionality is rarely debated, the ability to safely maneuver the microscope to its most needed locations has been dependent on the limitations of the few stereomicroscope stand designs provided by the microscope market. The two most popular designs, the boom stand and the articulating arm stand, have both benefits and deficiencies. The most important deficiency for both being their inability to allow a user to maneuver a microscope into the middle of a large area without sacrificing stability, cost, and portability. These issues can be resolved with the use of a bridge or gantry style stand that allows a user to mount a stereomicroscope, positioned perpendicular to a table surface, anywhere on a track in a stable manner allowing large two dimensional objects to easily slide under the track. This adaption can be easily done by mounting the vertical post from a stereomicroscope pole stand onto the sliding sled from a camera track slider. This adaption gives the conservator the ability to place virtually any modern stereomicroscope anywhere on a track. It is the authors hope that this adaption might be beneficial for any conservator that works on large two dimensional objects.

ACKNOWLEDGMENTS

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Tip: An Easy and Cost-Effective Method for Making a Transparent Suction Platten

ABSTRACT

When it comes to paper conservation, two indispensable pieces of equipment is our suction platen/table and our light tables. Suction platens and tables are used for a variety of treatments including stain reduction and pulp fills. While incredibly useful, suction devices do have their limitations. For some treatments, like stain reduction, the object is typically face down on the suction device, preventing the conservator from seeing what is occurring on the most critical side of the object. But, what if there was a way to combine the functionality of a suction platen or suction table with the benefits of a light table at the same time? The "transparent" suction allows the conservator to see through and carefully observe their objects during treatment. This talk will present an easy and inexpensive transparent suction device that can be placed on a light table, combining the function of the suction platen or table with the benefits of a light table.

INTRODUCTION

At the University of Hawaii Hamilton Library Preservation Department one of most common forms of damage that the Paper Conservation Lab sees and is asked to repair is the use of ball point pen handwriting by patrons on virtually all types of material in the library's collections (fig. 1). For many, the approach for the removal of ball point pen from paper would be considered fairly routine. The protocol would be to remove as much as was possible by putting the material on some blotter and applying either ethanol or another solvent to the pen ink on a suction disk until no more ink is visible on the blotter. Once no more ink is visible on the blotter one could safely assume that there was no more soluble ink left, and that was as far as one could go. As the mechanism of the suction table is to allow the ink to pass through the paper into blotter underneath, the conservator would usually have the option of applying the solvent from either side of the sheet, treating the paper with the ink on it either 'face-up' or 'face-down' against the suction table. While both of these approaches can get good results, both approaches have problems.

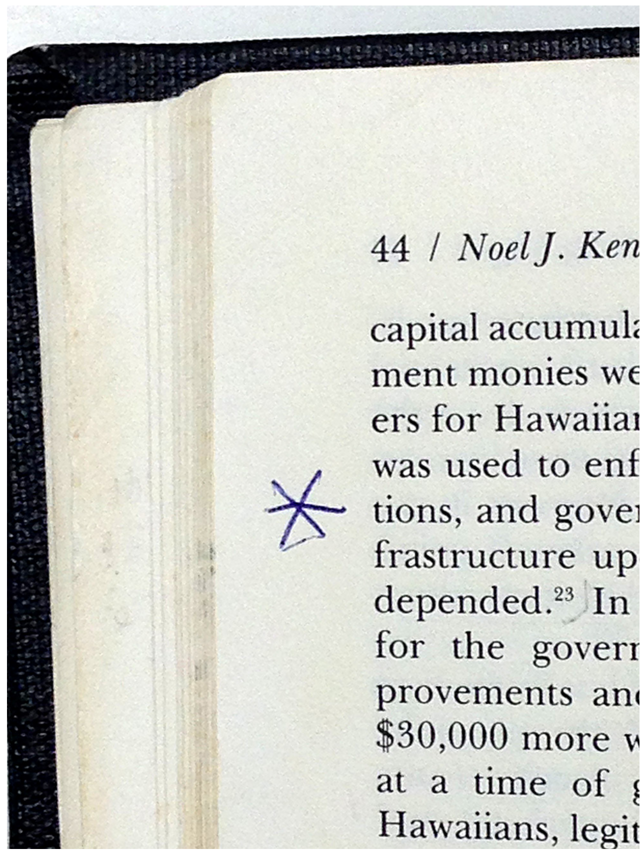


Fig. 1. A ball point pen inscription found on a UH library book page.

When a paper conservator tries to remove pen ink on a suction disk with the paper 'face-up', most of the ink will generally come out, but often a side effect of this is the appearance of some of the ink onto the verso of the page.

Presented at the Book and Paper Group's Lunchtime Tip Session, AIC's 44rd Annual Meeting, May 13–17, 2016, Montreal, Canada

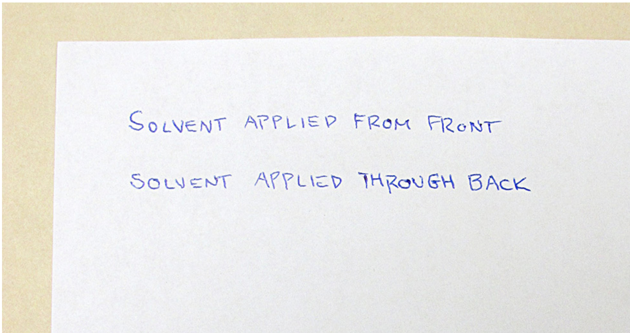


Fig. 2. Recto of paper, with ball point pen ink test, before treatment on a suction platen with ethanol.

Fig. 3. Recto of paper, with ball point pen ink test, after treatment on a suction platen with ethanol.

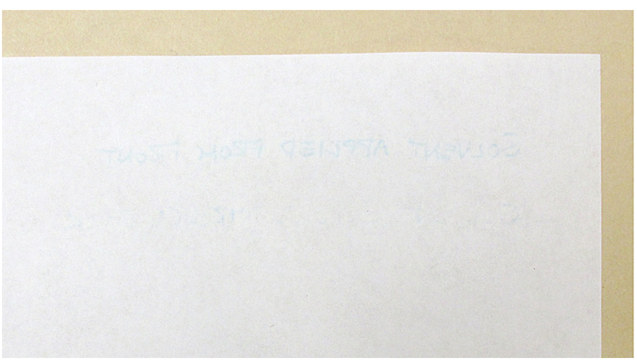


Fig. 4. Verso of paper, with ball point pen ink test, after treatment on a suction platen with ethanol.

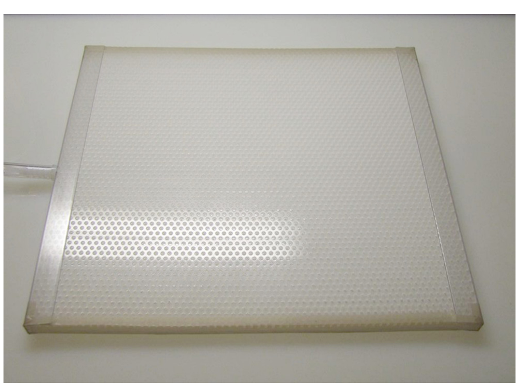
A quick test of this can be visible in figures 2-4 that shows different in results of applying the solvent from each side of the sheet. When a paper conservator tries to remove the pen ink on a suction disk ‘face-down’, attempting to prevent the ink from appearing on the verso, the conservator is often working ‘blind’ and cannot see where to apply solvent. This can present a problem when accuracy is needed due to the solubility of other nearby media. In a perfect world, many conservators might prefer to work ‘face-down’, as it reduces the risk of having inks show up on a nice clean verso, and it allows for a more direct pathway for the ink to flow into the blotter, but the drawback to working ‘blind’ often makes this approach undesirable.

What if there were a way to allow the conservator to both work ‘face-down’, as well as see through the sheet at the same time, so working ‘blind’ was no longer an impediment? What if there was such a thing as doing transmitted light suction table work? If one could merge the functionality of a suction disk with the benefits of transmitted light from a light table, then a conservator would no longer have to work ‘blind’. In addition, this could be beneficial to other routine bench top techniques; such as judging the density of pulp-fills, and being able to align, hold, and mend double sided material. This paper will illustrate how to easily and cheaply make a transparent suction disk that can be used on any light table (figs. 5-6).

MATERIALS REQUIRED

1) *12” x 12” perforated polypropylene sheet with 1/8” holes*
The thickness of the sheet should be 1/8” or 0.125”, and it should have 1/8” holes staggered on a 7/32” of an inch center to center. The color of the sheet should be opaque white. The size of the sheet purchased will be based on the size of the desired platen, but a 12” x 12” sheet was purchased for constructing the platen in this paper. A 12” x 12” sheet can also be purchased on Amazon® for approximately $15.00 before shipping. (fig. 7)

2) *24” x 48” 10mm three wall corrugated polycarbonate panel*
This is a material that is generally used in greenhouses. It is available in sheets up to 4ft x 8ft and also available in various



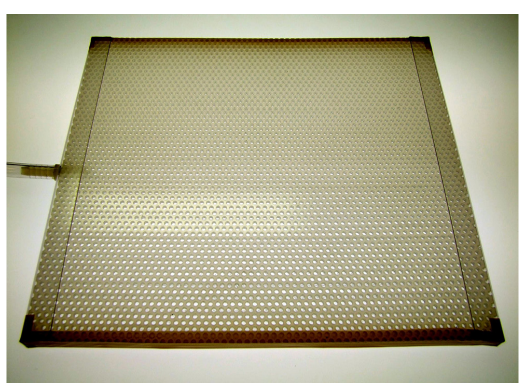


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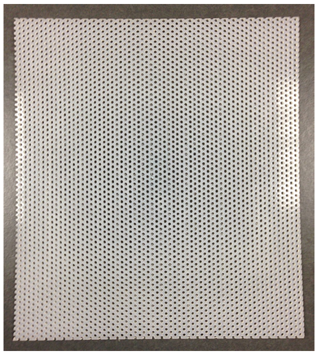
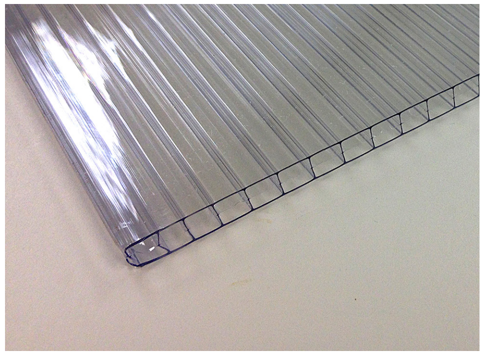
Fig. 5. Transparent suction platen on a light table with light off.

Fig. 6. Transparent suction platen on a light table with light on.





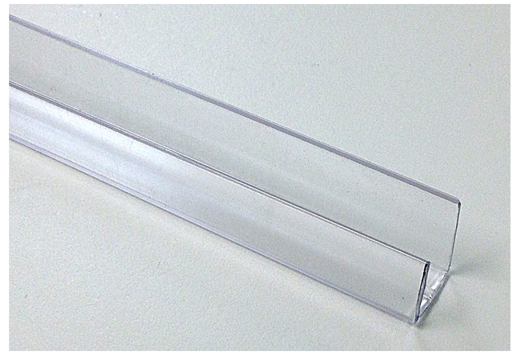


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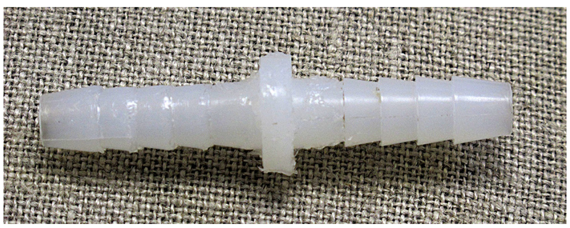
Fig. 7. Perforated polypropylene sheet.

Fig. 8. Corrugated polycarbonate sheet.

Fig. 9. Polycarbonate end cap.



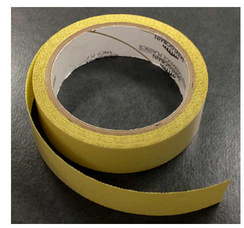


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Fig. 10. ¼" Teflon hose barb fitting (sometime called a hose mender).

Fig. 11. Loctite® brand clear silicon.

Fig. 12. Teflon tape.

thicknesses. There are many companies that sell it, but only a few that will sell smaller cut sheets, eliminating the need to purchase and ship a large sheet. For this project the corrugated polycarbonate panel was purchased from Charley's Greenhouse and Gardens®. In order to give enough room inside the sheet for the vacuum inlet, the 10mm three wall panel should be used. A 24" x 48" sheet will be the smallest available size that can be purchased, and it will cost approximately $25.00 before shipping. Upon request the company has been willing to cut this sheet in half to cut down the shipping cost. (fig. 8)

3) *48" polycarbonate end cap*
This is a U-Shaped plastic strip that is used to close off the open ends of the polycarbonate panel. This can also be purchased from Charley's Greenhouse and Gardens. A 48" strip will cost $3.50 before shipping. (fig. 9)

4) *polypropylene ¼" x ¼" hose barb fitting (sometimes called a hose mender)*
This is the piece that will allow a vinyl hose to connect the platen to a vacuum. It is available at most hardware stores for a few dollars. (fig. 10)

5) *clear silicon*
This will be used to create the seal around the hose barb. It is available at most hardware stores. (fig. 11)

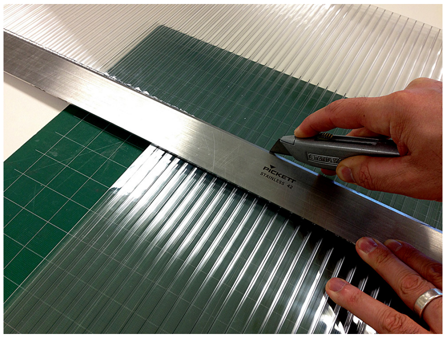
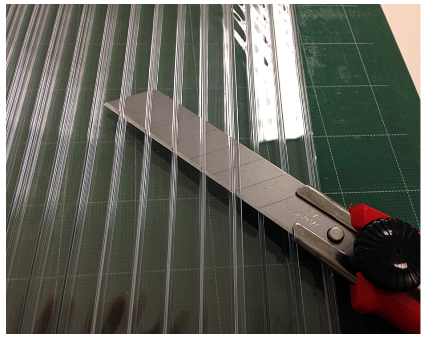
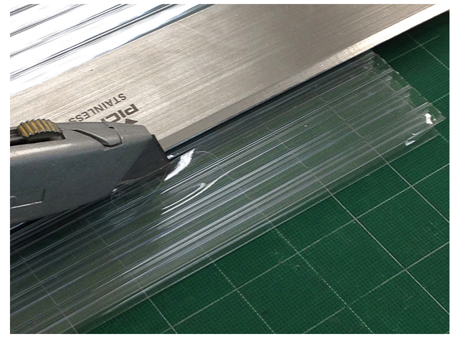
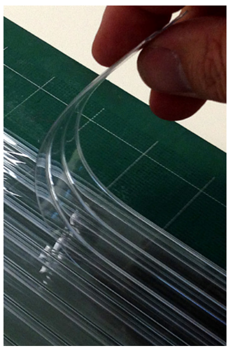
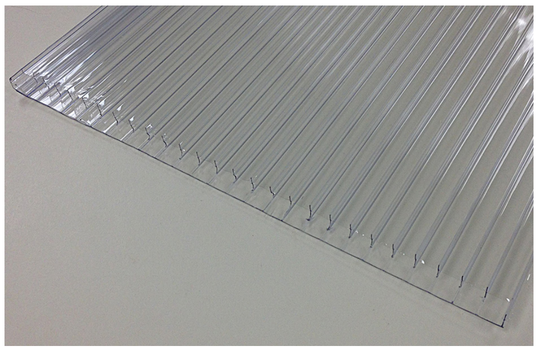
6) *Teflon tape*
This will be used to seal the edges and bottom of the platen. Rolls are available through Museum Services Corporation®. An 18 yard roll will cost $48.00 but will accommodate the construction of many platens. It also has many other uses so it probably won't go to waste in a lab. (fig. 12)

STEP FOR CONSTRUCTION

STEP 1. PREPARING THE CORRUGATED POLYCARBONATE

Using a utility knife and a heavy cutting ruler, cut the corrugated polycarbonate to the same size as the sheet of perforated polypropylene. When making the cut in the same direction as the channels, cut the polycarbonate so that the side of the sheet is also the wall of one of the channels. (fig. 13)

Using a utility knife with breakable blades, extend the blade of the knife all the way out, and carefully cut off the top layer of the corrugated polycarbonate to reveal the channels. The best way to do this is by cutting into the sheet two or three channels at a time, scoring the top layer with the knife

LEFT TO RIGHT, TOP ROW THEN BOTTOM

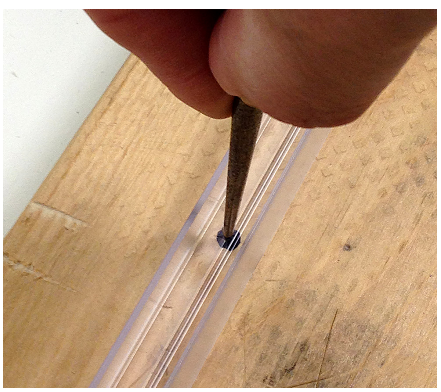
Fig. 13. Cutting the corrugated polycarbonate sheet to the same size as the perforated polypropylene.

Fig. 14. Cutting the top later off of the corrugated polycarbonate sheet to reveal the channels.

Fig. 15. Scoring the top layer of the corrugated polycarbonate sheet down the length of a channel.

Fig. 16. Peeling off a section of the corrugated polycarbonate sheet that has been previously scored.

Fig. 17. Cutting out of a ¼” notch off each and of the corrugated polycarbonates sheet to allow for air flow.



LEFT TO RIGHT

Fig. 18. Marking the hole in the polycarbonate end-cap before drilling.

Fig. 19. Drilling out the hole in the polycarbonate end-cap, for the hose barb, with a 5/16” drill bit.

Fig. 20. Inserting the hose barb into the hole with silicon applied to create a seal.

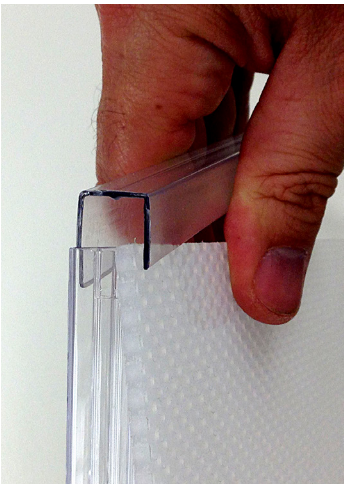
down the middle of one of the channels, and then peeling the top layer off. (figs. 14-16)

Using the utility knife carefully notch out approximately ¼” of the end of the channels on each side of the sheet, taking care to not cut the outer wall of the channels at the ends of the sheet. These notches will allow air to flow around the channels when the platen is sealed up. (fig. 17)

STEP 2. PREPARING THE END CAPS

Using a utility knife, cut the polycarbonate end caps so they are the same length as the open channel sides of the corrugated polycarbonate sheet.

Make a hole in one of the end caps for the hose barb fitting that aligns with one of the channels. This can be done by first putting one of the end caps on the corrugated polycarbonate sheet, marking the spot for the hole with a marker, creating an impression in the plastic with an awl, and finally drilling the hole with a 5/16” drill bit. Once the hole is drilled, install the hose fitting on the end cap by first squeezing some silicon under the flat spot of the hose fitting and then inserting it into the hole. If necessary, additional silicon can be added to the other side of the hole for additional sealing. (figs. 18-20)



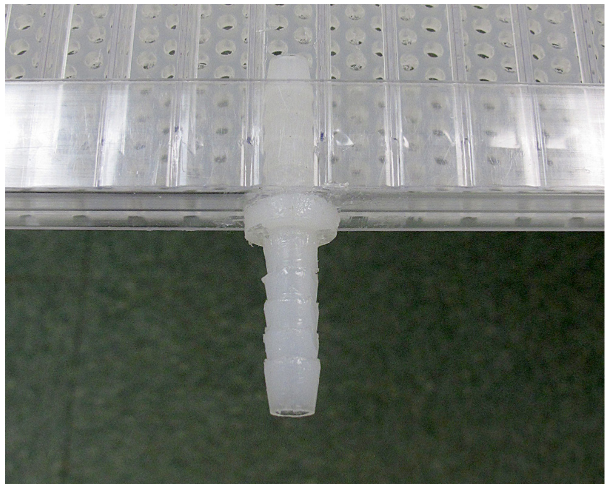


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Fig. 21. Applying the polycarbonate end-caps to the open channel sides.

Fig. 22. Close up view of hose barb fitting with the end cap inserted between the channels of the corrugated polycarbonate.

STEP 3. ASSEMBLING THE PIECES AND SEALING UP THE PLATEN

Place the rough side of the perforated polypropylene sheet against the open channel side of the corrugated polycarbonate sheet, and slide the end caps onto the ends where the open channels are visible, taking care to make sure the end cap with the hose barb slides comfortably into a channel. The larger side of the end-cap should be on the bottom, in order to allow for more suction area on the perforated surface. (figs. 21 and 22)

Using the Teflon tape, seal the sides that do not have the end-caps, taking care to wrap the tape around the corners. Seal the bottom of the platen by running a strip of Teflon tape over both of the end cap on the bottom. (figs. 23 and 24)

STEP 4. ENJOY YOUR BRAND NEW TRANSPARENT SUCTION PLATEN!

A 3/8” clear vinyl hose can be attached onto the hose barb that can then be easily attached to a vacuum system. Figures 25 and 26 show what a completed suction platen should look like when done.

OBSERVATIONS

REMOVING BALL POINT PEN INK

The design of this device was primarily for this purpose. The platen will allow the conservator to have the paper face-down against the suction surface and apply solvent through the verso, while simultaneously being able to see the ink through the paper. This should prevent the ink from migrating to the verso of the sheet and allow accurate application of solvents. Due to the slight lip formed by the end caps on the perforated surface of the platen, masking off areas of the platen to create a smaller suction area will work better with the use of clear polypropylene rather than with polyester film. In order to allow for better light transmission during treatment either Tek-Wip or #2 Whatman® filter paper can be substituted for blotter paper.

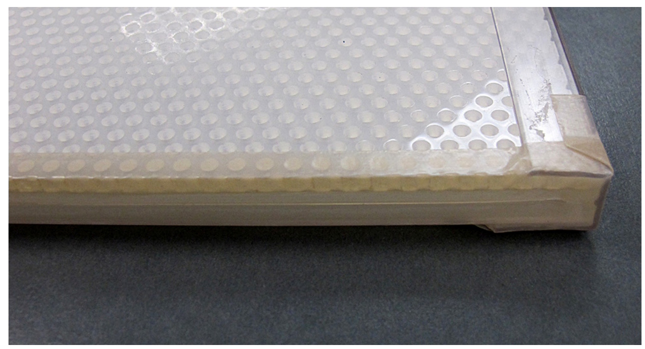

Fig. 23. Teflon tape is used to seal the two non-endcap sides of the platen.

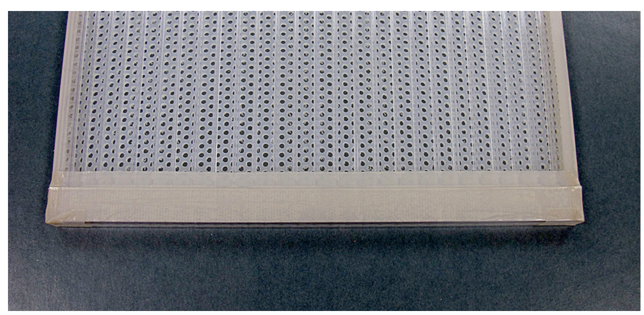

Fig. 24. A strip of Teflon tape is run across the two end caps on the bottom of the platen to create a seal.

CONDUCTING PULP FILLS

The platen can be very helpful for conservators that prefer to conduct their pulp fills on a suction disk or table. The clear suction platen will allow for the conservator to be able to judge the density of the fill, as it is happening, in relation to the density of the primary paper. When the pulpy water is

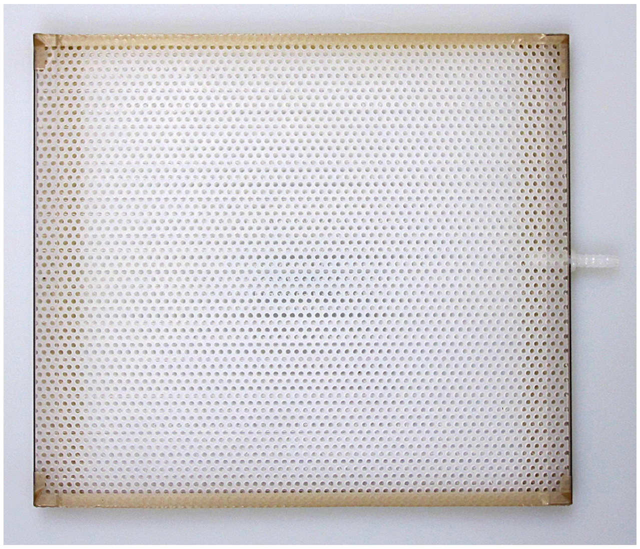

Fig. 25. Top of clear suction platen after completion.

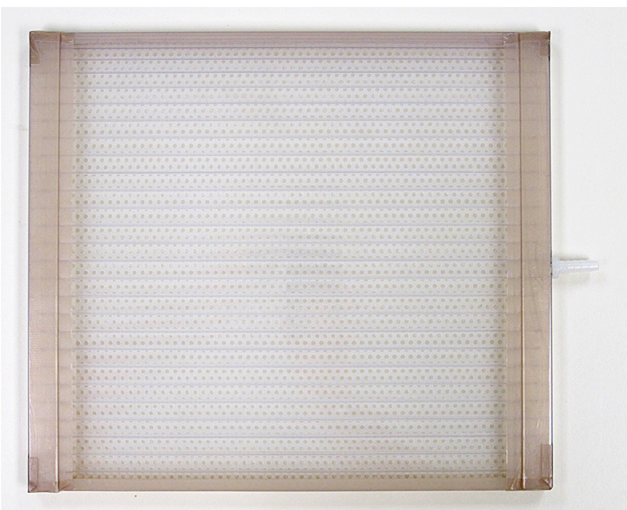

Fig. 26. Bottom of clear suction platen after completion.

applied to the area of loss the excess water will get pulled into the paper underneath. Due to the transmitted light properties of the suction disk and the ability to see through all of the layers at the same time, it can be difficult to determine, while conducting the pulp fill, whether the water is still in the fill itself or the paper underneath. Therefore, during the process of applying the pulp it can be helpful to frequently move the area being filled to a dry spot on the paper underneath.

ALIGNING AND REPAIR TEARS

As the clear suction platen will allow the conservator to see both sides of a sheet simultaneously, it can be very useful for aligning two area of a tear were the sheet might have media on both sides. It will also allow a conservator to accurately align a tear as if one were seeing it on a light table, and reinforce the verso of a sheet with tissue, all while the suction platen holds the sheet in place with the vacuum. In addition, due to the strong downward vacuum of the platen, repair tissue placed on the verso during the repair will often not require addition weights while the tissue dries, and it will also dry the repair out much faster as the airflow from the vacuum flows through the tissue.

STAIN REDUCTION

For certain types of stains having the ability to 'see' through the sheet during stain reduction can be very beneficial. It should be noted that while the perforated polypropylene has excellent resistance to many solvents, the corrugate polycarbonate underneath it does not. Certain solvents, such as acetone, will react and degrade the polycarbonate and eventually crack it. Before using the platen with a solvent it is strongly recommended that a drop of the solvent be applied to a scrap piece of the polycarbonate to observe the reaction.

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Tip: Silicone Shapers—
A Useful Tool to Aid in the Treatment of Works of Art on Paper

Silicone shapers are silicone tipped tools designed for artists to manipulate clay, pastels, and other heavy media like acrylics and oil paints. They have been advertised as clay shaper tools, colour shapers, and silicone shapers/brushes. These tools allow artists to move and shape media to achieve precise marks, and clean linear strokes. The silicone tip is easy to clean, has a non-stick surface, and comes in a variety of shapes and firmness, providing a range of use (fig. 1).

Silicone shaper tools can be helpful when performing tear repair, working with adhesives, and removing poultices. The advantage over using a brush is the non-stick surface, which allows the silicone tip to be wiped clean immediately. The fine tipped points and angles are also useful for precise placement and a range of motions. For example, the tapered point shapers allow for a flexible but firm rolling motion.

The slight static charge that can be produced using the silicone tip is of additional interest. This feature was particularly useful when performing treatment on a pastel portrait. Particulates and dust were present on the pastel surface after it had been unframed. Since the dust was not embedded in the pastel, I was able to pass the silicone tip close to, but not touching, the pastel surface, attracting the dust away from the friable media and latching onto the silicone tip without risking mechanical damage. No friable media was displaced using this tool and method.

Fig. 1. Silicone tools with varying tips.

SOURCE OF MATERIAL

COLOUR SHAPER®, Royal Sovereign Ltd UK

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Presented at the Book and Paper Group's Lunchtime Tip Session, AIC's 44rd Annual Meeting, May 13–17, 2016, Montreal, Canada

KASLYNE O'CONNOR

Tip: TEK-Wiping Out the Competition: The Ideal Reusable Absorbent Material

ABSTRACT

Originating from the custodial and technological industries, TEK-Wipe is a highly absorbent non-woven textile made from a blend of hydro-spun cellulose and polyester. This progressive material is durable, reusable, extremely strong when wet, chemically stable, and highly absorbent. TEK-Wipe can be paired with a large range of conservation treatments, such as for washing or drying in place of blotters, as an intermediary layer on the suction table, or for the humidification of sensitive media. Alternatively, it can also be used as a support for lining, drying wet books, cleaning glass plate negatives, for local tideline reduction, and even for varnish removal. As a sustainable alternative to blotters and other absorbent materials, TEK-Wipe is available in large rolls or small sheets that can be easily cut and formatted for any treatment size. This research examines the use and treatment variations that can be paired with TEK-Wipe, as well as two case studies of treatment adaptations. With conservation's expanding focus on reusability and durability over the long-term, TEK-Wipe is indeed proving to be a material to contend with.

INTRODUCTION

The concept of 'reusability' in conservation is held in high regard. More often than not, conservators around the world are faced with the need to recycle materials and borrow tools from other industries in order to make certain treatments more efficient and feasible. Whether it is using dental picks to clean hard to reach crevices in artefacts, porcupine quills to pick up fragile gelatin emulsions from photographs, or the newly popular food-grade Gellan Gum for washing and humidifying both paper and textiles, alternative and reusable resources are integral to and a mainstay in conservation.

Accordingly, originating from the custodial and technological industries, and capable of absorbing large amounts of water and still retaining its shape, TEK-Wipe (fig. 1) is a non-woven reusable fabric with the ability to change the dynamic of aqueous conservation treatments. As an alternative to cotton blotters and other absorbent materials, this environmentally and economically friendly product is available in a range of formats that can easily be cut down and formatted for any treatment size.

Fig. 1. TEK-Wipe is available in 100 yard rolls; Courtesy of M. Doutre 2016.

Many conservators have already discovered the large and comprehensive range of treatment variations that TEK-Wipe can be paired with. Minter (2002) first advocates for the uses of TEK-Wipe, and uses it for drying water-damaged books. Edwards (2014) discussed uses for TEK-Wipe and circulated samples of the material to conservators at the 2014 AIC Book and Paper Group Tip Session in San Francisco, California. Since then TEK-Wipe has been suggested on the conservation DistList to many professionals looking for inert and lint-free absorbent materials.

Presented at the Book and Paper Group's Lunchtime Tip Session, AIC's 44rd Annual Meeting, May 13–17, 2016, Montreal, Canada

This report came about from a need for a large, strong, inert, and absorbent sheet material for an aqueous treatment. The range of uses for this material throughout this singular treatment truly demonstrated the incredible versatility and variability of this multi-faceted fabric.

OVERVIEW OF TEK WIPE

MATERIAL CHARACTERISTICS

Available from a number of sources under trade names such as Texwipe or Technicloth, TEK-Wipe is a thin synthetic, non-woven, towel-like material made from a blend of cellulose (55%) and polyester (45%). (fig. 2) It is manufactured by hydro-entanglement, meaning that high-pressure water jets are used to bind fibers together without introducing any thermal or binding techniques. This process creates an incredibly strong fabric with capillary channels running in one direction that resist solvents and will not break down or leave residue behind when fully saturated. (fig. 3) Not only is this material chemically stable, inert (pH~6.47), and free of binders and starches, it will also not distort when subjected to high humidity. TEK-Wipe is available in both heavy- (122-126 g/m^2) and light-weight (64-69 g/m^2) formats and can be purchased as individual sheets or as a large roll (by the yard or by 100 yards) for any treatment need.[1]

ABSORBANCE

In terms of absorbance, the suitability of TEK-Wipe for aqueous treatments really goes above and beyond the requirements of a standard conservation material. The user is able to exercise considerable control with the introduction of moisture. TEK-Wipe is extremely flexible for most options and with any desired relative humidity when it comes to humidifying treatment alternatives. Lightly misting the wipes with a dahlia sprayer will create a relaxing low humidity environment, while total immersion in water will supply a generous amount of moisture to any treatment. More than an essential tool for releasing moisture, the high absorption rate of this material has made it an important inclusion in disaster salvage kits and a staple during emergency response situations.

RE-USABILITY

Since TEK-Wipe is able to retain such a large volume of liquid, given the right treatment it also has the ability to draw out considerable amounts of degradation. With large amounts of degradation can come a great deal of staining, however even when soiled, it's not the end for this fabric. TEK-Wipe can be easily washed by hand or in a washing machine, and therefore reused numerous times. To clear out water-soluble stains, TEK-Wipe distributors recommend soaking in warm water. For more resilient stains soaking the sheets in a solution of warm water and a small amount of detergent, followed by a thorough rinse is also quite effective. Though all washing

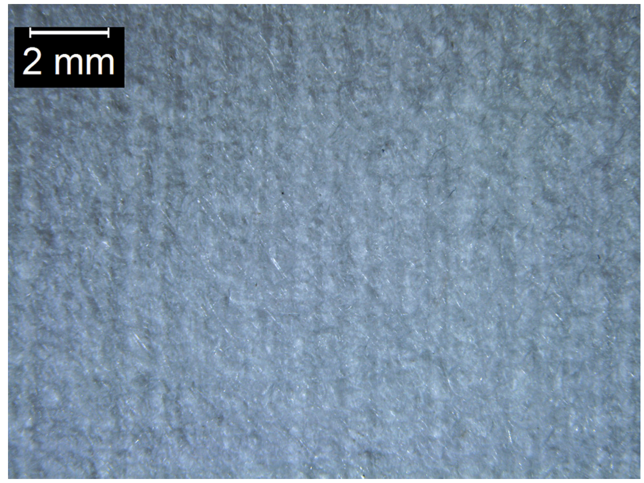

Fig. 2. Unidirectional fibers viewed under raking light with a Leica M125 stereomicroscope, x1.

Fig. 3. Defibrillation occurring in TEK-Wipe from scrubbing.

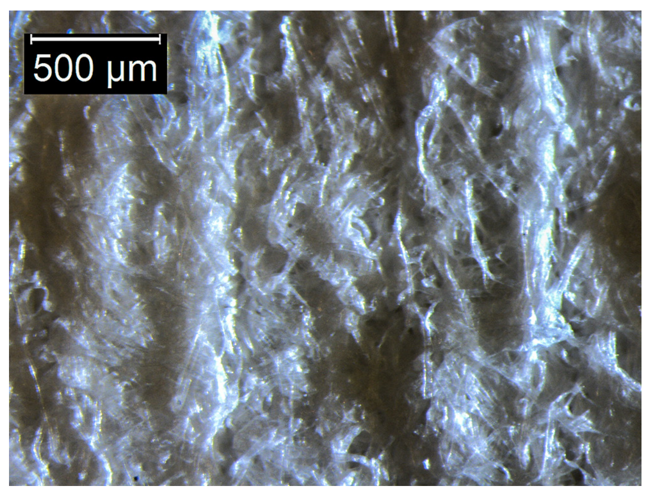

Fig. 4. TEK-Wipe fibers viewed under normal light with a Leica M125 stereomicroscope x5.

Fig. 5

LEFT TO RIGHT
a. Thick blotters hold moisture and expand when wet.
b. Thin blotters hold moisture and sag when wet.
c. TEK-Wipe fibers draw water out by capillary action resulting in no dimensional changes.

methods are safe, any heavy scrubbing must be avoided, as this will break up the fiber bonds in the fabric and result in defibrillation. (fig. 4)

DRYING

TEK-Wipe is a very low maintenance material. After being wet out, it can easily be left to air dry. Leaving the material on screens or racks is perfectly acceptable however the wipe will dry to the shape of its support. Re-humidifying the sheet will relax the fibers and flatten out any wave or cockle patterns resulting from its support while drying. Flattening TEK-Wipe on a smooth table with a brayer or squeegee will remove any wrinkles and excess moisture, allowing it to dry completely smooth and flat. Without weights or restraints, this method has the effect of edge tension drying on the fabric. After drying, the surface of this smoothed sheet will have two different textures: the surface that was exposed to air will retain its fiber texture, while the side at the interface with the table will be completely smooth.

FIBER COMPARISON

COTTON BLOTTERS

When it comes to the working properties of materials used in conservation, the texture, fiber formation, or overall strength, is a deciding factor in what will make or break the effectiveness of a treatment.

Since TEK-Wipe is adaptable, reusable, and highly inexpensive on a grand scale, it has been gaining popularity, especially when compared to traditional cotton blotters. Whether thick or thin, blotters themselves are quite versatile in terms of the type of washing they can be paired with. One of the downsides of blotters however is revealed with its low wet strength. Since blotters are able to absorb and hold so much water, their wet strength fails with this corresponding increase—resulting in fully saturated blotters that can fall apart when moved or reused too often. When thick blotters are wet out they hold moisture and expand, creating dimensional changes and long dry-times. (fig. 5a) Thin blotters also hold moisture locally, but rather than expanding they become weaker and sag with too much water. (fig. 5b) After aqueous treatments, blotters can become cockled, stained, and ultimately quite deformed, making their overall reusability for treatments less possible with time.

When comparing the aqueous function of blotters to those of TEK-Wipe, we can see some very interesting correlations. Since the fibers in TEK-Wipe run in one direction, water is not kept in a mass of interconnected fibers as with blotters, but is rather drawn out to dryer areas by continuous capillary action, remaining flat and uniform when wet locally and overall. (fig. 5c) This feature allows TEK-Wipe to become wholly, and evenly, humidified without being fully saturated, while the considerable fiber expansion also allows it to hold more water than a standard blotter. Unlike blotters, if full saturation is desired, the high wet strength of the fabric can withstand submersion and even being lifted by one end, wrung out and twisted like a towel to remove excess water. (fig. 6)

PARAPRINT

TEK-Wipe can also be compared in effectiveness with Paraprint. Paraprint is also a non-woven fabric with unidirectional fibers, making it an ideal candidate for slant or capillary washing. Unlike TEK-Wipe, however, Paraprint contains an acrylic binder that can become solubilized after the first aqueous or solvent treatment. Since the binder can wash away with time, Paraprint sheets will begin to wet out unevenly

Fig. 6. TEK-Wipe can be lifted by one end when wet without falling apart; Courtesy of A. Kaspar 2016.

when reused, creating a cycle of potentially inconsistent washes. TEK-Wipe, with no inherent binders or starches, will continuously wet out evenly with no inhibitions to the specific needs of each treatment.

TEK-WIPE USED WITH TREATMENTS

AS SUPPORT

TEK-Wipe is so strong and thin that it can easily be used as a support for lining and transporting objects without fear of creating tears or cockles in paper materials. Since the available rolls are sold by yards in quantities of 100, the only limitation for size is the 36-inch roll width. For oversize objects, such as posters, using long overlapping sheets will be able to provide protection and a base upon which to do washing, sizing, lining, or repairs.

DRY CLEANING

TEK-Wipe's smooth and chemically stable surface can also be used for dry-cleaning some objects and even surface cleaning glass plate negatives. Acting like a sponge eraser, it will pick up and hold debris and soil without leaving small fibers behind like other materials such as cotton will. Following a recommendation by conservators at the Folger Shakespeare Library, Edwards (2014) suggests using TEK-Wipe for dry cleaning after first crinkling it to relax the fibers. This very slightly roughens the surface of the fabric in order to draw in and reduce surface dirt that is more deeply embedded.

HUMIDIFICATION

As TEK-Wipe can be cut to any desired size, the concept of localized and in situ humidification opens many doors when it comes to treatment possibilities. For general humidification, TEK-Wipe can be used in combination with GORE-TEX® as a wet blotter replacement, or used alone where the wipes can be lightly misted or fully wet out depending on the sensitivity of the treatment.

TEK-Wipe can even be used with materials that are highly sensitive to humidity, such as parchment or documents containing iron gall ink. Prior to these treatments, lightly spraying a stack of TEK-Wipe sheets and leaving them covered under plastic sheeting for approximately fifteen minutes will allow the moisture to equilibrate between all the sheets without having localized damp areas. When humidifying sensitive objects in a TEK-Wipe stack, short times of about 5–10 minutes will sufficiently relax the documents and avoid deformations or lateral ink migrations. For iron gall ink in particular, TEK-Wipe has even been used in conjunction with reductive phytate treatments. In this set up, the wipes are saturated with calcium phytate and placed on both sides of the document in order to bind free iron ions in the ink. The treatment can be repeated as many times as necessary and can be monitored with bathophenanthroline indicator paper.

DRYING AND FLATTENING

When acting as a drying material for an object, just like drying TEK-Wipe on its own, capillary action in the fibers pulls moisture from one area to another to equalize drying. For sensitive objects, this slow drying time can allow better overall flattening without creating micro-cockles in a work. As with a traditional conservation drying stack, when cotton blotters become overly wet, there are no continuous fibers to pull moisture from the material. This and can result in the formation of wrinkles in sensitive objects after drying. To avoid this, blotters are changed frequently in the first stages of drying. This reduces the chance of creating cockles but increases the handling of fragile objects. In comparison, TEK-Wipe pulls moisture from a work slowly, drawing it out within the material fiber, resulting in very even drying which gives time for the object to relax. Since moisture is pulled out through the entire sheet uniformly, TEK-Wipe would not need to be changed as often as blotters if used in a drying stack. Reducing the amount of flipping and changing of drysheets would in turn create a safer and more stable drying environment for the object.

For other drying methods, Minter uses TEK-Wipe in a modified interleaving system to wick away water from wet books while still bound. The physical flexibility of the sheets, and their variable size, creates an array of opportunities for introducing TEK-Wipe into any drying system. Furthermore, using more than one sheet of TEK-Wipe at a time will increase the rate of capillary action within the sheets, thus becoming a more effective washing or drying tool with the more sheets used and ultimately reducing unnecessary handling of objects.

WASHING

When considering individual conservation treatments as a whole, the best use for TEK-Wipe is clearly shown in the variation of washing treatment options available. Whether used alone or as multiple stacked sheets, it can be used as a blotter replacement, or in conjunction with cotton blotters for standard blotter or float washing to reduce water-soluble degradation and mold staining.

By drawing on the strong porous structure of TEK-Wipe, it can also be used for slant or capillary washing to uniformly pull water and degradation products away from the surface of prints with sensitive or friable media.

Acting as a thin and absorbent towel, TEK-Wipe can also be used in conjunction with the suction table as it equals the suction power through filter paper but is ultimately much cheaper since TEK-Wipe can be cut to the size of the object or to the entire suction table, washed, and reused for other treatments without reduced suction power. The inherent characteristics of TEK-Wipe, when compared to filter paper or blotter, also allows suction table treatments to go on much longer than usual without having to stop and replace the base material. When the wipes are flooded with water, any degradation products that have been removed will continue to be pulled to the very edge of the sheet. This means that degradation products do not remain under your artefact, (fig. 7) but are rather pulled to the very edge of the TEK-Wipe with the water, allowing a more thorough and visibly effective cleaning.

TIDE LINES

TEK-Wipe has also been thoroughly investigated in terms of removing tide lines. The Library and Archives Preservation Department at Iowa State University in Ames, Iowa has used it effectively on large folios from horticulture journals suffering from water and mold damage. In their tests, TEK-Wipe performed well in a combination of washing scenarios (notably with a blotter sandwich, and slant and immersion washing), dramatically reducing the visibility of tide lines in normal light. Irwin (2016) has also described a set up to reduce tide lines that occur after exposure to moisture or when a work of art cannot be subjected to aqueous treatment. (fig. 8) When placed over an object and dampened with a light spray, a tacking iron is used to heat the area over the TEK-Wipe and activate capillary action in the fibers, causing any tide line to be drawn into the wipe from the paper. This quick and easy process can be repeated on the front and back of the work as many times as necessary.

Fig. 7. TEK-Wipe on the suction table will draw more water than blotters or filter paper and prevent the formation of tide lines on artefacts.

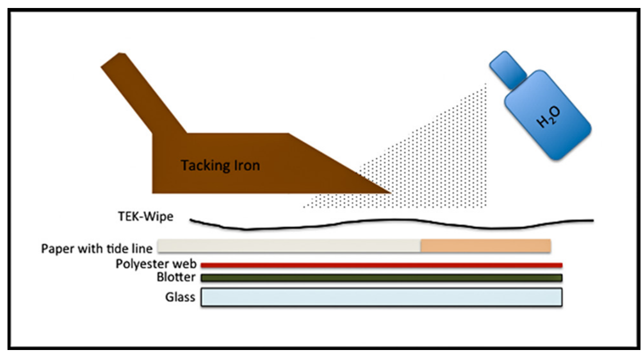

Fig. 8. Seth Irwin set-up for the reduction and removal of tide lines on sensitive works.

TREATMENT CASE STUDIES

When discussing the multi-disciplinary uses for TEK-Wipe, two treatments completed by the author and her colleagues at the Library and Archives Canada (LAC) Preservation Centre in Gatineau, Québec provided perfect situations to test uncommon uses for this absorbent material.

Fig. 9

LEFT TO RIGHT

a. Before treatment: Raking light [John Ellis, *Malcolm's Genealogical Tree of the Royal Family of Great Britain*, 1862, Color lithograph, 108x77 cm, Library and Archives Canada, AMICUS No. 42281363

b. After treatment: Normal light [John Ellis, Malcolm's Genealogical Tree of the Royal Family of Great Britain, 1862, Color lithograph, 108x77 cm, Library and Archives Canada, AMICUS No. 42281363.

VARNISH REMOVAL ON A RARE PRINT

Malcolm's Genealogical Tree of the Royal Family of Great Britain is a lined and varnished lithographic broadside print, by John Ellis of Toronto, Canada. (fig. 9a) From research it was discovered that the LAC print was one of only three recorded copies to have been found. Plagued with horizontal cracking from apparent unrolling, a repeating pattern of severe stains, and tacking holes at the top and bottom edge, it is believed that two wooden dowels (now missing) were once used as a support for this piece. Though adhesive still adhered the paper to the linen lining, the multitude of creases and cracks that had occurred at the dowel edges resulted in well over a hundred small paper fragments and many areas of loss. On the extremely brittle support, the varnish had yellowed and discolored the print. After the removal of the stained lining and applied facing, it was decided that in order to fully stabilize the print, the varnish would also need to be removed. Though solubility testing concluded that ethanol would be an effective varnish remover, since the top and bottom edges were fractured, removing the varnish by hand with cotton swabs was not an ideal option.

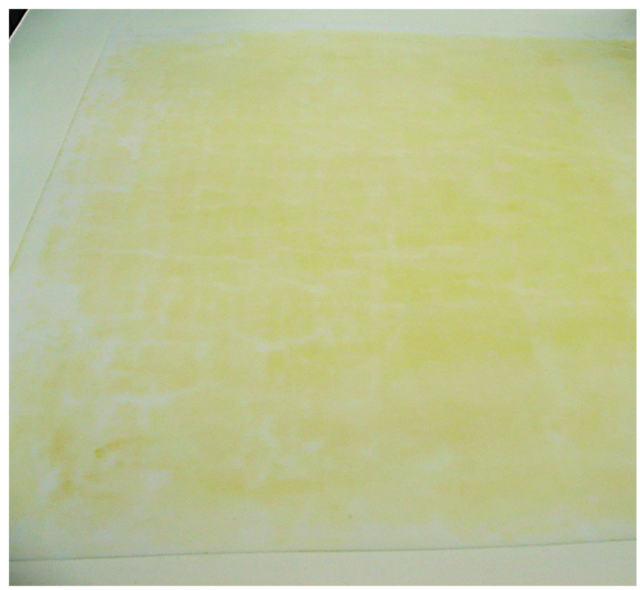

Fig. 10. Discolored varnish removed with TEK-Wipe and ethanol.

A previous LAC conservation report by Hirono (2015) eventually presented a solution. Following this research, and working in the fume hood, large pieces of TEK-Wipe were soaked in ethanol and immediately applied directly on the surface of the print, covered with a sheet of Mylar, and compressed with a piece of acrylic and weights. The soaked TEK-Wipe sheet remained on the print for approximately 15 minutes during which time capillary action in the wipe released the solvent onto the print dissolving the varnish. The varnish was then successfully absorbed back into the wipe. After the first TEK-Wipe was removed, the discolored yellow varnish was already heavily noticeable within the sheet. (fig. 10) This process was repeated twice more with new sheets to ensure all of the varnish had been absorbed. The second wipe had only a slight amount of varnish, and by the third sheet, all varnish had been evenly removed from the print. (fig. 9b)

To clean the TEK-Wipe the fabric was soaked in an ethanol bath to solubilize the varnish that had been absorbed into the sheet. Since the varnish fluoresced when viewed under ultra-violet radiation, this solvent bath was repeated as necessary to completely remove all traces of varnish residue from the fabric.

BACKING REMOVAL

Also in the LAC archives is a collection of hand-colored engravings from the National Audubon Society's compilation of J.J. Audubon's "Birds of America" series. This large collection of prints had been trimmed down and were all mounted overall to thick wood-pulp boards. Not only were the mounts acidic, but inclusions within the board were also creating distracting stains on the prints. Due to the large volume of prints in this series, mechanical removal of the backing was not plausible due to the enormous amount of required treatment time. Furthermore the adhesive bond between the board and the paper was still quite strong preventing a full mechanical removal of the mount. To facilitate and reduce the cumulative and ongoing treatment time, it was decided that a humidification and swelling treatment of the board would be paired with the mechanical removal of the mount once the board was reduced as much as possible.

The original humidification design involved the full immersion of thick blotters in water and their transportation to a large plastic sheet. The print would be placed, board side down on this wet blotter stack, encapsulated with plastic sheeting and covered with a sheet of acrylic and weights. The weight and the acrylic provided an even distribution of pressure over the print that drew water into the mount to reactivate the adhesive so it could easily be mechanically removed.

However when dealing with 4 or 5 large, thick, and fully saturated blotters, this became quite difficult. Often the blotter would start breaking apart after a single use and start to create creases in the prints. To investigate the possible working range for this backing removal method on one of the prints entitled "Red-Headed Woodpecker," this same technique was attempted with several overlapping sheets of TEK-Wipe, which could easily be cut to the size of the prints. Not only was transporting the sheets considerably easier, but TEK-Wipe was able to retain more water within the fibers without dripping all over the floor. After approximately four hours the moisture from the TEK-Wipe was drawn into the board and the print sufficiently to swell the adhesive and allow for mechanical removal of the remainder of the backing and adhesive residue. Once washed and dried, these large TEK-Wipe sheets could be reused for other large object treatments as they remained undamaged, clean, and free of distortions.

CONCLUSION

After testing TEK-Wipe with a range of two-dimensional treatment variations, the following advantages have been noted in this product:

- is chemically inert and safe for a range of sensitive materials
- can be used to introduce moisture locally or for overall treatments
- can be used for drying, cleaning, and even solvent treatments or de-acidification
- can be subjected to a range of flexible RH levels, for which the user is in complete control
- will retain dimensional stability without causing cockling or localized distortions in an object
- has the flexibility to be used with flat, bound, or distorted materials of any size safely
- has the potential to be useful in the treatment of some 3-dimensional objects
- can be reused without adverse side effects during treatment
- reduces handling of fragile objects by increasing the effectiveness of a wash

The treatments outlined in this article, while still only a portion of the ways that TEK-Wipe can be used effectively, substantiate the versatility of TEK-Wipe as a conservation material. The author hopes that these examples will be beneficial in demonstrating how the possibilities of aqueous treatments in conservation can be expanded beyond traditional means.

ACKNOWLEDGEMENTS

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NOTES

1. 66 sheets of 100-point blotter (66 sheets of 38 x 52 in. = 100.6 yd^2 ≅ $1300) are almost four times more expensive than the same amount of TEK-Wipe (1 heavy-weight roll = 100 yd^2 ≅ $350). Considering that TEK-Wipe is reusable, this represents an incredible cost in savings (Edwards 2014).

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MATERIALS

COTTON BLOTTER (actual name: Unbuffered 100% Cotton Blotting Paper)
University Products: The Archival Company
1-800-628-1912
www.universityproducts.com

TEK-WIPE (actual name: Hi-Tek Wipers, item:HTW-DT)
TEK Products
800-783-4944
www.tekproducts.com

PARAPRINT (actual name: HPCR-54 Paraprint OL 60)
HIROMI Paper Inc.
310-998-0098
https://store.hiromipaper.com

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Tip: A Preliminary Investigation Into the Use of Diethylenetriaminepentaacetic Acid and Ethylenediaminetetraacetic Acid to Treat Iron Induced Foxing in Paper Objects

INTRODUCTION

The purpose of this research was to understand the extent to which diethylenetriaminepentaacetic acid (DTPA) and ethylenediaminetetraacetic acid (EDTA) can reduce the iron content in iron-induced stains on paper. The tests were developed based on common treatment methods used to apply chelating agents to stains. The tests were more aggressive than what would be exercised in conservation practice in order to gain a preliminary understanding of the risks and benefits of chelation treatments.

Iron contaminants may be incorporated into paper from metal machinery and unfiltered water sources during manufacture, water damage, pollutants and dust, or ancillary materials in contact with the paper object (Ardelean and Melniciuc-Puică 2013; Choi 2007; Daniels 1996). Localized staining may be a result of iron contaminants and is sometimes called foxing.[1] As a transition metal, iron is highly reactive existing in the form of colored iron(III) corrosion salts or colorless but highly reactive iron(II) salts which catalyze oxidative cellulose degradation (Bicchieri and Pepa 1996; Daniels 2002; Giorgi 2013; Kolar 2001; Neevel 1995; Sheldon and Kochi 1981).

CHELATING AGENTS IN PAPER CONSERVATION

Conservators may address localized staining with routine stain reduction methods such as washing, alkalization, or bleaching. Washing and alkalization are appropriate for removing soluble degradation, however, iron salts are very difficult to solubilize, particularly the colored iron(III) salts. Bleaching addresses the effects of staining by changing the colored molecules into non-colored molecules rather than the cause of the staining. Also, reversion of staining has been recorded in objects after bleaching treatments, especially in the case of iron induced foxing (Gallo and Hey 1988; Owen1994).

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Alternatively, chelating agents have been used in paper conservation to improve stain reduction treatments, allowing metallic components of stains to be solubilized and removed from the paper. The properties of iron as a transition metal allow the heavy metal to react with chelating agents forming coordination bonds (Cramer, 1973). Chelating agents are a class of organic molecules that can form coordination bonds with heavy metal ions under the following two criteria: (a) the chelate must have two or more functional groups that can donate a pair of electrons to a positively charged metal ion forming a coordination bond, and (b) the stereochemistry of the chelate allows formation of rings during complexing where the metal ion acts as the closing member of the rings at the center of the complex (Burgess 1991; Dwyer and Mellor 1964). Successful chelation of metal ions will occur when the chelate formation (logKf) constant is higher than the solubility product (pKsp) of the targeted metal salt (Rivers and Umney 2003; Wolbers 2000).[2,3,4,5] Some chelates effectively used for stain reduction on works of art on paper include iron(II) chelators like ammonium citrates, DTPA, and EDTA; or iron(III) chelators like di (ortho-hydroxybenzyl)-edthylenediamine diacetic acid (HBED). A survey of conservation literature shows the use of a reducing agent such as sodium dithionite (SDT) or sodium metabisulfite[6] to reduce iron(III) into iron(II), an essential step for enhancing chelation treatment outcomes when using iron(II) specific chelates. Treatment methods include immersion, local application on the suction table with a brush or spray, or topical application with hydrogels (Baker 1987; Blank and Dobrusina 1984; Burgess 1991; Gent and Rees 1994; Hashimoto 2015; Irwin 2011; Owen 1994; Selwyn and Tse 2008; Sulliven et al. 2014; Suryawanshi and Bisaria 2005).

Some empirical studies have analyzed chelation treatment of paper staining, testing parameters that would only be appropriate in a laboratory setting. Baker (1987) found that EDTA and DTPA sodium salts had very little effect on stain reduction and observed reversion of treated staining after three years of natural aging. Blank and Dobrusina's (1984) test showed that the DTPA calcium salt improved the paper stability of the samples tested. Results from Suryawanshi and Bisaria (2005) revealed high concentrations of EDTA with unadjusted pH levels had adverse effects on paper strength after artificial aging. Immersing samples in alkaline EDTA and 2% weight per volume (w/v) solution of SDT effectively reduced staining and had the least damaging effect to the paper support after aging. Hashimoto (2015) found that overall discoloration was reduced with triammonium citrate immersion baths, however, samples that were not alkalized after chelation treatment increased in discoloration after aging. While these studies have found chelating agents to successfully reduce staining, they do not express effectiveness of treatment in terms of the amount of iron ions removed from the paper support, nor do they compare treatment methods commonly used for chelation treatments.

EXPERIMENTAL

The treatment methods and variables tested were chosen to reflect what has been commonly used in published case studies and analysis of chelation treatments in paper conservation. The following variables were tested to understand what impact they have on chelation treatment effectiveness: chelating agents (DTPA and EDTA), use of a reducing agent (SDT), different treatment application (immersion and local application on the suction table), and different solution pH levels (pH 9 and pH 10).

SAMPLE PREPARATION

Deionized water was sprayed onto Whatman No.1 ashless filter papers until they were evenly dampened in a plastic photographic tray. Iron filings and Saxa table salt were sprinkled onto the filter papers. The tray was covered with a sheet of acrylic and kept in an uncontrolled environment with elevated temperatures for a week. The papers were thoroughly foxed with no signs of mold bloom visible. Twelve samples and one control were cut from the foxed papers in 35mm diameter circles for the Spectro X-Lab 2000 x-ray fluorescence (XRF) small sample die.

TECHNICAL ANALYSIS

Samples were analyzed before treatment, treated with chelation treatments, dried, analyzed during treatment, immersion washed in 20ml of reverse osmosis (RO) water, dried, and analyzed after treatment. Samples were examined and photographed in visible and ultraviolet (UV) light. Details of photographic equipment used may be found in the Appendix. The L*a*b* values of stains in the samples before and after treatment were taken with a CM-2600d spectrophotometer using the small aperture view and SpectraMagic TM NX software. Quantitative XRF readings were taken of the samples using a Spectro X-Lab 2000 with a 400 W Pd end window x-ray tube High resolution Si(Li) semiconductor detector. Scanning electron microscopy (SEM) was conducted on select samples after treatment using an FEI Quanta 200 SEM with INCAEnergy Software.

SAMPLE TREATMENT

There were three treatment sets with four samples tested per set. The free acid of the chelates were dissolved in 20ml of diluted 20% ammonium hydroxide at pH 11.5 until the desired pH for the chelate solution was achieved. 0.4g of SDT was added to 20ml of RO water to make the 2% w/v solutions of SDT. Below is a breakdown of the samples and corresponding procedures tested:

Set 1. Immersion in 20ml of chelating solutions for six hours.

- sample 1—20ml of DTPA at pH9
- sample 2—20ml of DTPA at pH10
- sample 3—20ml of EDTA at pH9
- sample 4—20ml of EDTA at pH10

Set 2. Immersion in 20ml of 2% w/v SDT reducing agent for two hours followed by immersion in 20ml of chelating solutions for six hours.

- sample 5—20ml of DTPA at pH9
- sample 6—20ml of DTPA at pH10
- sample 7—20ml of EDTA at pH9
- sample 8—20ml of EDTA at pH10

Set 3. Local application with a brush on the suction table of 20ml of 2% w/v SDT followed by local application of 20ml of chelating solutions.

- sample 9—20ml of DTPA at pH9
- sample 10—20ml of DTPA at pH10
- sample 11—20ml of EDTA at pH9
- sample 12—20ml of EDTA at pH10

RESULTS

NORMAL LIGHT

For samples immersed in SDT and chelate solutions (samples 5–8), noticeable changes in staining plateaued after forty-five minutes to an hour of treatment. Visible staining was significantly reduced. Samples treated locally on the suction table experienced lateral movement of the staining; no visible reduction in staining was observed. Dark gray tidelines surround the treated areas. No visual change was apparent in samples treated by immersion in chelating solutions. Distinction between the types of chelate used or the different solution pH levels could not be made visually. Immersion treated samples appeared slightly swollen and samples treated locally had displaced paper fibers in the treated areas. Table 1 shows all samples in normal light before and after treatment.

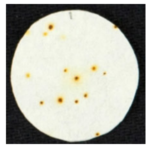
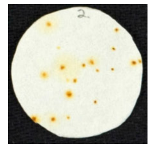
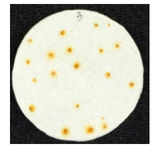
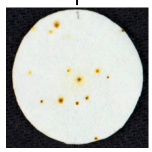
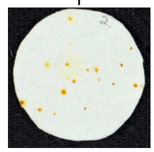
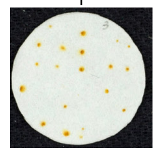
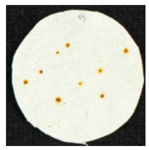
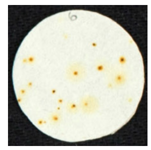
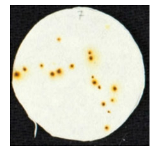
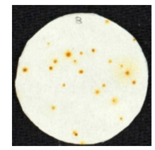
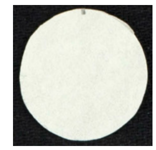
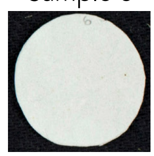
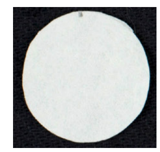
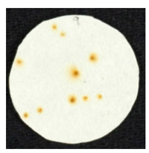
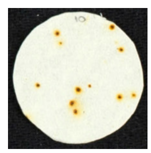
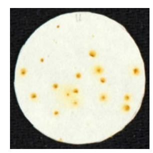
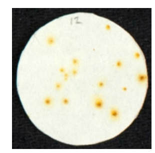
		DTPA pH 9	DTPA pH 10	EDTA pH 9	EDTA pH 10	
6 hour immersion in 20ml of chelate solution	Before Treatment					
		Sample 1	Sample 2	Sample 3	Sample 4	
	After Treatment					
2 hour immersion in 20ml 2% w/v SDT followed by 6 hour immersion in 20ml of chelate solution	Before Treatment					
		Sample 5	Sample 6	Sample 7	Sample 8	Control
	After Treatment					
2 hour immersion in 20ml 2% w/v SDT followed by 6 hour immersion in 20ml of chelate solution	Before Treatment					
		Sample 9	Sample 10	Sample 11	Sample 12	
	After Treatment					

Table 1. Images of all sample rectos in normal light before and after treatment.

ULTRAVIOLET FLUORESCENCE

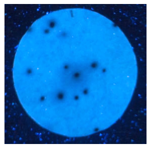
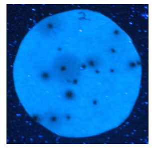
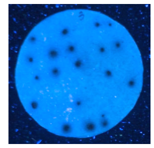
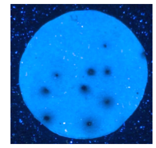
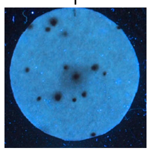
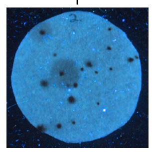
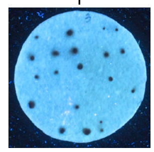
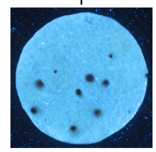
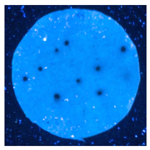
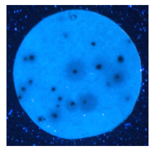
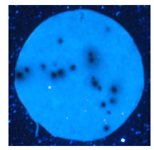
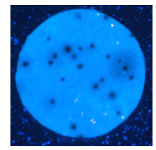
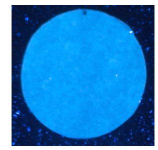
Table 2 displays all samples in UV light before and after treatment. Samples 8 to 11 immersed in SDT then chelate solutions showed little UV absorbance after treatment. All samples treated locally had fluorescent tidelines. Samples treated solely by immersion in chelate solutions show no change under UV light after treatment. No distinctions between solution pHs was possible through UV fluorescence. Finally, the support of all samples treated with EDTA had an overall pale yellow fluorescence (fig. 1)

SPECTROPHOTOMETRY

Spectrophotometer readings were taken of one stain in each sample using a template for consistency. Three readings of the same stain were measured before treatment and again after treatment. Chart 1 shows the change in a* readings (Δa*) recording the shift in the measured stains from red to green. A strong shift from red to green occurred in samples treated by immersion in SDT prior to chelating solutions (samples 5 to 8) correlating with the decrease in visible staining formerly mentioned.

X-RAY FLUORESCENCE

A general decrease in iron content of all samples treated with chelating agents was seen with XRF analysis regardless of any other variables tested (see chart 2). The most significant drop in iron concentrations was found in samples treated by immersion in sodium dithionite followed by immersion in

		DTPA pH 9	DTPA pH 10	EDTA pH 9	EDTA pH 10	
6 hour immersion in 20ml of chelate solution	Before Treatment					
		Sample 1	Sample 2	Sample 3	Sample 4	
	After Treatment					
2 hour immersion in 20ml 2% w/v SDT followed by 6 hour immersion in 20ml of chelate solution	Before Treatment					
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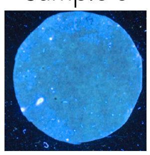
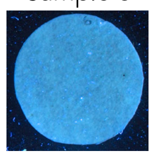
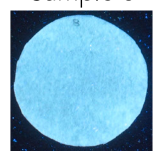
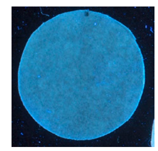
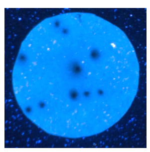
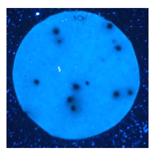
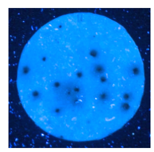
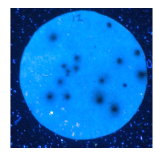
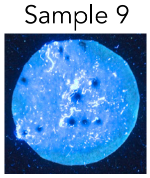
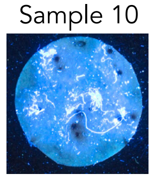
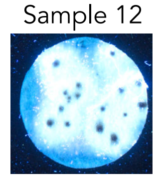
	After Treatment					
2 hour immersion in 20ml 2% w/v SDT followed by 6 hour immersion in 20ml of chelate solution	Before Treatment					
		Sample 9	Sample 10	Sample 11	Sample 12	
	After Treatment					

Table 2. Images of all sample rectos in ultraviolet light before and after treatment.

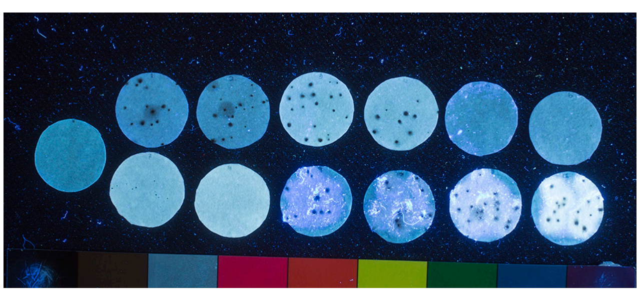


Fig. 1. Ultraviolet fluorescence of all samples after treatment, arranged in numerical order from left to right, top to bottom. All samples treated with EDTA chelate solutions show a pale yellow fluorescence after treatment.

chelating solutions. Solutions at pH 9 were generally more effective in reducing iron content than pH 10 solutions. Interestingly, samples treated with EDTA showed the greatest reduction in iron content compared to samples treated with DTPA. Refer to chart 2 for XRF results.

SCANNING ELECTRON MICROSCOPY

The control and samples 2, 4, 6, 8, 10 and 12 were selected for analysis with SEM after treatment to assess physical changes in the paper fibers and iron deposits in stained areas. Readings were taken at three levels of magnification, approximately 100xM, 500xM, and 2500xM. Images were taken of areas of paper fibers at 100xM and 500xM followed by at least two different locations of iron deposits at 500xM and 2500xM.

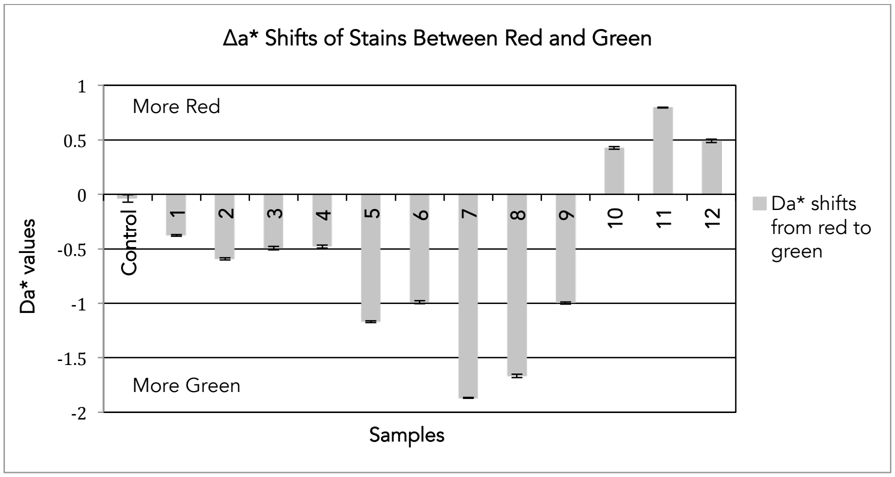


Chart 1. The Δa* values showing shifts from green to red.

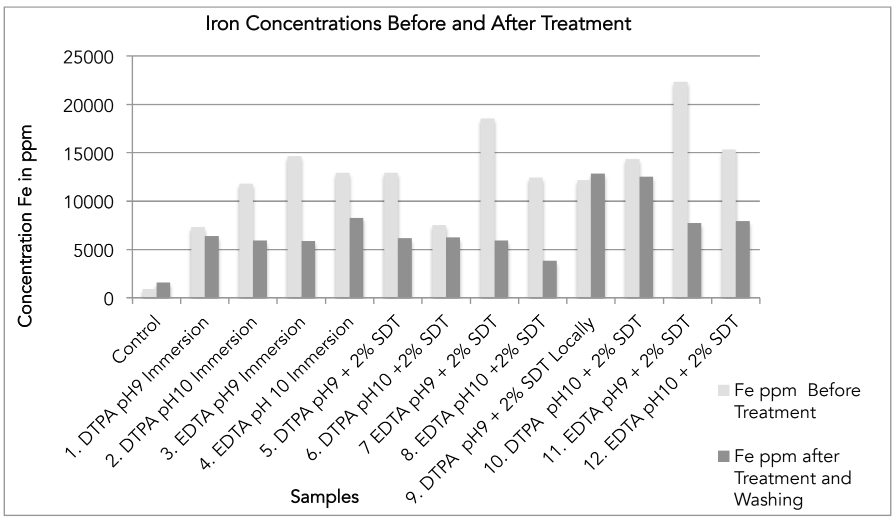


Chart 2. The iron concentration in parts per million (ppm) of all samples before and after treatment. The XRF was operated Gordon Forest by Life Sciences staff.

As shown in fig. 2, the paper fibers in the control were compacted and dehydrated. The paper fibers appear to be more swollen and less compacted in samples treated by immersion (fig 3). Samples treated on the suction table showed a drastic physical change in the paper fibers apparent at the 100xM range. Some fibers were swollen, disturbed, and raised out of the surface plane; while other areas of the same sample remained compacted and looked similar to the fibers in the control (fig. 4).

Iron deposits examined in samples treated by immersion in chelating solutions completely coat the paper fibers and significant corrosion is apparent at the 2500xM range (fig. 5). Samples treated by immersion in SDT followed by chelating solutions showed very fine, dense, iron deposits with no corrosion coating the surrounding paper fibers (fig. 6). Examination of samples treated with local application of SDT followed by chelating solutions on the suction table had iron deposits that were slightly less corroded (fig. 7). Interestingly, many small deposits are seen extending from large deposits into the support at the 100xM range indicating lateral movement of the iron deposits as a result of local treatment (fig. 8).

DISCUSSION

Treatment by immersion in SDT followed by immersion in chelation tested on samples 5 to 8 were the most successful in reducing visible staining and decreasing the iron ions because the treated surface area was maximized and longer open working times were possible. Chelation treatment appeared ineffective in samples after forty-five minutes to an hour of treatment. Absorption of UV light was significantly reduced and spectrophotometer readings recorded a significant shift

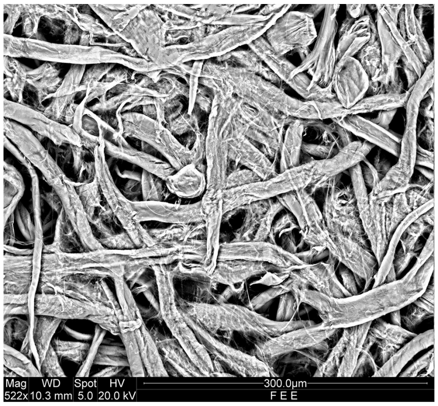


Fig. 2. Untreated, desiccated and compacted fibers: control at 522xM, working distance 10.3mm, area 1. Image taken by Kayleigh Fuller, Conservation Program staff.

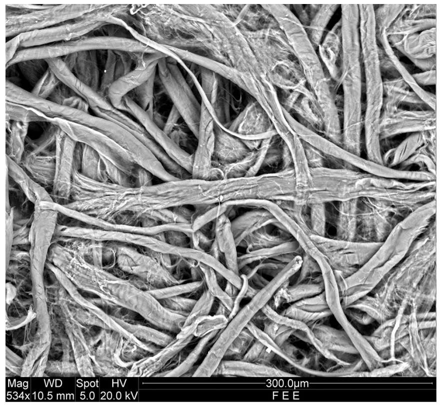


Fig. 3. Slightly hydrated and less compacted fibers: sample 2 immersion treatment in DTPA at 534xM, working distance 10.5mm, area 3. Image taken by Kayleigh Fuller, Conservation Program staff.

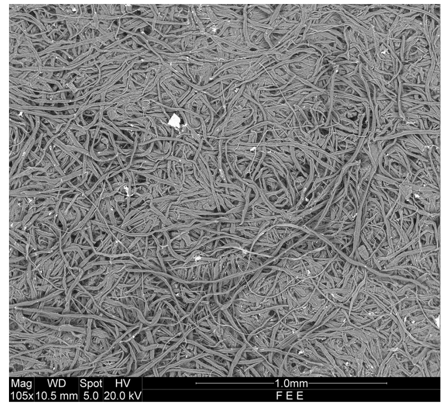


Fig. 4. Disturbed paper fibers in some areas and compacted fibers in others: sample 10 localized treatment with 2% SDT followed by DTPA at105xM, working distance 10.5mm, area 3. Image taken by Kayleigh Fuller, Conservation Program staff.

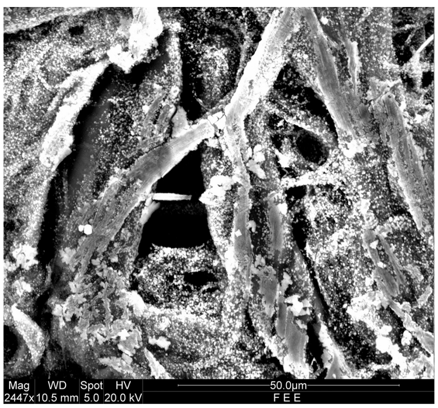


Fig. 5. Corroded iron deposit with fibers coated with corrosion: sample 2, immersion treatment with DTPA at 2447xM at 10.5mm working distance, area 2. Image taken by Kayleigh Fuller, Conservation Program staff.

Fig. 6. Very dense, small iron particles with no corrosion coating surrounding fibers: sample 8, immersion treatment with 2% SDT followed by EDTA: 3484xM 10.4mm working distance, area 6. Image taken by Kayleigh Fuller, Conservation Program staff.

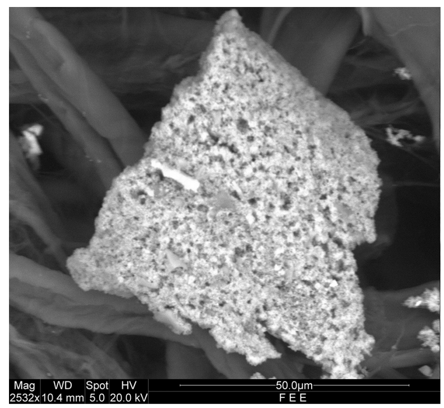


Fig. 7. Moderate corrosion of large iron deposits with very little corrosion on surround fibers: sample 10, localized treatment with 2% SDT and DTPA at 2532xM, working distance 10.4mm, sample 10 area 4. Image taken by Kayleigh Fuller, Conservation Program staff.

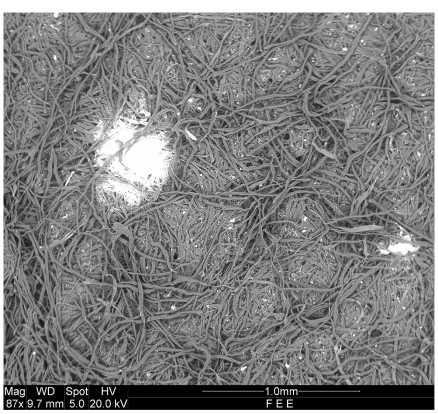


Fig. 8. Small iron particles scattered laterally around large iron deposits: sample 10 localized treatment with 2% SDT and DTPA at 87xM, working distance 9.7mm, area 5. Image taken by Kayleigh Fuller, Conservation Program staff.

from red to green. XRF analysis showed a slight increase in the amount of iron ions removed from the paper supports compared to samples treated by chelation without SDT. Physical differences in the fibers and iron deposits in select samples after treatment related to treatment application methods as well as using SDT in combination with chelates were observed with SEM.

Visual analysis in normal light, spectrophotometer readings and SEM did not allow for differentiations between either the performance of the two chelates tested or the effects of solution pH on treatment outcomes. However, XRF revealed that all samples treated with EDTA had greater decreases in iron concentrations than samples treated with DTPA. This was unexpected because EDTA has two fewer complexing sites than DTPA and its formation constant is lower than the iron(II) solubility product. Also, samples treated with EDTA showed a pale yellow fluorescence. XRF analysis indicated that pH 9 chelate solutions generally gave better treatment results than pH 10 solutions. This was surprising because a higher pH would allow for more of the complexing sites in the chelate molecule theoretically improving chelation.

This preliminary investigation has shown that chelating agents DTPA and EDTA were noticeably effective in reducing iron concentrations and visible staining in samples. It is important to continue investigating chelation treatments because of its ability to successfully treat aggressive iron degradation in paper objects. Future research opportunities include the investigation of aging characteristics of chelation treatments as well as refining treatment methods to improve open working times, control the surface area treated, and reduce physical changes in the paper supports.

ACKNOWLEDGEMENTS

I would like to thank Dr. Charis Theodorakopoulos and Dr. Jane F. Colbourne for their support and guidance throughout my research for my masters thesis at Northumbria Univeristy, UK. I would also like to thank the Faculty of Health and Life Sciences and the Faculty of Engineering and Environment at Northumbria University for making the XRF and SEM/EDS analyses possible. Also, a special thanks to Kayleigh Fuller and Gordon Forest for their technical support and expertise in using the XRF and SEM/EDS as well as all who helped me refine and review this research for the American institute for Conservation's Book and Paper Group.

NOTES

1. It is important to note that foxing may also refer to localized discoloration caused by microbiological attack, localized moisture condensation, and irregular accelerated aging. Choi, S. 2007. Foxing on paper: a literature review. *Journal of the American Institute for Conservation*. 46 (2): 137-152.

2. The solubility product for iron(II) hydroxide is 15.1 and for iron(III) hydroxide is 37.4. These numbers show that iron(III) salts are very insoluble and therefore difficult to remove from paper with aqueous treatments.

3. DTPA is an octadentate chelate with eight complexing sites giving it the potential to form stable bonds with metal ions. The DTPA formation constant for iron(II) is 16.0 and for iron(III) is 27.5. Rivers, S. and Umney, N. 2003. *Conservation of Furniture*. Oxford: Butterworth Heinemann.

4. EDTA is a hexadentate chelate with six potential complexing sites. The formation constant of EDTA for iron(II) is 14.3 and for iron(III) is 24.2. Rivers, S. and Umney, N. 2003. *Conservation of Furniture*. Oxford: Butterworth Heinemann.

5. DTPA will successfully complex iron(II) but iron(III) salts will not be effected. EDTA has a slightly lower formation constant compared to the iron(II) solubility product yet it is the chelate most commonly used in paper conservation.

6. Sodium metabisulfite is used as an alternative for SDT to decrease health and safety risks. However, SDT is more commonly used in combination with chelation treatments because sodium metabisulfite is not as effective. Irwin, S. 2011. A comparison of the use of sodium metabisulfite and sodium dithonite for removing rust stains from paper. In *The Book and Paper Group Annual, Vol. 2.* Washington, DC.: AIC. 37-46.

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APPENDIX

Photographic Equipment

Visible Light Photography:

- Camera-Cannon EOS 6D, 50mm lens
- Light Source- 'Cold' studio white lights

Ultraviolet Fluorescence Photography:

- Camera-Cannon EOS 6D, 50mm lens
- Light Source- Large UV BLB Strip Lights from CLE Design Ltd 280-440nm short wave UV
- Filter- Camera- 2E Kodak Filter

Suppliers for Materials

- *Whatman No. 1 (ashless) filter papers*: Sigma-Aldrich Company Ltd.
- *Ammonia 20%*: Sigma-Aldrich Company Ltd. # UN2672
- *DTPA for complexometry ≥ 99.0%*: Sigma-Aldrich Company Ltd. #32319-100G-F
- *EDTA ≥ 98.0%*: Fluka Analytical through Sigma-Aldrich Company Ltd. #03620-250G
- *Sodium Dithionite*: BDH Laboratory Supplies #GPR UN1384

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CHRISTINA TAYLOR AND TINA C. TAN

Tip: A Method of Mounting Works on Paper Using Embedded Magnet Strips

In preparation for the Museum of Fine Arts, Houston (MFAH) exhibition *Contingent Beauty: Contemporary Art from Latin America*, paper conservators at the MFAH developed a mounting system with magnets to display Johanna Calle's *Perímetros (Urapán)*, 2012, a 12-part assemblage of typed text on ledger book pages positioned on a wall to depict a tree (fig. 1). The mounting system provided a clean, invisible aesthetic, and was constructed to be reusable for future display without significantly increasing storage space. Spun polyester-web pockets were adhered to the verso of each folio with BEVA 371 film (two or four pockets were adhered to each folio depending on the orientation) (fig. 2). Each set of pockets held a thin PETG (Vivak®) strip with embedded rare earth magnets (1/2 in. diameter x 1/16 in. thickness, N-42 strength) (fig. 3). Metal screws were drilled into the display wall in locations that corresponded to the magnets in the Vivak® strips. A Vivak® template, with holes drilled in the same locations as the magnet-embedded strips, simplified positioning the metal screws during installation. The folios were hung along the top edge, allowing the bottom of the sheet to hang freely (a preference of both the artist and curator). When de-installed, the Vivak® strips were removed, the pockets were kept on the verso of the work, and all components were stored in a compact storage housing constructed from common archival storage materials (fig. 4).

Fig. 1. Installation view of *Contingent Beauty: Contemporary Art from Latin America,* 11/22/2015-2/28/2016 at the Museum of Fine Arts, Houston. Photographer Will Michaels. @ MFAH. MFAH Archives. (Left) Johanna Calle, *Perímetros (Urapán)*, 2012, typed text on notarial ledger book paper, 280 x 200 cm.

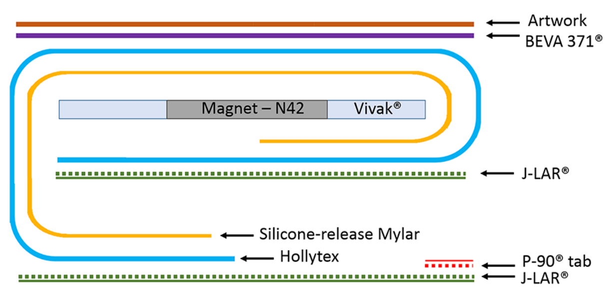

Fig. 2. Profile diagram of pocket construction

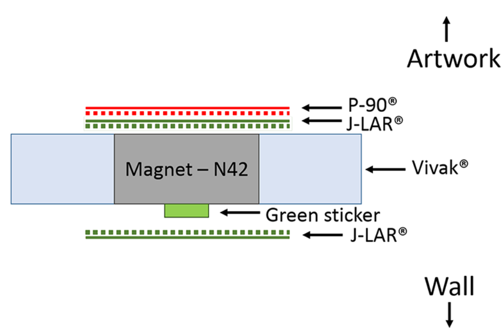

Fig. 3. Profile diagram of strip construction

Presented at the Book and Paper Group's Lunchtime Tip Session, AIC's 44rd Annual Meeting, May 13–17, 2016, Montreal, Canada

Fig. 4. (Top) upper level of storage box showing Vivak® strips with embedded magnets secured with twill tape; (Bottom) lower level of storage box showing removable trays holding folios with Mylar clips and polyethylene strap. Photographer Matthew Golden.

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JODIE UTTER

Tip: Discreet/Isolated Fills

As a third-year intern in the Asian conservation department at the Museum of Fine Arts, Boston, I was preparing a number of lined Japanese prints for exhibition. The linings were of thick paper attached with a strong paste; removing the lining would have been difficult and time consuming. In addition, old binding holes and insect damage were present in vital areas of the printed images. Traditional fills, attached to the print's verso would have added more paste and moisture to the already heavy lining, there was also a danger of ink or discoloration transfer. A different, less intrusive and time-consuming technique was needed to address the visual impact of the damage.

Solution: The losses were "filled," but not directly on the object. Rather a fill paper was toned, shaped to match the loss and then secured to the print's back mat. The print was then laid over the fill. Once matted, framed and glazed, the viewer would see a toned fill, thereby creating a straightforward, low time commitment solution.

Fig. 1. After treatment, detail, bottom left corner: William H. Johnson, Jitterbugs II, ca. 1941, modified screen print, 43 x 46.5 cm, Amon Carter Museum of American Art, Fort Worth, Texas, Amon G. Carter Foundation purchase, 2000.11.

Presented at the Book and Paper Group's Lunchtime Tip Session, AIC's 44rd Annual Meeting, May 13–17, 2016, Montreal, Canada

Over the years I have modified this technique to address objects on thin or brittle paper. A repair acts to secure an area of loss or damage, but the repair must always be "weaker" than the object being treated. This can create visual integration problems when, for example, a fragile work like José Guadalupe Posada's broadside prints, or a William Johnson screen print on brittle newspaper need fills and structural repair. In these two cases the repairs and fills were created using lightweight, pre-toned Kozo fibered paper. The objects were made more stable by this approach but it did nothing to visually integrate the fill with the object. The technique above was used to rectify this problem. An opaque paper was toned, generally cut to shape, and secured to the object's back mat. (fig. 1)

The thin translucent fill attached to the object when laid over the opaque toned paper on the back mat, together made a visually acceptable combination that did not attract the eye, allowing the viewer to the see the object and not be distracted by the repaired damage. (figs. 2-5)

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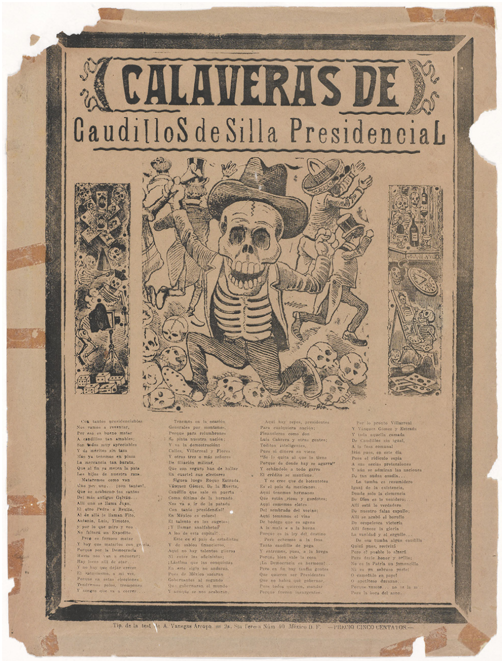

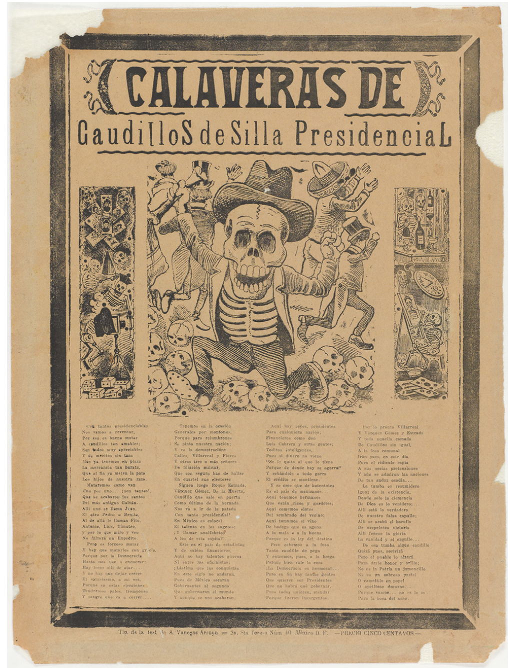

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Fig. 2. Before treatment, normal light, recto: José Guadalupe Posada, Calaveras de caudillos de silla presidencial, ca. 1890-1913, etching, 40.1 x 30.2 cm, Amon Carter Museum of American Art, Fort Worth, Texas, Amon G. Carter Foundation purchase, 1978.52.

Fig. 3. After treatment, normal light, recto: José Guadalupe Posada, Calaveras de caudillos de silla presidencial, ca. 1890-1913, etching, 40.1 x 30.2 cm, Amon Carter Museum of American Art, Fort Worth, Texas, Amon G. Carter Foundation purchase, 1978.52.

Fig. 4. Treated Posada print next to mat board with toned and shaped fills adhered to back mat: José Guadalupe Posada, Calaveras de caudillos de silla presidencial, ca. 1890-1913, etching, 40.1 x 30.2 cm, Amon Carter Museum of American Art, Fort Worth, Texas, Amon G. Carter Foundation purchase, 1978.52.

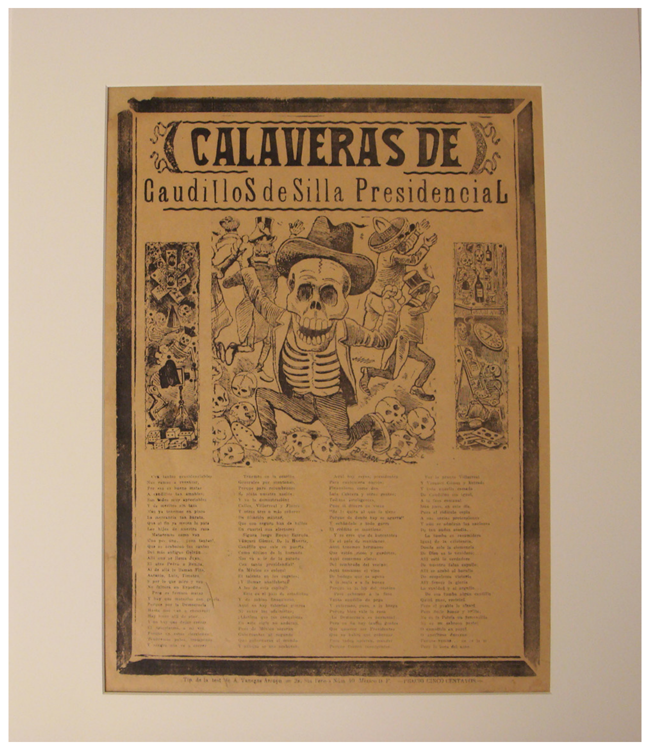

Fig. 5. Treated Posada print with window mat closed: José Guadalupe Posada, Calaveras de caudillos de silla presidencial, ca. 1890-1913, etching, 40.1 x 30.2 cm, Amon Carter Museum of American Art, Fort Worth, Texas, Amon G. Carter Foundation purchase, 1978.52..

Tip: The Book Halter, an Alternative to the Colibrì Book Jacket

Conservators often hesitate to apply library labels directly to book bindings, particularly in the case of older books bound in leather, cloth, or decorated paper. Because of their fragility, such books are unsuited for the Colibrì Automatic Book-Covering System (www.colibriusa.com), which many research libraries use to create polyethylene dust jackets for new case-bound or paperback books. The polyethylene "book halter" described here is a solution for bindings that need to be labeled on the spine but cannot be opened fully to receive a Colibrì book jacket (fig. 1).

The Colibrì system consists of three standard sizes of polyethylene book covers, each with two pockets to accommodate the book boards, as well as a heat welder. The jackets protect book covers from dirt and abrasion, and they also provide a surface to which library spine labels or barcodes can be adhered. In its advertisements, Colibrì claims that it takes only 20 seconds to cover a book using this system. While this may seem like a time-saving boon to library staffers, fitting a book into a Colibrì cover requires swinging both book boards away from the text block until they meet opposite the spine (fig. 2). This position puts stress on the spine and inner hinges of the book, making the system inappropriate for old, weak, or fragile bindings.

The Colibrì halter was developed to allow American Philosophical Society library staff to attach labels to older books that are too sturdy to require boxing but too fragile to be forced into the potentially damaging position required to put on a Colibrì jacket. Heat-sealed polyethylene straps wrap each book board adjacent to the spine, and a third strap, attached with double-stick tape, links the two board straps at the bottom of the spine. The straps can be cut from Colibrì book covers and sealed with the Colibrì welding machine, and the halter can be attached without undue manipulation of the book. The halter also saves money and materials, since five or more halters can be made from each Colibrì jacket (fig. 3). With time for cutting materials, each halter takes

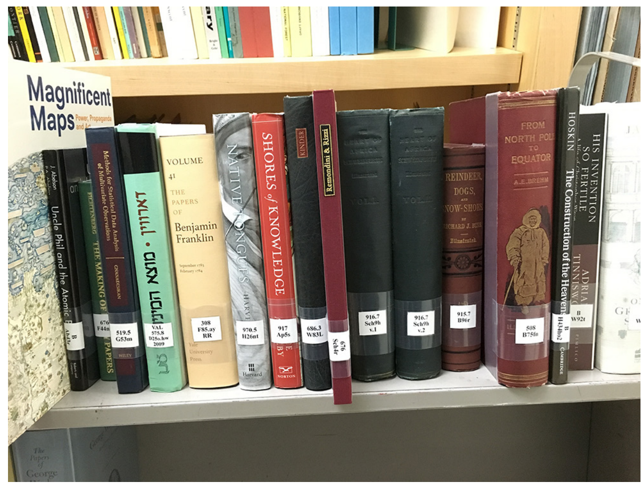

Fig. 1. A row of books equipped with Colibrì book halters.

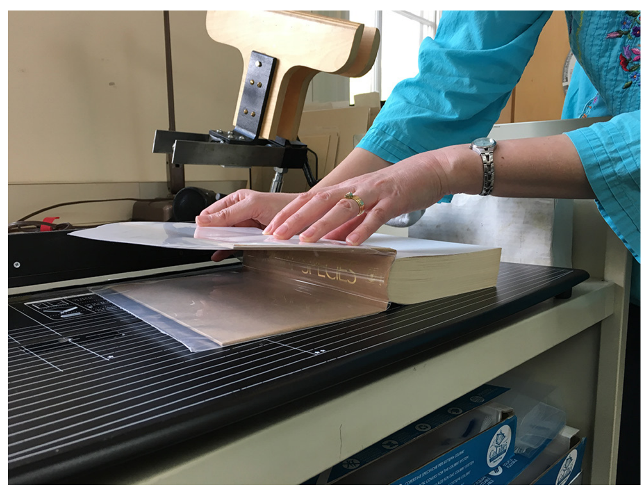

Fig. 2. The position a book must assume to be covered with a full Colibrì dust jacket (courtesy of Keara Teeter).

Presented at the Book and Paper Group's Lunchtime Tip Session, AIC's 44rd Annual Meeting, May 13–17, 2016, Montreal, Canada

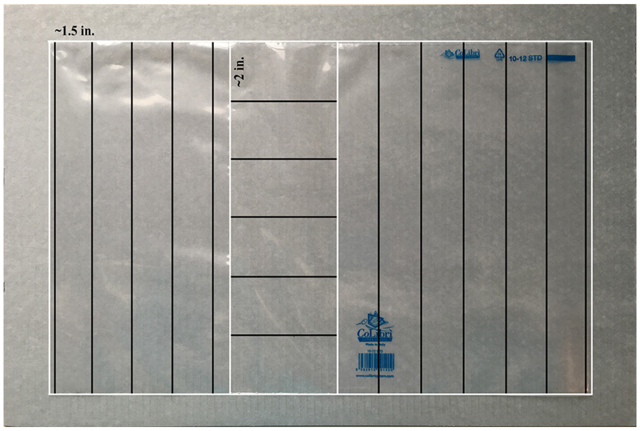

Fig. 3. Cutting diagram for a Standard Colibrì cover (49.21 cm x 12.625 cm; 19 3/8" x 12 5/8").

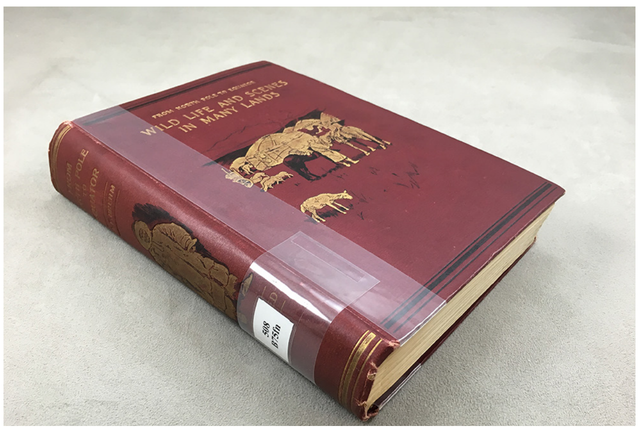

Fig. 4. The finished Colibrì book halter with attached library label.

approximately 8 minutes to make—far more than the 20 seconds required for a full jacket, but far less than the time required to make a custom book box.

To manufacture the book halter, select the Colibrì cover that would fit the chosen book. Using a board sheer or knife, cut the pockets of the cover into vertical strips approximately 3 cm (1.25 in.) wide (or wide enough to accommodate any barcode labels that must be attached to the book boards). Cut the spine of the Colibrì cover into horizontal spine strips tall enough to accommodate the height of any spine labels. Each pocket strip is a double thickness of polyethylene with narrow heat seals at the top and bottom. Open a pocket strip and slide it over one book board, nestling it into the hinge of the book. Leave excess plastic at the head of the book. Place the closed book on the Colibrì machine with the head facing the welding bar and the strapped board down. Snug the book up against the welding bar and use the machine to weld and trim the strap. Repeat with the second board. Finally, with the book closed, use strips of 3M 415 double-sided tape to secure a polyethylene spine strip to the two board straps. Trim away any excess plastic from the spine strip. The book halter is now complete (fig. 4).

While these book halters are visually unobtrusive and dispense with the need to place adhesive labels or marking inks directly on book covers, they are not perfect. When shelving two books with book halters side by side, the straps that wrap the book boards can catch on each other, stretching and warping the polyethylene. Shelving books at an angle and then rotating them upright helps to prevent this problem. Readers who experiment with the book halter and make improvements to the design are encouraged to share their results.

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