

THE TEXTILE SPECIALTY GROUP  
**POSTPRINTS**  
Papers Delivered at the Textile Subgroup Session

American Institute for Conservation  
Twenty-Sixth Annual Meeting  
Arlington, Virginia  
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VOLUME EIGHT



# THE TEXTILE SPECIALTY GROUP POSTPRINTS

Edited by

Camille Myers Breeze

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## PREFACE

This is the eighth volume of the Textile Specialty Group Postprints. It contains the papers delivered at the textile subgroup session of the annual meeting of the American Institute for Conservation, held in Arlington, Virginia on June 6 1998. Three of the papers relate to the 1998 general session topic of Emergency Preparedness and Emergency Response. The remaining eight papers deal with other research topics in the field of textile conservation.

For the second year in a row, a Spanish translation of each abstract is provided. I would like to thank the four members of the Comité Nacional de Conservacion Textil, Chile, for their hard work and for the success of their collaboration: Emilia Cortes, Textile Conservator, the Metropolitan Museum of Art; Patricia Lissa, Museo Isaac Fernandez Blanco, Buenos Aires, Argentina; Carol Sinclair, Museo Chileno de Arte Precolombino, Santiago, Chile; and Isabel Alvarado, Museo Histórico Nacional, Santiago, Chile.

Where possible, the editing of this publication has followed the guidelines of documentation style 2 of *The Chicago Manual of Style*, 14th ed. (The University of Chicago Press 1993).

The compilation of this journal relied heavily on the use of E-mail and the Internet for correspondence, proofreading, and data transfer. Most of the graphics in this volume have been scanned and provided to the printer in digital format.

The editor wishes to thank the following people for their help in preparing this publication: Peter Breeze for his invaluable technical assistance and moral support; Dr. Sarah MacLennan Kerr for sharing her editorial expertise; Cristin Lind for editorial assistance; Robert Espinosa, Compiler and Managing Editor of the Book and paper Group Annual, for the example and standard that his publication has set; Beth McLaughlin, outgoing editor of the Textile Specialty Group Postprints, for making the transition so easy; and finally the authors, whose kind words of support have made this such an enjoyable experience.



# WHEN PATCHING IS IMPRACTICAL: NONTRADITIONAL COMPENSATION FOR LOSS IN A QUILT

SUSAN R. SCHMALZ

**ABSTRACT**—Textile conservators are increasingly exploring nontraditional compensation techniques for loss. Alternatives to dyed-fabric inlays include a wide variety of hand-coloring methods on textile supports. This paper will focus on a treatment technique incorporating acrylic paint on crepeline, devised to visually reintegrate massive losses to a chintz border on a mid-nineteenth-century quilt. The quilt is from the collection of Hampton House, a National Historic Site in Maryland, inhabited for over two centuries by the illustrious Ridgely family. The numerous damages to the quilt border made traditional fabric inlays impractical. The treatment solution involved stabilizing the deteriorating brown chintz and concealing the exposed batting with painted crepeline overlays. Golden Artist's Colors acrylic paint was selected after numerous test swatches of paints, inks, and dyes were assessed for aesthetic appearance, ease of application, cost, reversibility, and stability in fluctuating heat and humidity. The effectiveness of this technique provides another valuable option to textile conservators.

## INTRODUCTION

Hampton House, the Georgian mansion which is the centerpiece of Hampton National Historic Site, just north of Baltimore, Maryland, has a notable collection of quilts. The estate was established by the Ridgely family in 1745. Members of the family lived there until 1979, when the National Park Service took over the administration. The park is unique because most of the

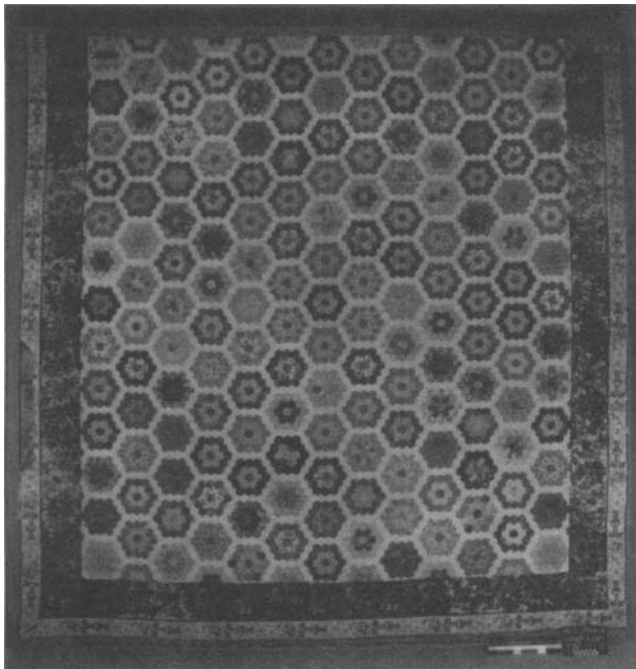


Fig. 1. Quilt before treatment. Photo by Susan Schmalz.

furnishings, including the quilts, have remained in the family and are now part of the permanent collection.

I surveyed a number of these quilts as an advanced intern with the National Park Service, Division of Conservation, Harpers Ferry Center. During the survey at the mansion, textile conservator Jane Merritt and I came across a very striking quilt with severe deterioration (Fig. 1). Like several others in the collection, it had areas of brown cotton that were actively deteriorating. This is a common ailment for historic cottons, due to the metal additives used to mordant the brown dyes. The losses in this quilt were concentrated within the border area, and this made it a good candidate for an experimental conservation treatment using painted compensation. Our goal was to develop a technique that would stabilize and visually reintegrate the losses on the quilt border. I drew from my many years as a practicing artist, working with paints on fabrics, and from my training in a painting conservation lab. The hand-coloring methods already used by textile conservators were also investigated. The technique described in this paper adds to the repertoire of compensation options for deteriorated, multilayered textiles, especially quilts.

## DESCRIPTION

This large pieced quilt, almost 10 feet by 10 feet, dates from the 1840s to 1860s. The central design, referred to as a “Grandmother’s Flower Garden” pattern, is surrounded on three sides

by a dark brown and white chintz border. The backing fabric is an unbleached muslin, and the filling is an unbleached cotton batting. The central panel of the quilt top is comprised of multi-colored hexagonal patches from a wide variety of plainweave, printed calico fabrics, mostly unglazed cottons, interspersed with a few glazed cottons. These are grouped into hexagonal flower-like cells defined by a white hexagonal grid.

The 11-inch-wide, block- or roller-printed, glazed chintz border consists of a brown and a white band, with chinoiserie-style floral, foliage, and urn motifs printed in red, blue, green, and yellow. A narrow brown band at the outer edge is turned over to the back to serve as a binding edge. The interior of each hexagonal patch is quilted with two concentric circles. The brown section of the border is quilted with elongated diamonds, and the white section with radiating "V"s.

#### CONDITION

The quilt, with the exception of the brown border, is generally in good condition (Fig. 2). The dyes have faded and yellowed very slightly over time, and there is overall light soiling on the front and back. The intact glazing on the chintz border indicates that the quilt has not been wet-cleaned. The white portion of the chintz border, and all of the fabrics in the central panel, are supple and strong, with the exception of a few brown patches.

The brown portion of the chintz border and the binding edge are in poor condition. The fabric is very brittle, as the destructive effect of the mordants used in the brown dyes have been accelerated by light exposure. Areas of the brown background have deteriorated completely around the designs printed in other colors, leaving exposed batting. The largest areas of damage are concentrated in distinct sections on the two side borders, and along the bottom edge by the bed posts. These borders received the greatest amount of light exposure from the large windows flanking the bed on which the quilt was regularly exhibited. There is a 31.5-inch-long and 2.5-inch-wide stain along the left edge of the quilt where the dye from the binding edge has bled into the white section of the border. The stain has permeated through to the back of the quilt.

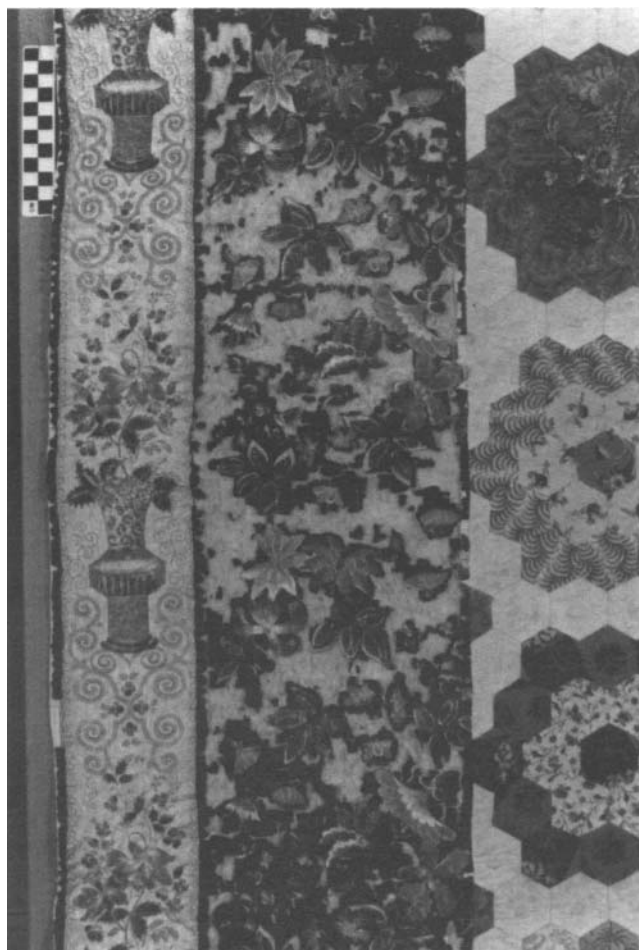


Fig. 2. Detail of quilt before treatment. Photo by Susan Schmalz.

In the past, the quilt was rotated onto display in the guest bedroom of the house during the winter (when the light came in at a low angle through the south-facing windows). During the rest of the year, it was folded and stored along with others in a large wardrobe in the master bedroom. The house is not climate controlled. Shutters on the windows were kept closed, except during hours of public visitation and cleaning.

#### TREATMENT GOALS

The most pressing need was to stabilize the quilt border, because fabric and batting were actively falling off. For this, the traditional conservation solution of sheer overlays was considered. However, the white batting would still be visually disturbing. We wanted to go one step further and aesthetically reintegrate the areas of loss. How could this be done on a sheer, open-weave support? Traditional fabric infills would be difficult to apply to the complex areas of loss, and

not necessarily produce visually acceptable results. A paint medium appeared to be a good solution for several reasons. As a liquid, it was easily applied to conform to any configuration; color mixing and matching were easy; and it would dry to form a continuous film. Most textile conservators probably consider painted compensation highly unconventional, but after reviewing the options available, we decided that this was the best treatment for this particular object.

#### MATERIALS CONSIDERED

Developing the technique began with a literature search, consultations with textile and painting conservators and conservation scientists, and much practical experimentation with materials. Silk crepe-line and Stabiltex were considered as support fabrics. Nylon net was rejected because of its open structure and its aging problems. The challenge was to find a paint that could be applied to the sheer fabric and have all the desirable qualities. We wanted a water-based material of low toxicity, with nondestructive off-gassing products. It had to be easy to apply, dry relatively quickly, bind the pigment well, and form a continuous, nontacky film. We were not concerned with washability, because the quilt was not to be washed, and lightfastness wasn't a great concern because the quilt would be kept in dark storage most of the time.

The colorants tested were fabric paints, airbrush colors, three different brands of acrylic paints, and many other clear media that are added to paint to change its properties. These media include gels, molding pastes, extenders, and drying media, all of which alter the working properties, drying speed, and film hardness of the paint. Gloss and matte media, and polymer varnishes, effect the paint sheen when it dries. The thirty-nine water-based materials tested were:

Jones Tones Fabric Paint  
Dr. Ph. Martin's Spectralite Airbrush Color  
Jacquard Textile Color  
DEKA Permanent Fabric Paints  
Versatex Textile Paints  
Versatex Airbrush Ink  
Versatex Binder  
Versatex Extender  
Lascaux Products Permanent Brown Acrylic Paint  
Thickener HV  
Acrylic Emulsion D 498-M  
Matting Agent

Acrylic Transparent Varnish 575—Gloss  
Acrylic Transparent Varnish 575—Matte  
Impasto Gel Medium—Gloss  
Impasto Gel Medium—Matte  
Lascaux Medium—Gloss  
Lascaux Medium—Matte  
Lascaux Medium—Satin  
Liquitex Products: Paint—Burnt Umber  
Liquitex Gloss Medium Varnish  
Golden Artist's Colors Products:  
Burnt Umber Acrylic Paint (Heavy Body)  
Burnt Umber Light Acrylic Paint (Heavy Body)  
Yellow Ochre Light Acrylic Paint (Heavy Body)  
Polymer Medium—Gloss  
Matte Medium  
Fluid Matte Medium  
Polymer Varnish—Gloss  
Polymer Varnish—Matte  
Polymer Varnish—Satin  
Molding Paste  
Regular Gel—Gloss  
Regular Gel—Matte  
Regular Gel—Semi-gloss  
GAC 100 (Universal Acrylic Polymer)  
GAC 200 (Increases Film Hardness)  
GAC 500 (Self Leveling)  
GAC 700 (Film Clarity)  
GAC 900 (For Clothing Artists)

#### MATERIALS TESTING

##### Physical Properties Test

The preliminary tests used to narrow the field of colorants and media involved brushing these products onto crepe-line and Stabiltex, and after drying, evaluating their handling properties. The acrylic media were applied straight and mixed 1:1 with acrylic paint. All the fabric paints and inks were quickly eliminated, due to heat-set requirements, their inability to form opaque continuous films, tackiness, and limited palette. The acrylic paints provided the desired qualities, including opacity, control, and minimal tackiness. Silk crepe-line was chosen as the final overlay material because it has less of a sheen than Stabiltex and because our lab is set up to dye it quickly.

##### Research into the Stability of Acrylic Paints

From the three acrylic paint lines, Golden Artist's Colors were selected over Lascaux and Liquitex. Golden offered the largest assortment of products; the staff had worked with conservators; their products had received high ratings from conservators; the prices were most reasonable; and the products were readily available. An



Fig. 3. Inpainting onto crepeline overlay. Photo by Susan Schmalz.

additional benefit for this project was the almost perfect color match between their Burnt Umber Light and the brown color in the quilt—it could be used straight from the tube. The advantages of this were: less mixing meant minimal color matching; not having to add a medium gave better opacity because pigment content was optimal; and the sheen was closest to that of a glazed textile covered with silk crepeline.

#### Further Testing of Golden Products

The second set of tests were performed using only the Golden Artist's Colors products. An attempt was made to duplicate conditions under which the quilt would be stored, and also to duplicate the conditions, in the rare event, should climate control break down. The quilt would be stored rolled and interleaved with acid-free tissue after conservation, in a climate-controlled outbuilding used for storage, rather than in the mansion as before. Small mock-ups that corresponded to the layered structure of the real quilt with painted overlays were constructed. These

were rolled on small tubes and placed in a biological isolation chamber. The heat was elevated as high as 114°F and the humidity as high as seventy-seven percent to determine if the paint film would develop enough tackiness to adhere to the batting. The results of these tests proved that Golden acrylic paint out of the tube was minimally, if at all, effected by increases in heat and humidity. Temperature reduction was not a significant concern, because extremely cold temperatures would be required to embrittle the paint, and it is unlikely that the quilt would encounter such low temperatures.

Further simple tests included bending for flexibility, and rubbing the samples against a white muslin to test for crocking. Scientists were consulted on the stability of the pigment and binder, and on the harmfulness of off-gassed products. After we were convinced that acrylic paints would do no harm to the quilt and could give the desired effect, I proceeded with the treatment.

## TREATMENT

Several yards of silk crepe-line were custom dyed to the desired brown. Approximately 36-inch-long strips were cut slightly wider than the width of the brown border; the excess would be trimmed after stitching. To prevent the cut edges of the crepe-line from fraying, they were taped onto a ruled cutting board with silicone-coated Mylar underneath. A thin line of dilute semi-gloss acrylic medium was brushed on. After drying (in about five minutes) the fabric was trimmed along this line.

The top edge of the crepe-line was sewn with two-ply silk-filament thread to the upper edge of the brown border. An interleaf of silicone-coated Mylar was placed between the crepe-line and the quilt, and pinned taut with a few insect pins through preexisting holes. The Mylar was extended well beyond the inpainting area to protect the quilt. The paint was misted with a little water to dilute it to a workable consistency and prevent it from drying too quickly.

As a source of ventilation, an exhaust trunk was poised above the area to be inpainted, because the technique involves working in close proximity to the paint. The acrylic was brushed onto the crepe-line in the areas where the batting showed (Fig. 3). One 3-foot length of crepe-line was completed at a time, and allowed to dry (about an hour with the exhaust trunk above it). A thin line of acrylic medium was applied to the bottom edge of the overlay, so that the edge could later be trimmed without fraying. The painted crepe-line was then peeled up from the silicone-coated Mylar, the Mylar removed, and the next section was set up.

After each of the three sides of the quilt was finished, the bottom edge of the crepe-line was stitched down with two-ply silk-filament thread, and trimmed. Once all three sides were painted and stitched down, it was decided that every third line of quilting in the border should receive a few stitches to make the crepe-line conform to the quilted texture, and make it less obvious. Care was taken to stitch only in preexisting holes. Although dry to the touch, the quilt was laid out flat for another two weeks to allow any slow evaporating additives in the paint to dissipate completely.

The final appearance of the quilt met with the expectations of the curator of Hampton House. The losses were effectively stabilized,

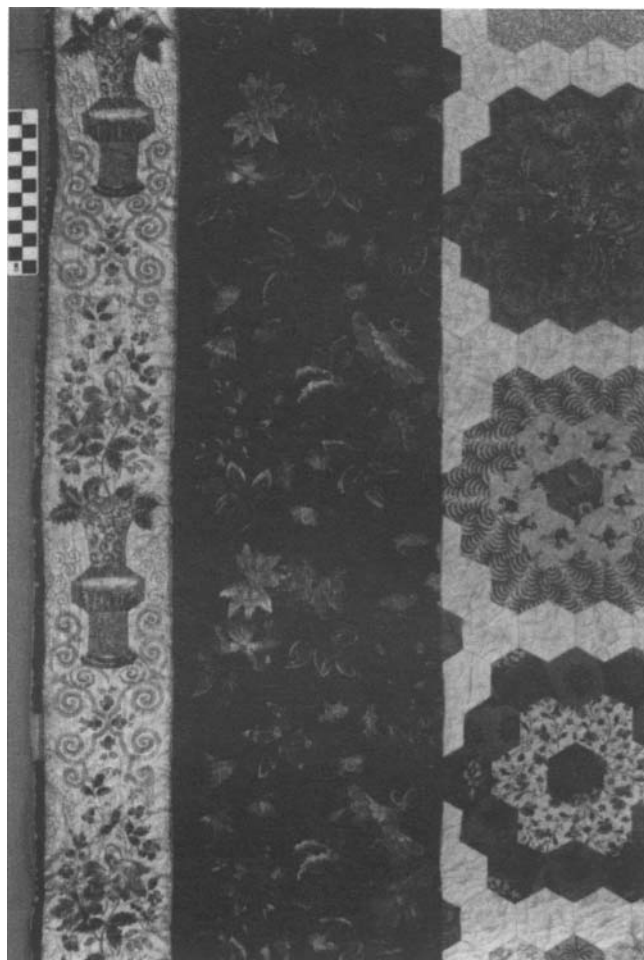


Fig. 4. Detail of quilt after treatment. Photo by Susan Schmalz.

concealed, and visually reintegrated. The brown border appears just slightly darker than before (Figs. 4, 5).

## PREPARATION FOR STORAGE

In preparation for storage, the quilt was rolled on a 6-inch-diameter tube that was first padded out with polyester batting and covered with washed cotton muslin. It was interleaved with unbuffered acid-free tissue, covered with an outer wrap of Nomex (a smooth, soft, nonwoven, fire-retardant, chemically inert aramid fiber product made by Dupont) and placed in a Marvelseal (an aluminized polyethylene and nylon barrier film) bag.

## CONCLUSION

The textile conservation staff of the Harpers Ferry Center, National Park Service, Division of Conservation felt confident with the treatment



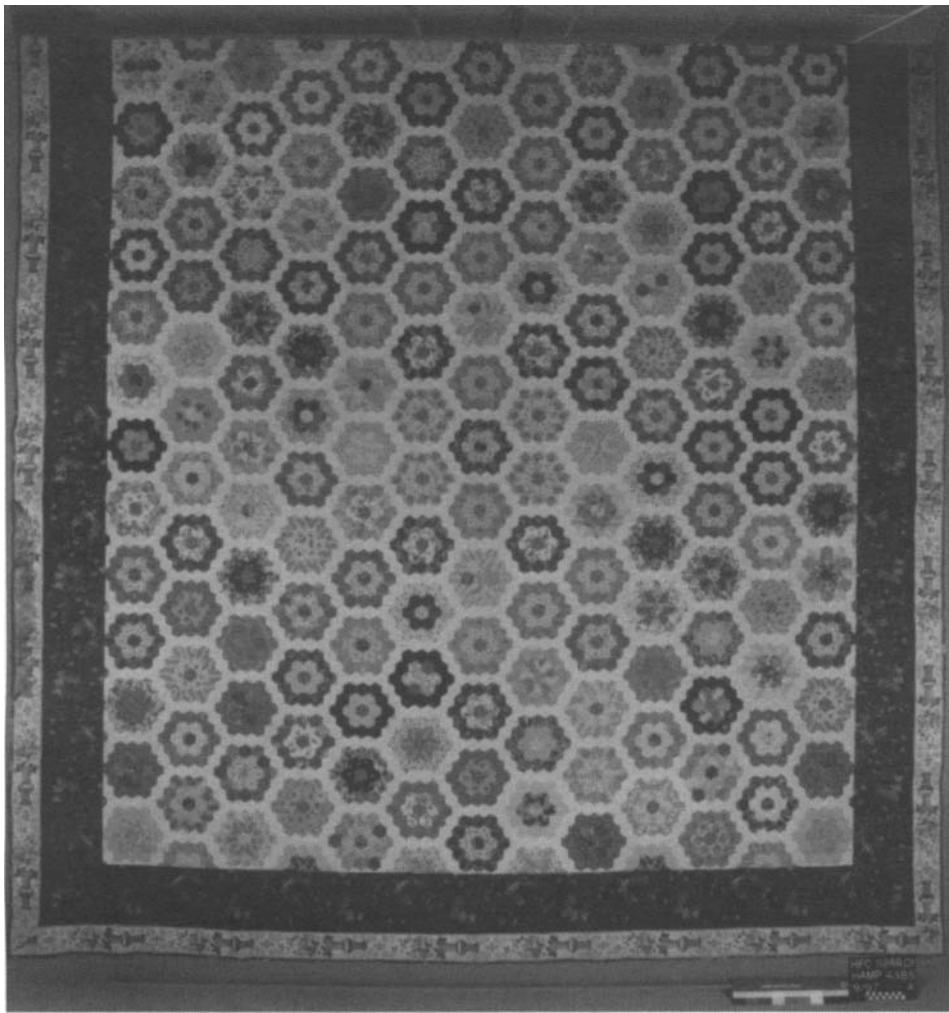


Fig. 5. Quilt after treatment. Photo by Susan Schmalz.

decision, because the park follows the detailed National Park Service Guidelines for collections care. From now on, the display of the quilt will be limited to rare occasions, and it will be stored in a climate-controlled outbuilding which is regularly monitored by park staff. It cannot be deaccessioned because it is site associated, and is expected to remain permanently in the collection of Hampton House and in the care of trained National Park Service staff. For future reference, this treatment can be monitored quite conveniently by a National Park Service textile conservator, because of the site's close proximity to the conservation facilities in Harpers Ferry, West Virginia.

#### ACKNOWLEDGMENTS

I would like to thank Jane Merritt, textile conservator at the National Park Service, Division of Conservation, Harpers Ferry Center, and Lynne Dakin Hastings, curator of Hampton

National Historic Site, for their support with this project. Additional thanks to Deby Bellman, museum specialist at the Division of Conservation, Harpers Ferry Center.

#### MATERIALS AND SUPPLIERS

DEKA Permanent Fabric Paints, Dr. Ph. Martin's Spectralite Airbrush Color, Jacquard Textile Color, Jones Tones Fabric Paint, Versatex Textile Paints, Versatex Airbrush Ink, Versatex Binder and Extender: Dharma Trading Co., P.O. Box 150916 San Rafael, CA 94915; 800-542-5227.

Golden, Lascaux, and Liquitex paints, media and product catalogues: New York Central Art Supply, 62 Third Avenue, New York, NY 10003; 800-950-6111.

Golden Artist's Colors information: Goldnart@norwich.net; <http://www.goldenpaints.com>.

#### REFERENCES

- Erlebacher, J. D., M. F. Mecklenburg, and C. S. Tumosa. 1992. The Mechanical Behavior of Artists' Acrylic Paints with Changing Temperature and Relative Humidity. *AIC Paintings Specialty Group Postprints, Twentieth Annual Meeting*, Buffalo, New York: 35-40.
- Gettens, R. J., and G. L. Stout. 1966. *Painting Materials—A Short Encyclopedia*. New York: Dover Publications, Inc.
- Hamm, J. 1997. Personal communication. State University College at Buffalo, Art Conservation Department, RH230, 1300 Elmwood Avenue, Buffalo, NY 14222.
- Hamm et al. 1993. The Discoloration of Acrylic Dispersion Media. In *Saving the Twentieth Century: The Conservation of Modern*

*Materials*, ed. D.W. Grattan. Canadian Conservation Institute. 381-392.

Hayes, J., B. Gavett, and M. Townsend. Personal communication. Golden Artist Colors, Inc., 188 Bell Road, New Berlin, NY 13411.

Horie, C. V. 1987. *Materials for Conservation*. Butterworth: London.

Kaldany, M., R. Sigurdardottir, and M. Berman. 1997. Compensation for Loss in Textiles Using Commercially Available and Easy to Use Artists' Coloring Materials: Evaluating Their Stability, Fiber Compatibility and Aesthetics. *AIC Textile Specialty Group Postprints*, Twenty-fifth Annual Meeting, San Diego, California: 63-78.

Varnell, C. 1991. Inpainting Textile Patches. *AIC Poster Session*, Nineteenth Annual Meeting. Albuquerque, New Mexico.

Vuori, J. 1995. Painting Irgalan Dyes Onto Silk Crepe. *Textile Conservation Newsletter* No. 28 (Spring). 5-6.

Whitmore, P. M. 1997. Personal communication. Carnegie Mellon University, 4400 Fifth Avenue, Pittsburgh, PA 15213.

Whitmore, P. M., and V. G. Colaluca. 1995. The Natural and Accelerated Aging of an Acrylic Artist's Medium. *Studies in Conservation* (40). 51-64.

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# INSECT INFESTATION: A LARGE TAPESTRY'S FUMIGATION AND STABILIZATION FOR STORAGE

BETSY GOULD

**ABSTRACT**—This paper discusses the treatment, stabilization, and long-term storage preparation for a very large wool tapestry that was damaged by an inappropriate display environment. The display environment allowed for extensive light damage and an infestation of casemaking clothes moths. The tapestry's core treatment consisted of fumigation by oxygen anoxia for the insect infestation, and stabilization for permanent storage, as the textile was not returned to its display site.

## INTRODUCTION

The tapestry, *E Pluribus Unum* by Marla Mallett, was commissioned under the General Services Administration's (GSA) Art-in-Architecture program. It was installed in 1979 at the Strom Thurmond Federal Courthouse, in Columbia, South Carolina. The uncontrolled environment of the Courthouse entrance, inappropriate for the safe housing and display of textiles, caused irreversible damage to the artwork, and provided a perfect breeding ground for a thorough infestation of casemaking clothes moths of the *Tinea* species. Due to its poor condition, the tapestry was taken down in 1991, and the GSA made a decision not to reinstall the textile, but to have it treated for its infestation, and stabilized for permanent storage in their new facility.

## DESCRIPTION

The tapestry is large—27 feet by 14 feet—and weighs 500 pounds. It is complexly constructed of wool and a coated rayon. Microscopic analysis identified the wool and rayon, but could not identify the coating. The tapestry consists of twelve separate panels, each about 18 inches to 20 inches wide. The panels are a hand-woven, weft-faced plain weave, which are connected together via bundles of the coated rayon fibers. The bundles of fibers are inserted and threaded through woven tunnels that connect them to the next panel. The tunnels are formed by a double-weave construction, where one plane separates to form a tunnel. The tunnels are woven with the same size weft as the ground, or with multiple wefts of different sizes, small to bulky, creating a textured appearance. They run edge to edge on the panel, or are split into two tunnel rows. There are nineteen tunnel rows between each panel, except one panel where there are eighteen. There are twenty-one

fiber bundles ranging from 35 inches to 420 inches long, and they are inserted through the panels in a varied pattern.

## GENERAL CONDITION

The textile has suffered considerable damage due to the combined effects of the inappropriate, uncontrolled display environment. It allowed overexposure to direct ultraviolet light, as the opposite window walls are unfiltered; to heat; to high relative humidity from the adjacent exterior doors; and to harmful insect infestation. Lack of periodic inspections of the textile, both while installed and in storage, lack of routine maintenance such as vacuuming, nonprofessional handling when the textile was deinstalled, and inappropriate storage in a maintenance workroom, have all contributed to the deterioration and degradation of the tapestry. The overall effects of such extreme conditions are lasting and irreversible, as they dry out, abrade, and permanently weaken the fibers, causing an overall fragility to the textile.

The tapestry was infested with casemaking clothes moths (Alpert 1997). The moths conceal themselves in dark areas, shun the light, and lay batches of eggs on their material of choice, in this case the wool tapestry. The larvae, which hatch from the eggs, spin a cocoon around themselves, leaving the front end open so that the body is encased while feeding, but it can use its jaws and legs. It then eats as it crosses the material, carrying its case, and leaving a trail of grazed textile and frass. The larva molts within the case, and when fully grown pupates within the cocoon. Eventually the adult moth, measuring about 7 to 9 mm, emerges to mate and lay eggs. The completed life cycle lasts anywhere from two months to four years, but average two generations per year (Pinniger 1994).

The evidence of the insect infestation, including large amounts of insect frass debris, white larva casings, and dead moths, was visible throughout the tapestry and fiber bundles on all surfaces, both front and back, especially burrowed inside the tunnel rows and through the top sleeve. A GSA maintenance report indicating the active infestation stated that in 1991, an insecticide, chlorophyrifors type Dursban\*4E (DowElanco), was applied to the front side of the artwork with a pump sprayer while the artwork was still hanging on the wall inside the Federal Courthouse.

#### TREATMENT PERFORMED

The scope of treatment was to stabilize the textile and ready it for long-term storage in the GSA's new Fine Arts Storage Facility. The treatment was broken down into six phases:

1. On-site documentation and disassembly
2. Shipment to fumigation site
3. Fumigation treatment
4. Shipment to Boston Art Conservation
5. Conservation treatment at Boston Art Conservation
6. Shipment to the permanent storage facility

#### PHASE ONE: ON-SITE DOCUMENTATION AND DISASSEMBLY PROCESS

Because of the insect infestation, the tapestry's sheer size, weight, fragility, and complexity, the initial phase of the conservation treatment was required to take place on site at the courthouse. The tapestry had been stored since 1991 in a basement maintenance and repair workroom of the GSA Office of Property Management. Upon our initial examination, the textile storage facility was revealed, and found to contain a vast array of supplies, from paints, varnishes, coatings, and solvents, to wood supplies and machinery, electrical equipment, and printing supplies. It was extremely dusty and dirty and very poorly ventilated, with solvent fumes hanging in the air—an inappropriate area for artwork storage, or as a conservation work site.

The 500-pound tapestry was found folded up, wrapped in very dusty polyethylene sheeting, and stored on the bottom of a metal shelving unit. The GSA maintenance staff removed the

textile from the shelving unit for us and unrolled the textile face-up on the polyethylene sheeting, which lay on the concrete floor. It was not possible to photograph the whole artwork, or whole panels in one frame, due to its size and lack of clearance around the piece.

#### Documentation

In addition to taking measurements, fiber samples for later analysis, and photographs, documentation included a written description of the tapestry's construction and assembly, as well as colored drawings—one highlighting the tunnel rows of the panels and the other highlighting the fiber bundles as they were threaded through the tunnel rows of the twelve panels. Because of the complexity of the construction, these drawings will be very important in assisting with the reassembly of the artwork at a future installation.

#### Condition of the Panels

All panels are hand sewn at the top to create a sleeve for the hanging device. When the tapestry was deinstalled in 1991, the top edges of all twelve panels were cut from the metal hanging unit, leaving those edges raw, exposing the warps, and unraveling the wefts (Franklin 1997). The bottom hems are finished with a twill tape, hand sewn to the panel. Ten panels have broken warps and unraveling wefts at the folded bottom edge as well, ranging from minor to extensive damage. Broken fiber fragments are found throughout the artwork on all surfaces. In the construction of the weft-faced weave, the disparity between the warp and weft in their twist, ply, weight, and tension, has caused the tapestry to be extremely weak and pull with gravity under its own weight. This is especially evident on the reverse, where the fiber bundles have added strain to the panel construction and caused broken and damaged warps in the ground behind the tunnel rows. As a result, the unsupported fiber bundles sag. Throughout the panels, the thick woven mohair tunnel rows are the weakest. The disparity between the weight of the warp and weft is most evident here, where they are separating and pulling apart.

#### Condition of the Fiber Bundles

The fiber bundles are made up of many individual strands of fibers, with a single strand encircling the fibers to create a bundle. They vary a bit in thickness and length. They are twisted, some together with one or two bundles,

then threaded through the tunnel rows. Some of the bundles' strands are pulling apart and are quite tangled. The fiber bundles were also infested with the moths, and suffered damage due to overexposure to light, which is noted by the blonde striations found through the fibers.

#### Light Damage

There has been extensive photochemical damage to the textile as a result of long and intensive exposure to light, both natural and incandescent/fluorescent. The light level readings I took at the display location ranged between 2,100 to 3,000 lux—50 is appropriate for textiles or objects specially sensitive to light (Thomson 1994). With exposure to light, the rate of degradation of an organic medium is high, and there can be significant shifts in color. These color shifts are not reversible. They are evident throughout the tapestry by comparing front to back, inside of the tunnel rows to the front, and where the fiber bundles covered the panel.

#### Disassembly

The two components of the tapestry, the woven panels and the threaded fiber bundles, were disassembled, allowing the textile to be more manageable for handling, vacuuming, shipping, fumigation, and storage purposes, and to lessen the possibility of further damage. After the vacuuming of several panels, the panels and fiber bundles were disconnected from each other in stages using the documentation drawings as reference guides. Each fiber bundle was unthreaded from the connecting panel and labeled with its appropriate number, then laid out, combed, and straightened as much as possible without untying the fiber encircling the strands to make the bundle. The panels and fiber bundles were wrapped individually for shipping in polyethylene sheeting to help insure against any possible insect migration while in transit. Twelve custom nonarchival corrugated boxes were used for transit to the fumigation site, during fumigation, and for transit to the studio. Each box held one panel and several fiber bundles.

#### PHASE TWO: SHIPMENT TO FUMIGATION SITE

The twelve boxes were shipped from the Courthouse to the Society for the Preservation of New England Antiquities (SPNEA). According to a GSA requirement, each shipping stage was done by Federal Express.

#### PHASE THREE: FUMIGATION TREATMENT

After considering several methods of fumigation, including freezing the tapestry on a refrigerated transport truck between South Carolina and Boston, the SPNEA fumigation bubble was chosen. It is a large 11-foot-square by 8-foot-high, gas-impermeable plastic bubble. It works by using carbon dioxide to deprive the insects of oxygen (Rattigan 1997). The combination of low oxygen and an increase in the carbon dioxide content of the treatment air, as well as an increase in temperature and a decrease in relative humidity from the ambient air, results in the highest mortality rate. This treatment kills all phases of the insect—egg, larva, and adult—without leaving behind chemical residues, and without subjecting the artwork to extremes of temperature (Florian 1997). The length of the fumigation cycle is about three weeks. The boxes did not have to be opened or the artwork unpacked for treatment.

#### PHASE FOUR: SHIPMENT TO CONSERVATION STUDIO

The twelve boxes were shipped by Federal Express from the SPNEA bubble site in Haverhill, Massachusetts to Boston Art Conservation.

#### PHASE FIVE: PREPARATION FOR LONG-TERM STORAGE

The panels and fiber bundles were unpacked from the nonarchival boxes and unwrapped from the polyethylene sheeting, both of which were discarded. The panels were thoroughly examined for any sign of live insects, which was not found, but there was a tremendous amount of frass and fiber shedding on all the panels. The panels and fiber bundles were thoroughly vacuumed for a second time. Netting was then sewn along the top edges of the panels where they had been cut and the wefts were unraveling.

It was a requirement by the GSA to be as conservative with the permanent storage space as possible, which eliminated flat storage options. Custom archival textile boxes of heavy, corrugated blue board measuring 22 inches by 42 inches by 8 inches, were made by the Hollinger Corporation. One panel was stored per box. Each panel was accorded into the box in four layers. The twenty-one fiber bundles were divided between six boxes, for a total of eighteen

storage boxes. The materials for packing the panels and fiber bundles were assembled:

- Custom archival storage boxes—42" × 22" × 8".
- Tunnel row padding—1" unfinished polyester batting cut into 22" × 18" squares.
- Tunnel row padding covers—washed unbleached muslin cut into 26" × 14" squares.
- Box liners—washed unbleached muslin cut into 65" × 80" pieces.
- Box separators—washed unbleached muslin cut into 27" × 47" pieces.
- Polyester batting cut to individual sizes for padding boxes.
- Cotton twill tape for tying muslin liners, padding, and panels together.
- Archival labels.

The polyester batting squares were tightly rolled, covered with the muslin, and inserted into the tunnel rows to provide support. The muslin box liners were laid into the boxes, then panels were accorded into four layers into the boxes, with the tunnel row padding supporting the layers. The accorded panels all ended with the top-reverse side up. The labels were placed between layers of netting, which were stitched around the label to hold it in place. One panel was stored per box.

The fiber bundles were layered into the boxes with a muslin separator between each bundle. There are two to five bundles per box, depending on the length and weight of the bundle. Each bundle was labeled. To fill out the boxes and add additional support where needed, the sides of the boxes were packed with polyester batting covered with washed muslin. The muslin box liners and padding were tied up into a package to prevent the panels and the fiber bundles from sliding and shifting while in transit.

#### PHASE SIX: SHIP TO GSA STORAGE FACILITY

The eighteen archival boxes were slipped into nonarchival corrugated boxes for protection

during shipping by Fed-Ex to the new GSA storage facility in Alexandria, Va.

#### CONCLUSION

The fumigation by oxygen anoxia was very successful, especially for such a large and complex textile. The bubble allowed the piece to be fumigated in one cycle, it left behind no chemical residue, and it did not subject the artwork to extremes of temperature such as heat or freezing, which the tapestry should not be exposed to because of the extensive damage it had already sustained.

#### REFERENCES

- Alpert, G. 1997. Personal communication. Entomologist, Harvard University, Cambridge, Massachusetts.
- Florian, M. 1997. *Heritage Eaters: Insects & Fungi in Heritage Collections*. London: James & James.
- Franklin, J. 1997. Personal communication. Director, General Services Administration maintenance staff, Strom Thurmond Federal Courthouse, Columbia, South Carolina.
- General Services Administration. 1991. Maintenance Report, Strom Thurmond Federal Courthouse, Columbia, South Carolina.
- Pinniger, D. 1994. *Insect Pests in Museums*. London: Archetype.
- Rattigan, G. 1997. Personal communication. The Society for the Preservation of New England Antiquities, Haverhill, Massachusetts.
- Thomson, G. 1994. *The Museum Environment*. London: Butterworth.

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# UP ON THE ROOF: LIGHT BLEACHING OF LARGE TEXTILES, TWO CASE STUDIES

JOY GARDINER AND JOANNE HACKETT

**ABSTRACT**—The use of daylight to bleach textiles is a well-known traditional method. Using aqueous light bleaching for historic artifacts of paper has been extensively documented in the paper conservation literature. However, in the textile conservation literature there is little discussion of the use of light bleaching for textile artifacts. This paper will present two case studies in which aqueous light bleaching was chosen as the treatment option for two severely discolored quilts. The discussion will include: the pros and cons of bleaching historic textile objects and the rationale for this option over more widely used bleaching methods; a brief review of the mechanism of light bleaching and what was learned from the paper conservation literature; and how the bleaching was carried out—on the roof of the Research Building at the Winterthur Museum.

## INTRODUCTION

This paper presents two case studies in which, after careful consideration, it was decided to light bleach large textile objects. Both of these objects in the collection of the Winterthur Museum had severe aesthetic problems that wet-cleaning did not rectify.

The use of light to bleach textiles is a method that has been used for centuries. The repeated sequence of scouring with an alkali, souring with an acid, then bleaching in the sun, is believed to have originated before the 1st century AD (Easton 1971, 3). During the height of the bleaching fields in Haarlem (16th to mid-18th centuries), in addition to being laid out on the grass and being oxidized, the linen was “was never allowed to dry altogether, but was constantly sprayed during the day by means of watering-cans or long narrow shovels, while remaining exposed to the dew at night” (Driessen 1944, 1733). In effect, this made the procedure an aqueous one.

As bleaching was such an important part of the processing of many textiles, there are certain expectations of just how white a textile object should appear. At times, the yellowing and greying of degradation products and soiling plus prominent staining is found to be too much to visually bear as “patina”. In this state it may be felt that the piece cannot be properly interpreted.

Bleaching has been a treatment option for undyed cellulosic fiber that has been used with caution by textile conservators for many years. Since Poot's study and publication in 1964,

much of the bleaching has been carried out using stabilized hydrogen peroxide, an oxidative bleach. In recent years, little has been written about textile conservation bleaching. There has been concern about the long-term detrimental effects of these treatments. Bleaching is a chemical reaction in which the breaking and reforming of bonds occurs. The question of whether this is just a short term “cosmetic” fix that will be subject to color reversion, is also of concern.

Aqueous light bleaching was chosen over more traditional chemical bleaches, such as stabilized hydrogen peroxide (oxidative) or sodium borohydride (reductive). It was felt that the required degree of lightening could be achieved without the extensive use of these chemicals. With light bleaching, it is relatively easy to stop the procedure by simply blocking the light source. Where the bleaching occurs can be greatly controlled, and there is no worry of seepage from capillary action. The color, unlike the bright white that can occur with peroxide bleaching, is a creamy white. And finally, the extensive testing and literature from paper conservation indicates that this is a relatively safe, effective means for bleaching cellulose.

## LIGHT BLEACHING

The only mention of the use of light to bleach cellulosic textiles in conservation found by these authors is Annis and Reagan's article in which the use of sunlight to bleach dry samples was tested. In this study, the authors were getting promising results in visual improvement

and lack of acceleration of fiber degradation (Annis & Reagan 1979, 176).

In paper conservation, much has been written about this topic (see references) after Keyes introduced the idea of aqueous light bleaching for paper artifacts in 1980. Aqueous light bleaching has been used in numerous treatments of paper artifacts. Much of the literature discusses the effects of this procedure on 100 percent cotton fiber papers (Schaeffer et al. 1992) and therefore can be transferred to cellulosic textiles.

As in all bleaching, if one of the double bonds in the conjugated chain of the chromophore is attacked, the conjugation will be broken and the compound will become colorless (Crafts Council 1983, 115). These colorless products may or may not be removed depending on the details of the treatment procedures, and on whether the products are still covalently bound to polymeric material (Burgess 1988 in Schaeffer et al. 1992). The bleaching reaction begins when the light energy is absorbed by a chromophore, which converts to a reactive peroxide or free radical (Phillips 1985 cited in Schaeffer et al. 1992). Either of these products react to cause a chemical change, usually an oxidative process. This makes light bleaching mechanically similar to chemical bleaching, but without the chemicals that need to be added and then removed to stop the reaction (Schaeffer et al.).

Placing the object in a water bath allows for the degradation products of the process to be rinsed away. This also provides a medium in which the pH can be raised. In Schaeffer et al.'s study done with modern 100 percent cotton paper, it was found that the pH of all of the papers fell with artificial aging (1992). The greatest decrease was found in those papers that were exposed to light while dry, as opposed to those that had been wet.

The raising of the pH of the bath or buffering has been found to improve the light bleaching of paper in various ways: it provides oxygen to assist the oxidation bleaching mechanism; it neutralizes acidic products as they are rinsed from the object; and there appears to be less color reversion in items light bleached in buffered solutions rather than in untreated water (Duhl and Baker 1986, Lepage and Perron 1985).

Studies have found that there was little effect on the tensile properties of cotton paper samples bleached by light as compared to pre-washing alone (van der Reyden et al. 1988). Annis and Reagan found no detrimental effects on the structure of the cotton fibers in textile samples with dry sun bleaching or hydrogen peroxide bleaching (1979).

#### Procedure

In aqueous light bleaching, a bath of water is prepared of a sufficient depth to cover the object. The pH of the water is usually raised to 7.5–8.0 (Dulh, Baker 1986, 5) often with calcium hydroxide or magnesium bicarbonate (Schaeffer et al. 1996). The object is placed in the bath and exposed to the light source, either daylight or an artificial source. A UV filter may be used, but this must be either placed above the bath to allow air circulation and prevent a raising of temperature from a greenhouse effect, or be placed under the water but not touching the object (Dulh, Baker). Cross linking of cellulose or its derivatives can be induced by light irradiation below 360 nm (Ranby and Rabek 1975 cited in van der Reyden 1988, 75).

Opaque paper templates can be used to limit the light exposure of certain areas of the object. These areas may either be light sensitive, or those that do not need bleaching. The bleaching is monitored and the object removed when a sufficient degree of lightening has been achieved. This usually occurs in the first two hours of the process (van der Reyden, 84). The amount of degradation products that are released into the water may require that the water be changed during the bath, and that the object be rinsed at the end of the procedure.

#### CASE STUDY I: A WHITEWORK QUILT

The first treatment to be discussed is of a large (120 inches by 101 inches) whitework quilt, 1825–1845, maker unknown (Fig. 1). This piece is well designed and shows very good craftsmanship. Unfortunately, the quilt was so visually uneven that the curator of textiles would not accept it as a donation unless there was a good possibility that it could be made presentable for exhibition.

The top is made from a fine, plain-woven white cotton, and the back from a coarser, plain-woven white cotton. The design has a central motif of a basket of flowers surrounded by a

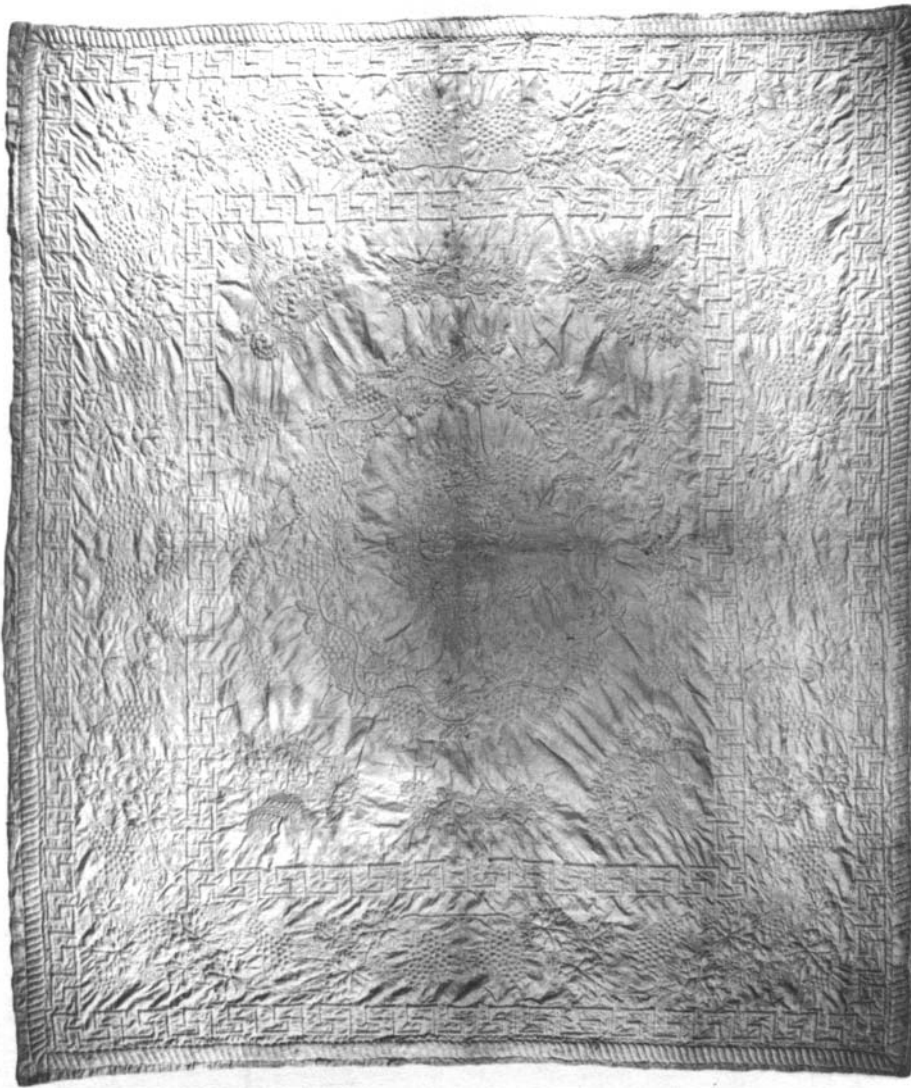


Fig. Quilt before light bleaching. Courtesy, Winterthur Museum.

serpentine wreath of grapes and leaves; a horn-of-plenty is in each corner surrounded by a rectangular Greek key band; the lower border consists of a larger band of grapes and leaves followed by the final, outside band of Greek key (Detailed Object Report—Winterthur Museum).

Structurally, the quilt was in good condition. The fabric appeared stable and not embrittled, but there were thirteen small tears on the face of the quilt, one larger area of damage at one corner, and two small areas where the seams had opened. Aesthetically, there was surface soiling and an overall yellowing and greying of the fabric. The surface soiling was especially evident in the fold lines and along all four edges. Tideline stains of varying sizes were found on much of the surface, as well as some foxing.

As this quilt was only being considered for acquisition if the discoloration and staining could be reduced, it was proposed that it be wet-cleaned. If the discoloration and staining were not sufficiently reduced, then a bleaching treatment would be considered. After cleaning the tears would be stabilized.

#### Wet Cleaning

The quilt was wet-cleaned by Vicki Cassman with the first year students in the Winterthur/University of Delaware Art Conservation Program as part of the textile block in 1989. The quilt was given four baths in deionized water with a 0.02 percent anionic surfactant solution of 50/50 Orvus WA Paste and Triton X-100. The piece was rinsed, blotted, placed on screens face up, covered with cheese cloth, and left to air dry. The drying was finished in the lab's drying chamber with air circulation only.

After the washing, the yellowing was significantly reduced, but the stains and

greying still remained. It was decided with the curator that an aqueous light bleaching treatment would be undertaken to make the visual condition acceptable for display. This treatment was carried out by Joy Gardiner with Margaret Fikioris. Gardiner had previous experience of light bleaching several small costume objects while a post-graduate intern at the Philadelphia Museum of Art.

#### Light Bleaching

On a clear day in late September of 1989, the treatment took place on the roof of the Research Building of the Winterthur Museum. This site was chosen as there was a large, flat space that was relatively undisturbed and received adequate sunlight. Also being situated on the level directly above the textile lab, hoses carrying

deionized water could be run up the stairs to the roof.

A 320-cm-square tank was formed from fifteen-cm-by-four-cm wooden supports, standing on edge. The corners of the planks were mitered and fastened together with hinges and pins. The tank was lined with a double layer of polyethylene sheeting.

Deionized water was drawn into the tank to a depth sufficient to cover the quilt. The pH of the water was raised with a saturated solution of calcium hydroxide to pH 8–8.5. The pH was measured with colorpHast(r) pH 6.5–10.0 indicator strips. The initial temperature was 29°C/82°F.

At noon the quilt was placed in the bath face up. There was overall exposure to the sun until 1:30 P.M. To diminish the mottled appearance of the quilt, templates of an opaque light-weight acid-free paper were torn to shape and placed over the lightest areas. As other areas lightened, they were also covered with the paper. By 2:30 P.M. all but the darkest spots were covered with the templates. The water appeared quite yellow from additional degradation products being removed. This water was partially siphoned off at 3:00 P.M. and the tank refilled with clean water.

Between 3:30 P.M. and 5:30 P.M. the treatment was completed. The final pH was 7–7.5 and the temperature was 28°C/81°F. The quilt had been lightened and the mottling evened out to a noticeable degree. The tank was drained by pulling two of the corner pins, dropping one of the side, and allowing the water to run onto the roof. After draining, the quilt was blotted with cotton mattress pads, rolled onto a tube, and carried down to the textile lab. It was spread out and partially draped on the racks in the drying cabinet, covered with a sheet, and left to dry.



Fig. 2. Quilt after light bleaching. Courtesy, Winterthur Museum.

The partial draping of the drying procedure allowed for the formation of tidelines. These were removed in a bath of deionized water in the wetcleaning tank in the textile lab at a later date. The quilt was air dried flat on screens, covered with a sheet. The areas of loss and tears were stabilized as needed with cotton thread and fabric. The wrinkles were reduced with localized ultrasonic humidification.

## Results

As had been noticed during treatment, the piece had a much more even appearance and was lighter to an acceptable degree (Fig. 2). No additional structural damage to the piece was noted as a result of the light-bleaching procedure. It was decided that the piece would be displayed in Winterthur's Philadelphia Empire Bedroom.

To concretely describe the change in the appearance and to monitor any future reversion, "before bleaching" readings had been taken with a Minolta Chroma Meter. Unfortunately, mechanical problems with the only available chroma meter prevented the readings being taken before the piece was needed for display.

## CASE STUDY II: A PIECED AND APPLIQUED QUILT

The quilt, comprised of polychrome pieced and appliquéd design on an off-white ground (Fig. 3), was made by Margaret Nichols of Delaware in 1813 for her sister Hannah on the occasion of Hannah's marriage to Jacob Pusey. Hannah died the following year giving birth to her first child, Samuel N. Pusey. The quilt descended in Samuel's family until it was acquired by the H. F. duPont Winterthur Museum in 1958 (Swan 1977).

The quilt has a central applied motif of three birds in a fanciful tree that sprouts many different types of flowers and leaves. The block-printed cottons used for the appliqué predate the quilt by several decades (Orlofsky and Orlofsky 1992). The tree and birds are applied to an off-white plain-weave cotton, quilted all over with a scallop pattern. The date "1813" and the initials "HN" are quilted into the background. The central panel is surrounded by five concentric borders of pieced triangles and applied flowers quilted with floral vines, scrolls and parallel lines. The outer border, which appears on three sides only, has an applied decoration of swags and bows quilted with a chevron pattern of parallel lines. Five different print fabrics and two off-white ground fabrics were used in the quilt.

As a Delaware-made textile with a known maker and date, the quilt was considered an important part of the Winterthur Museum collection and as such was due to be photographed and cataloged during 1997 for an upcoming publication of the Museum's quilt collection. However, the quilt was withdrawn from exhibition some years ago, and on examination prior to photography for the catalog, it became clear why. The ground textile was severely discolored, so much so that the quilt was not only

unexhibitable but was also too visually distorted to photograph for publication.

### Examination

Structurally, the quilt was in fair condition. Most of the fabrics were strong, with the exception of the dark brown areas in the block-printed floral cotton, which were brittle and showing signs of wear with small losses appearing throughout the quilt. Aesthetically, the quilt was in poor condition. There was extensive discoloration throughout the off-white ground fabric. There were also light stains and marks that appeared to have been caused by a liquid having spilled on the quilt, which had some kind of bleaching action. The reverse of the quilt was also discolored with a distinct cross-shaped stain through the center.

Curiously, there were clearly defined differences in the level of discoloration in various areas on the front of the quilt. In areas where two different ground fabrics had been pieced together in the same border, a clear delineation in the discoloration was seen. Various theories



Fig. 3. Quilt before light bleaching. Courtesy, Winterthur Museum.

were put forward to explain this difference in discoloration. One theory was that the dark brown dye from the block prints had run into the surrounding fabric and had been taken up differentially by the fabrics. Another theory was that there was some inherent difference in the ground fabrics, such as a glazing or finish that had deteriorated. Further examination was required before a treatment plan could be put forward.

The dyes in the printed fabrics were tested for fastness with deionized water and blotting paper. Dyes that proved fugitive were further tested with drops of two percent (w/v) acetic acid and two percent (w/v) aqueous ammonium hydroxide. Both the brown dye in the central tree appliqué, and the brown dye in the block printed floral cotton, proved to be fugitive in water and in both basic and acidic conditions. The areas of discoloration in the ground fabric were also tested with deionized water and with one percent (w/v) Orvus in deionized water. The discoloration transferred to the blotter a little, but not in an encouraging way.

The areas of dark brown dye, and areas of the discolored off-white ground fabrics, were analyzed for elemental information by X-ray fluorescence spectroscopy (XRF). The brown dye spectra showed a significant peak for iron, indicating the presence of an iron mordant. The off-white areas had very small peaks for iron, indicating its presence.

Very small samples (approximately 2 mm square) of the dark brown dye area of the floral print and a small sample of each of the off-white ground fabrics were taken in for analysis by scanning electron microscopy with elemental capabilities (SEM—EDX). This analysis was inconclusive.

The results of these tests, while showing that the brown dyes were indeed fugitive and prone to running when washed, did not prove that the discoloration in the off-white areas was displaced dye. One would have expected significant iron peaks in the off-white samples indicating the presence of the iron mordant. We came to the conclusion that the staining/discoloration was organic in nature, and was probably due to some inherent difference in the fabrics used to make the quilt.

The treatment proposal was to reduce the staining and discoloration on the quilt with the

least amount of treatment necessary. To this end, the quilt would be vacuumed and then wet-cleaned in the usual manner. It was felt that the movement of the somewhat-fugitive brown dyes could be controlled using a drying sheet (Francis 1992; Johnson-Dibb 1995). After drying, the quilt would be reevaluated to determine whether further treatment steps would be necessary.

If after wetcleaning, the quilt was still thought to be too discolored, it would be light bleached following a similar procedure used earlier in the treatment of the white quilt. This treatment was to be carried out by Joanne Hackett under the supervision of Linda Eaton and Joy Gardiner.

#### Wetcleaning

The quilt was vacuumed, back and front, through a screen. Covered with a layer of nylon net, the quilt was then laid face up in the wash tank. It was given three soaking baths with deionized water. The initial soaking water was extremely dark and acidic (pH 4.4).

The tank was drained and the surfactant solution of one percent (w/v) Orvus in deionized water was sponged onto the upper surface of the quilt. The sponging took thirty minutes, after which the tank was once again filled with water and the quilt was allowed to soak with the surfactant for an hour. The surfactant solution was then drained away and the quilt was thoroughly rinsed.

After rinsing, the quilt was blotted with towels and laid out on drying screens. The upper surface of the quilt was covered with a linen sheet in close contact. The quilt was allowed to dry before the drying sheet was removed and the results of washing evaluated.

Although the quilt was brighter and slightly less yellow/brown overall, the ground fabric was still considerably discolored, and if anything, the removal of the overall soiling made the contrast of the light and dark ground colors more noticeable. After consulting with the textile curator, the decision was made to go ahead with the light bleaching.

#### Further Testing Prior to Light Bleaching

Before light bleaching the quilt, a small facsimile quilt was made in order to test the procedure. A piece of naturally aged white cotton was chosen, and then cut up and pieced back

together to form two squares. Each square was formed from smaller pieces of cotton with a clear differences in color. A layer of cotton batting was placed between the two squares, and the whole was quilted together using cotton thread.

The facsimile quilt was placed in a shallow photo-developing tray, and a small square of blotting paper was placed in the center of the quilt covering a portion of each of the different-colored cotton pieces. Ten liters of deionized water was placed in the tray to cover the small quilt. Thirty ml of saturated calcium hydroxide had been added to the water ahead of time to raise the pH to 8.4. The tray and the quilt were then placed on the roof, in full sun, for four hours.

After light bleaching, the quilt was brought back inside, the blotting paper was removed, and the quilt was rinsed with deionized water. After drying, a distinct square of darker fabric could be seen in the center of the quilt where the blotter had been. The surrounding fabric had been lightened and the differences in color of the various pieces was lessened.

As very many paper templates would be needed to cover the printed fabrics in the pieced and appliquéd areas of the quilt, photocopying Mylar tracings of the pattern was suggested to speed the process. The relative light-blocking qualities of blotting paper and photocopy paper were tested under a variety of conditions. The papers were tested using a Yu Fung Digital Light Meter and an Elsec UV Monitor Type 762 in order to measure both the light-blocking properties of the papers, and the proportion of UV light transmitted (Table 1). The results of this experiment were somewhat surprising. While blotting

paper allows less light to pass through it than photocopy paper, the photocopy paper reduces the amount of UV light passing through it by a much greater extent. For example, in natural daylight, blotting paper allows 2140 lux of light to pass through, compared with 4050 lux for photocopy paper. However, photocopy paper allows only 70  $\mu\text{W}/\text{lm}$  (micro watts per lumen, or a ratio of the amount of UV present in light) of UV light to pass through compared to 325  $\mu\text{W}/\text{lm}$  (micro watts per meter squared, equivalent to the ultra violet light load) for blotting paper. This translates to a total load of 283500  $\mu\text{W}/\text{m}^2$  for the photocopy paper compared to 695500  $\mu\text{W}/\text{m}^2$  for the blotting paper. This is probably due to fillers in the photocopy paper, such as titanium dioxide.

As a result of this experiment, photocopy paper was used to mask the printed cottons on the surface of the quilt.

#### Light Bleaching

The quilt was laid face up on an examination table. Mylar film was laid over the upper surfaces of the quilt and the printed areas were traced using a Sharpie brand permanent marker. The Mylar was then cut into manageable pieces and photocopied onto standard photocopy paper. The photocopies were cut out and pinned to the quilt top with 000 size stainless steel insect pins.

A temporary wash tank was built on the roof of the research building at the Winterthur Museum. Sheets of Masonite board were used to provide a flat surface for the bottom of the tank. The tank previously discussed was reused and lined with a three m square polyethylene drop cloth.

		Natural Daylight	60 W. Incandescent	Fluorescent
<b>No Paper</b>	Lux.	122230	4470	809
	$\mu\text{W}/\text{lm}$	550	89	22
	$\mu\text{W}/\text{m}^2$	6726500	397830	17798
<b>Blotting Paper</b>	Lux.	2140	606	93.5
	$\mu\text{W}/\text{lm}$	325	40	11
	$\mu\text{W}/\text{m}^2$	695500	24240	1029
<b>Photocopy Paper</b>	Lux.	4050	1260	197.7

Table 1. The light-blocking properties of blotting paper and photocopy paper measured with a Yu Fung Digital Light Meter, and an Elsec UV Monitor Type UV meter.



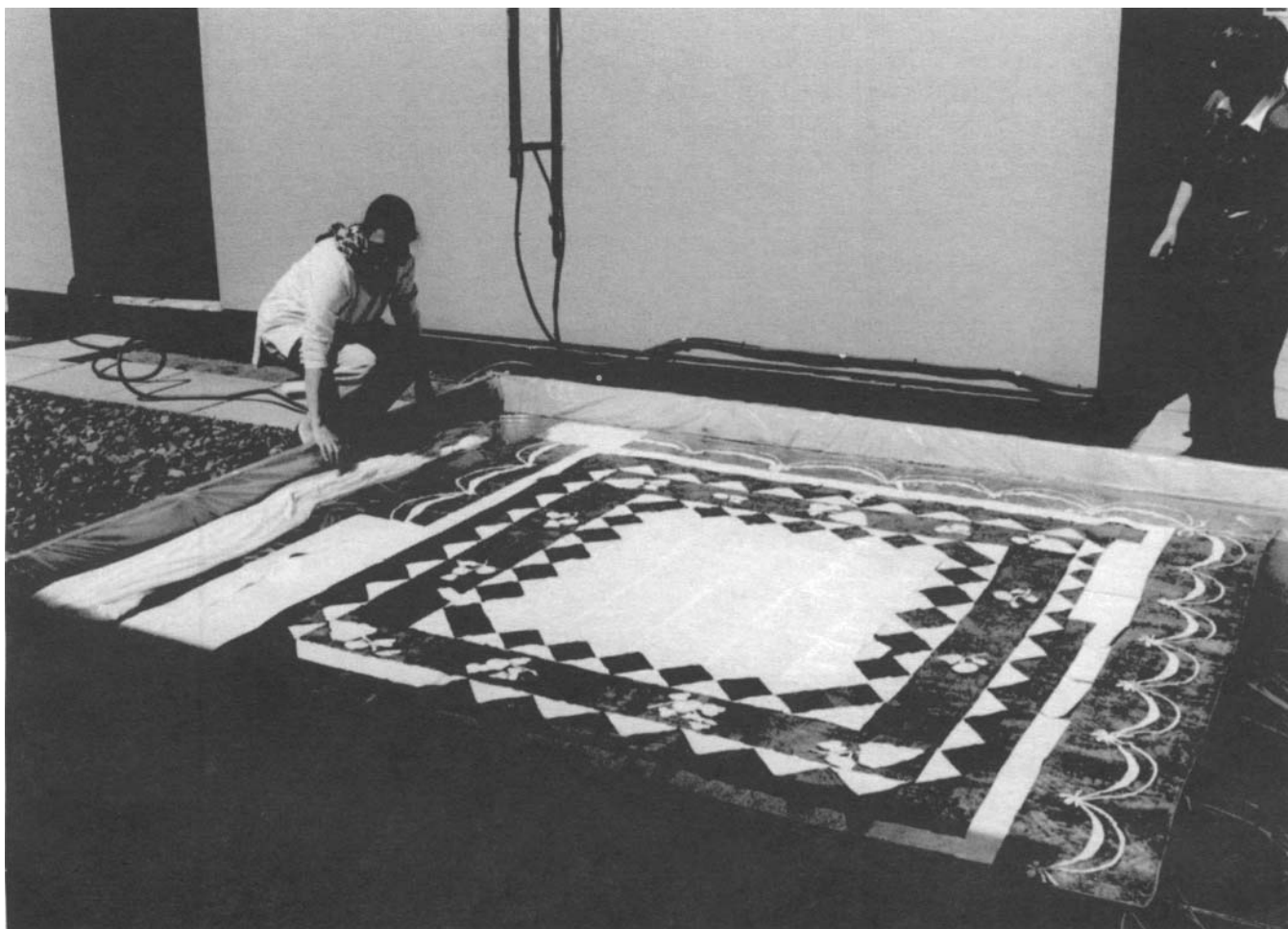


Fig. 4. Light bleaching up on the roof.

A garden hose was connected to the deionized water supply in the textile lab. Deionized water was flushed through the hose. The hose was then run up the stairs of the research building from the textile lab to the roof. The tank was filled with 367 l of deionized water, which was then buffered with 1.1 l of saturated calcium hydroxide to a pH of 8.4. The quilt was laid face up in the buffered water and floated into position in full sunlight (Fig. 4).

The topography of the roof allowed the full sun to fall upon the quilt from around 10:30 A.M. to 4:00 P.M. if the quilt was floated from one side of the tank to the other as the sun changed position during the day. The quilt was left in full sun until 3:30 P.M. when one corner of the tank was released and the buffered water was allowed to run out. The buffered water was considerably yellowed, and had dropped in pH to just below neutral. A slight warming of the solution was also noted, though this was not as much as had been expected. The tank was then

filled up with deionized water again and a slow running rinse was commenced. At this point the paper photocopies were removed from the quilt.

After rinsing, the quilt was drained and rolled onto a PVC pipe. The pipe and quilt were carried down to the textile laboratory and the quilt was unrolled onto drying screens. The quilt was blotted with towels.

After blotting, thin dark lines on the cotton were observed on the quilt. These lines appeared where the photocopy paper had been cut slightly too large, and the paper had overhung from the printed area onto the ground fabric. This fine lines were treated with a 3 percent hydrogen peroxide solution, applied with a fine sable paintbrush. The peroxide was left for ten minutes and then rinsed with deionized water applied with an eyedropper. The quilt was then covered with a drying sheet and left overnight.

		Pre-wash	Post-wash	Post-light bleach
<b>Sample a</b>	$l^*$	55.18	58.14	63.72
	$a^*$	+6.24	+5.24	+2.88
	$b^*$	+25.33	+22.24	+17.09
<b>Sample b</b>	$l^*$	54.80	55.69	66.79
	$a^*$	+6.23	+5.48	+2.55

Table 2. Minolta Chroma Meter reading of discoloration in the off-white cotton in the first concentric border.

Where  $l^*$  = the degree of brightness on a scale of 0 to 100.

Where  $a^*$  = the degree of green/red. Green from 0 to -60, red from 0 to +60.

Where  $b^*$  = the degree of blue/yellow. Blue from 0 to -60, yellow from 0 to +60.

## Results

After drying, the quilt was considerably lighter, and the contrast between the different off-white ground fabrics had been reduced. The areas of light-colored staining were also much less noticeable. The fine dark lines caused by the photocopy overlap were not very noticeable

when dry, and so no further treatment was done (Fig. 5).

In order to monitor the effectiveness of the wetcleaning and consequent light bleaching, the color of the discolored off-white cotton was measured before treatment, after wetcleaning, and after light bleaching, using a Minolta

Chroma Meter. A Mylar template was cut to fit into the diamond-shaped areas of off-white cotton in the first concentric border. Three holes were cut into the template the same size as the Chroma Meter head. Three spots in two sample areas were measured and the results averaged. This averaging was done to minimize the errors inherent in the colorimetry of textiles.

The weave structure of fabrics tends to scatter the light returning to the receptor in the Chroma Meter head, leading to inaccurate measurements. Here, the purpose of the Chroma Meter measurements was to monitor the change in the color after various stages of the treatment, and so the question of color accuracy was less crucial. The results of the colorimetry were significant (Table 2).

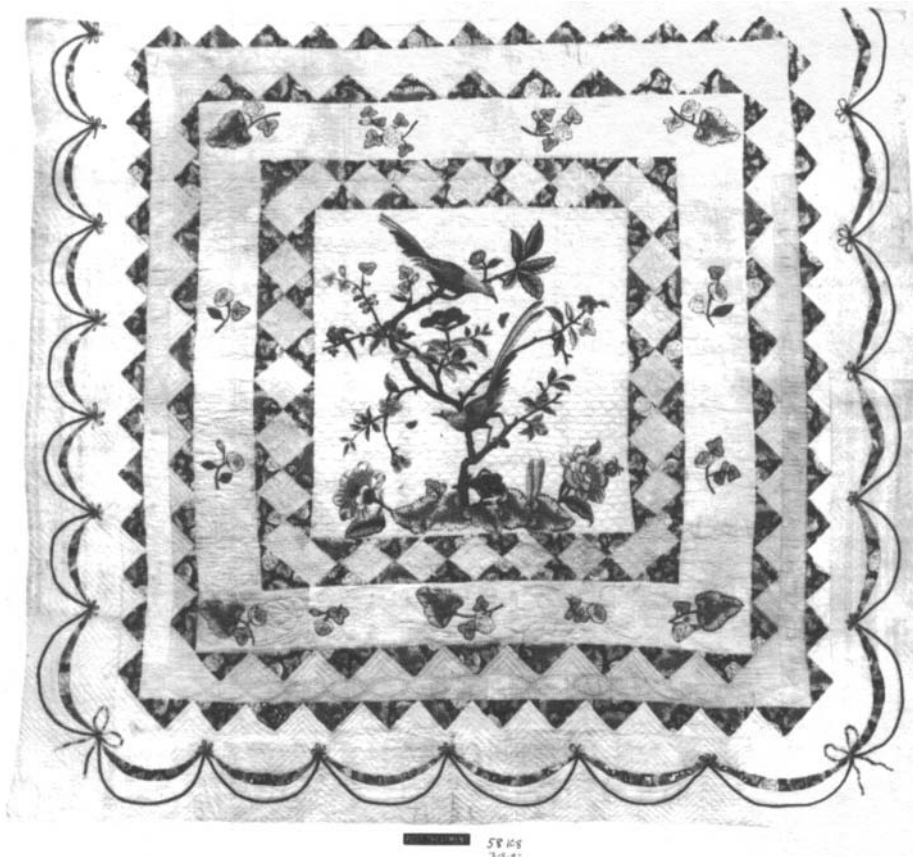


Fig. 5. Quilt after light bleaching. Courtesy, Winterthur Museum.

Summarized, the table shows how wet-cleaning alone did little to improve the brightness, or the degree of yellowing in the off-white fabric, but that light bleaching improved the brightness and reduced the yellowing significantly.

#### CONCLUSIONS

For these two textiles, aqueous light bleaching proved to be a successful, controllable treatment option. Both textiles were revived to a very good to excellent aesthetic condition. The resulting color of the bleached areas is a pleasing creamy white. Where the poor aesthetic condition of similar pieces required it, the authors feel that this would be a viable treatment option.

Much of the work that has been done on this topic in paper conservation can be translated to use in textile conservation. However, with large textiles, the possible challenges include protection from overhead birds—we were vigilant and lucky.

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#### REFERENCES

- Annis, Z., and B. M. Reagan. 1979. *Evaluation of Selected Bleaching Treatments Suitable for Historic White Cottons*. *Studies in Conservation* 24: 171–178.
- Baker, C. 1982. Practical Methods for Sun and Artificial Light Bleaching Paper. *AIC Book and Paper Group Postprints*, Tenth Annual Meeting, Milwaukee, Wisconsin: 14–15.
- Branchick, T. J., K. M. Keyes, and F. C. Tahk. 1982. A Study of the Bleaching of Naturally Aged Paper by Artificial and Natural Light. *AIC Preprints*, Tenth Annual Meeting, Milwaukee, Wisconsin: 29–39.
- Burgess, H. D. 1988. Practical Consideration for Conservation Bleaching. *JIIIC-CG* 13. 11–26.
- Crafts Council. 1984. *Science for Conservators, Book 2, Cleaning*. London: Crafts Council.
- Driessen, L. A. 1944. Linen Weaving and Linen Bleaching in Holland. *CIBA Review* 48 (May): 1733–1738.
- Duhl, S., and C. Baker. 1986. Considerations in Light Bleaching Art on Paper. *Paper Conservation News* 40: 5–6.
- Durovic, M., and J. Zelinger. 1993. Chemical Processes in the Bleaching of Paper in Library and Archival Collections. *Restaurator* 14: 78–101.
- Feller, R. L., S. B. Lee, and J. Bogaard. 1982. The Darkening and Bleaching of Paper by Various Wavelengths in the Visible and Ultraviolet. *AIC Book and Paper Group Postprints*, Tenth Annual Meeting, Milwaukee, Wisconsin: 64–80.
- Francis, K. 1992. Observations on the Drying Behavior of Textiles. *AIC Textiles Specialty Group Postprints*, Twenty-first Annual Meeting, Buffalo, New York: 1–6.
- Hofmann, C., D. van der Reyden, and M. Baker. 1991. Comparison and Evaluation of Bleaching Procedures: The Effect of Five Bleaching Methods on the Optical and Mechanical Properties of New and Aged Cotton Linter Paper Before and After Accelerated Aging. *The 1991 Book and Paper Group Annual*, AIC. 109–127.
- Johnson-Dibb, R. 1995. Contact Cleaning of Textiles. *AIC Textiles Specialty Group Postprints*, Twenty-third Annual Meeting, St. Paul, Minnesota: 35–37.
- Keyes, K. M. 1980. Alternatives to conventional methods of reducing discoloration in works of art on paper. In *Conservation of Library and Archive Materials and the Graphic Arts*, ed. G. Petherbridge. London: Butterworths. 49–55.
- \_\_\_\_\_. 1982. Alternatives to Conventional Methods of Reducing Discoloration in Works of Art on Paper. *AIC Book and Paper Group Postprints*, Tenth Annual Meeting, Milwaukee, Wisconsin: 98–102.

Lee, S. B., J. Bogaard, and R. L. Feller. 1989. Damaging Effects of Visible and Near-Ultraviolet Radiation on Paper. In *Historic Textile and Paper Materials II: Conservation and Characterization*, ed. S. Haig et al. The American Chemical Society.

\_\_\_\_\_. 1989. Darkening of Paper Following Exposure to Visible and Near-Ultraviolet radiation. *JAIC* 28.

Lepage, M., and J. Perron. 1985. Investigation of Some Aspects of the Light Bleaching of Paper. Student paper given at Art Conservation Training Programs Conference, Winterthur, Delaware. 54–68.

O'Conner, D., and H. Granger-Taylor. 1983. *Colour and the Calico Printer*. London: P. J. Henderson and Co.

Orlofsky, P., and M. Orlofsky. 1992. *Quilts in America*. Abbeville Press Inc.

Palmer Eldridge, B. 1982. A Sun Bleaching Project. *AIC Book and Paper Group Postprints*, Tenth Annual Meeting, Milwaukee, Wisconsin: 52–55.

Schaeffer, T. T., M. T. Baker, V. Blyth-Hill, and D. van der Reyden. 1992. Effects of Aqueous Light Bleaching on the Subsequent Aging of Paper. *JAIC* 31: 289–311.

Schaeffer, T. T., V. Blyth-Hill, and J. R. Druzik. 1996. Aqueous Light Bleaching of Paper: Comparison of Calcium Hydroxide and Magnesium Bicarbonate Bathing Solutions. *JAIC* 35: 219–238.

Swan, S. B. 1977. *Plain and Fancy: American Women and Their Needlework, 1700–1850*. Rutledge Books.

Trosper Schaeffer, T., D. van der Reyden, and M. Baker. 1991. Effect of Aging on an Aqueously Light Bleached, Mixed Pulp Paper. *The 1991 Book and Paper Annual*, AIC. 205–215.

Poot, A.H.A. 1965. Chemical Bleaching of Ancient Textiles. *1964 Delft Conference on the Conservation of Textiles, Collected Preprints*. 2nd ed. London: IIC. 53–64.

van der Reyden, D., M. Mecklenburg, M. Baker, and M. Hamill. 1988. Update on Current Research on Aqueous Light Bleaching at the

Conservation Analytical Laboratory. *The 1988 Book and Paper Group Annual*, AIC. 73–106.

#### SOURCE OF MATERIALS

Chroma meter: Minolta Chroma Meter CR-100/110 with a Minolta Data Processor DP-100. Minolta, 101 Williams Drive, Ramsey, NJ 07446.

UV meter: Elsec UV Monitor Type 762. Littlemore Scientific and Engineering Co., Railway Lane, Oxford, U.K.

Light meter: Yu Fung Digital Light Meter. Model YF-170.

Stainless steel insect pins: Wards Natural Science Establishment Inc., PO Box 1712, 300 Ridge Road East, Rochester, NY 14603.

Orvus WA Paste: Talas, 568 Broadway, New York, NY 10012; 212-219-0770

Calcium hydroxide and hydrogen peroxide: Fisher Scientific Co., 52 Fadem Road, Springfield, NJ 07081.

Mylar: Light Impressions, 439 Monroe Avenue, PO Box 940, Rochester, NY 14603-0940.

ColorpHast(r) pH indicator strips: Markson Lab Sales, P.O. Box 1359, Hillsboro, OR 97123-9981.

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# BOROHYDRIDE: AN ALTERNATIVE TO OXIDATIVE BLEACHING OF CELLULOSIC TEXTILES

SUSAN ADLER

**ABSTRACT**—Textile Conservators have long been reluctant to use bleaching agents, due to their detrimental effects on the fibers. The bleaching agents most often used in conservation are oxidizing agents, which can cause fiber damage. In contrast, borohydride bleaching removes degradation discoloration from aged cellulose, while helping to stabilize the cellulose fiber. Case studies of eight discolored cellulose objects treated with borohydride are described. These studies show that treatment with sodium borohydride gives consistent visual results, producing even, overall, mellow whitening of degraded cotton textiles. It has been shown effective in reducing a wide range of extraneous stains, and has little or no effect on the natural colorants in cotton and linen. Accelerated aging studies comparing sodium borohydride-treated samples to hydrogen peroxide-treated samples have indicated that color reversion occurs to a lesser degree in borohydride-treated samples. Results also suggest that the rate of discoloration of borohydride-treated textiles is comparable to the rate of discoloration in untreated textiles.

## INTRODUCTION

### Origin and Degradation Discoloration in Cellulose

The cellulose molecule is a long chain of repeating glucose units. The repeating ring structure produces very stable polymer chains. These chains do not branch, so that cellulose remains stable despite a high degree of polymerization. There are three alcohol (C-OH) groups on each ring of the chain, and it is these groups which provide the electrostatic forces which permit the chains to stack closely, forming cellulose fibrils. These alcohol groups, however, are among the principal targets for oxidation in the aging process. Incomplete oxidation results in the conversion of alcohol groups to carbonyl groups (-C=O). Further oxidation converts the group to the acid carboxyl group (-COOH). Since any of the three alcohol groups on each ring may be attacked, a variety of products may result—all loosely termed oxycelluloses. Oxidation may be initiated by atmospheric oxygen or by a number of chemical agents, and is accelerated by heat, and catalyzed by transition metals such as iron, cobalt, and manganese.

The carbonyl groups which result from partial oxidation of cellulose are the principal source of the yellow-brown color characteristic of cellulose degradation (Feller 1971, Burgess 1987). More importantly, these carbonyl groups cause a strain on other bonds in the molecule, making them vulnerable to breakage and weakening of the fiber (Block and Kim 1984, Nevell 1985, Singh 1986).

### Mechanism of Bleaching

Bleaching agents work by disrupting the molecular group responsible for color. In the case of cellulose degradation discoloration, this is the carbonyl group. Most traditional bleaching agents (chloramine-T, hypochlorite, perborate, hydrogen peroxide) are oxidizing agents which convert the carbonyl to an acid carboxyl group. Traditional reducing bleaches (sodium hydrosulfite, sodium bisulfite, sodium dithionite, and borohydride) act by reconvertng the carbonyl group to an alcohol, in essence reversing the oxidation process to a degree (Burgess 1988).

Textile conservators have long been reluctant to use bleaching agents, due to their detrimental effects on fibers. The chlorinated compounds frequently result in unstable compounds, which lead to color reversion and possible fiber damage (Feller 1971). Sulfur-containing bleaches (with the exception of sodium dithionite) have poor color stability, due to their inability to produce end-products that resist oxidation by atmospheric oxygen (Burgess 1988). Hydrogen peroxide has been the bleaching agent of choice for most textile conservators because it is effective and relatively mild. Nonetheless, it is an oxidizing agent with the incumbent dangers of any oxidizing agent for cellulose material (Nevell and Zeronian 1985). In addition, the molecular oxygen generated by hydrogen peroxide is itself damaging to cellulose under alkaline conditions (Taher 1975, Steinmiller 1976).

Sodium borohydride treatment of cellulose has a stabilizing effect. The conversion of carbonyl to alcohols relieves strain on molecular bonds, and improves stability of the molecule. Borohydride is a specific reducing agent and does not affect existing acid carboxyl groups on the molecule; it does, however, stabilize the carboxyl group through the alkaline sodium present in the process, and thereby inhibits the acid hydrolysis usually attributed to carboxyl groups (Nevell 1985). Several studies suggest that cellulose reduced through treatment with borohydride is resistant to hydrolysis, oxidation, and damage from near UV radiation (Block and Kim 1984, Nevell 1985, Block and Roy 1987).

#### Effect on Natural Colorants

Processed cotton is the purest form of cellulose known in nature, being nearly ninety-nine percent cellulose. Natural color in cotton is dictated by genetics. It has been suggested that the coloring matter is present in a complexed state as waxes and organic pigments (Steinmiller 1976). Linen contains between sixty-five percent and eighty-nine percent cellulose, the actual content being dependent on the conditions of growth and processing (Poot 1964). Other components of linen include hemicelluloses, pectic substances, and lignin; it is these components that provide the natural colorant in linen. While oxidizing agents affect these natural colorants, borohydride is a mild and selective reducing agent which has little or no effect on the natural colorant.

#### Working Properties of Sodium Borohydride

Borohydride must be delivered to the bleach bath as a salt. Paper conservators have traditionally used ammonium borohydride and potassium borohydride as well as sodium borohydride. The large bath volumes used by textile conservators make sodium borohydride the most practical borohydride salt to use. When discussing the mechanism of borohydride in general in this paper, the term "borohydride" alone is used. When discussing a treatment or procedure where a particular salt was used, the salt is specified (sodium borohydride in the case of the studies reported in this paper).

Borohydride releases hydrogen gas as it decomposes, a process which is greatly accelerated by the presence of acid. Borohydride reacts violently with strong oxidizing agents. These characteristics cause it to be regarded as a hazardous material when used in large quantities, as

it is for industrial purposes. In the small quantities and controlled conditions in which it is used in the laboratory, however, it is benign. It should be stored tightly closed and kept dry. It should be opened under adequate ventilation. Borohydride is a skin irritant and care should be taken during its use (Morton International, Inc.). For the bleaching treatments described here, dilute solutions are used, and normal precautions have proved adequate.

Sodium borohydride is readily available as a white crystalline powder, which dissolves easily in water at room temperature. It self-buffers at pH 9. During borohydride treatment of a textile, hydrogen is continuously evolved, and appears as a thin layer of bubbles which must be moved away from the textile in order to allow optimum access of the chemical to the fiber. This can be easily done by gentle agitation, or by brushing bubbles aside with a glass rod.

The borohydride bleaching process is slow, generally requiring two to four hours. This allows close monitoring of the process, and fine tuning of the degree of bleaching.

#### CASE STUDIES

Eight objects showing degradation discoloration were treated with sodium borohydride.

#### Procedures

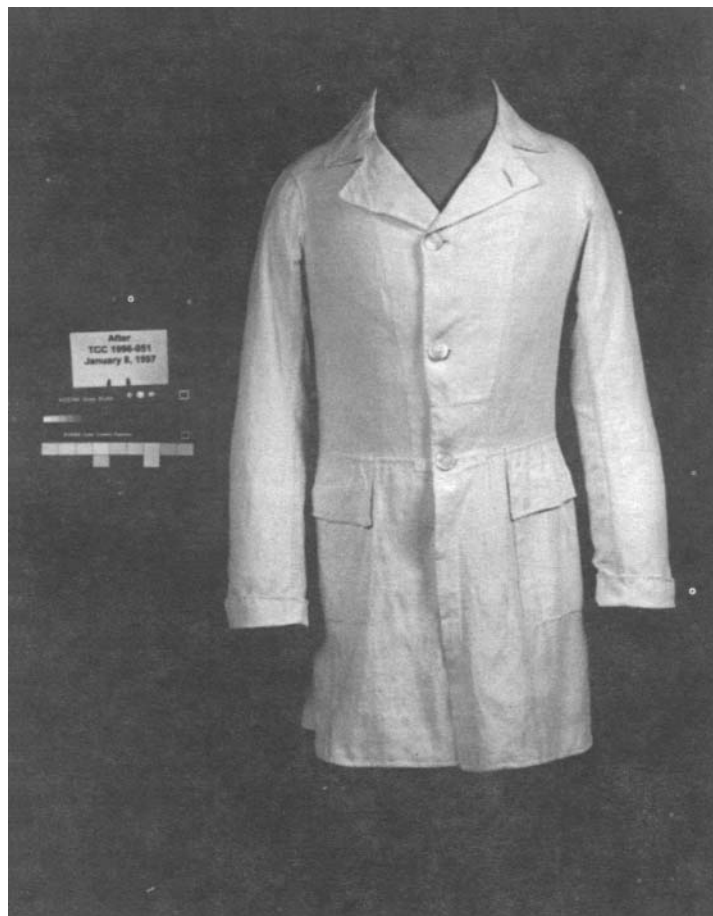
The following bleaching procedure was adapted from that used at the National Museum of Denmark (Ringgaard):

1. The textile was surface cleaned.
2. The textile was wetcleaned with anionic surfactant and deionized water, and was thoroughly rinsed, with the final rinse made alkaline (pH 8) with ammonia.
3. The textile was introduced into 0.1 percent sodium borohydride solution, at a bath ratio of 40 ml:1 g of fabric.
4. The textile was allowed to soak for three hours, with periodic dispersal of hydrogen bubbles.
5. The textile was rinsed thoroughly and dried in an appropriate manner.

Table 1. Summary of Treatments with Sodium Borohydride.

Object	Staining	Treatment Variation	Treatment Results
Linen fichu	Overall degradation discoloration. Small medium-brown stains. Blackish soiling in rectangular pattern.		Wetcleaning removed most of degradation discoloration. Borohydride removed remaining discoloration. Significantly reduced but did not eliminate stains.
Cotton undersleeves; faded ink signature on one sleeve	Overall degradation discoloration. Small brown, liquid-based stains. Small black streaky stains. Scattered corrosion-type stains.		Wetcleaning removed much of the degradation discoloration. Borohydride removed remaining discoloration; significantly reduced stains. Signature is clearer and brighter.
Cotton undersleeves with linen trim	Overall degradation discoloration. Assorted brown stains of unknown origin. Scattered pinpoint corrosion-type stains. Random small greenish streaks.		Overall mellow white appearance. Brown stains significantly reduced. Greenish streaks remain but appear bluer.
Cotton fichu with cotton embroidery	Overall uneven degradation discoloration. Two medium-brown liquid-based stains.		Even, overall mellow white. Stains significantly reduced.
Man's linen frock coat	Uneven degradation discoloration following crease pattern. Scattered corrosion-type stains.	Buttons removed before cleaning	Even, overall mellow white appearance. Stains significantly reduced.
Linen towel (39" x 21")	Overall degradation discoloration. Corrosion-type stains in center and proper right.	Bath ratio 38 ml:1 g fabric	Overall mellow white appearance. All stains reduced
Tablecloth. Cotton warp, linen weft. (58" x 66")	Overall degradation discoloration, more severe along fold lines. Scattered brown stains.	Bath ratio 38.5 ml:1 g fabric	Wetcleaning removed much of degradation discoloration. Borohydride further reduced yellowing and stains.
Eighteenth-century linen shirt.	Severe overall degradation discoloration. Tideline staining. Heavy corrosion-type staining. Foxing (positive test for iron)	No alkaline rinse.  4 1/2 hours soak time in borohydride solution.	Degradation discoloration removed. All stains significantly reduced. Overall mellow white color.



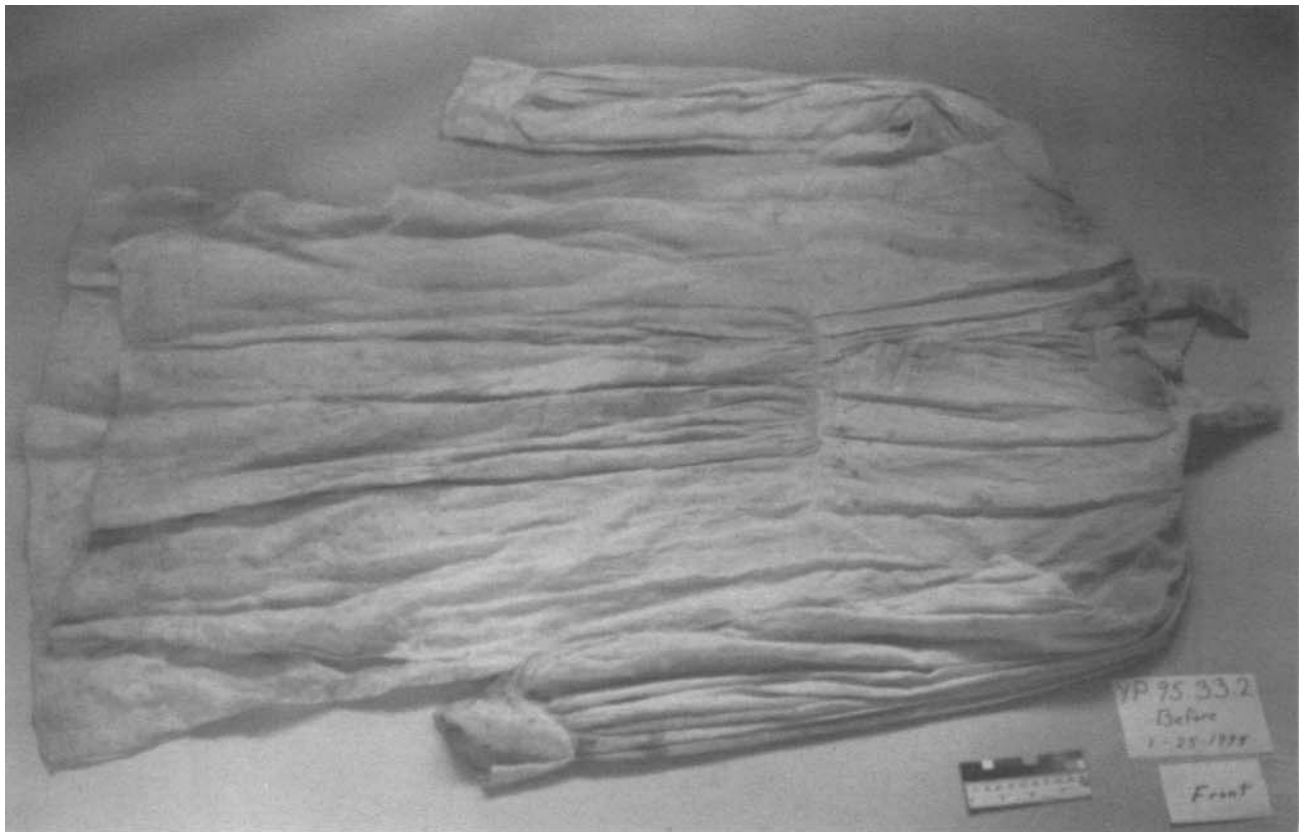


Above: Fig. 1. Man's linen frock coat, before treatment. Photo courtesy of the American Textile History Museum, Lowell, Massachusetts

Left: Fig. 2. Man's linen frock coat, after wet-cleaning and treatment with sodium borohydride. Photo courtesy of the American Textile History Museum, Lowell, Massachusetts.

Opposite above: Fig. 3. Eighteenth-century linen shirt, before treatment. Photo by permission of the Jamestown Yorktown Educational Trust, Jamestown, Virginia.

Opposite right: Fig. 4. Eighteenth-century linen shirt, after wetcleaning and treatment with sodium borohydride. Photo by permission of the Jamestown Yorktown Educational Trust, Jamestown, Virginia.



## Summary of Treatment Results

Table 1 gives an overview of the objects treated, the types of discoloration present, and the results observed after borohydride treatment.

In each of the eight case studies, Borohydride was extremely effective against degradation discoloration, resulting in an even, overall mellow white coloring (Figs. 1, 2). As a mild and selective reducing agent, borohydride would be expected to be less effective against extraneous stains than an oxidizing bleach. It proved, however, to be effective in reducing a wide range of stains. This is particularly well illustrated by the results of borohydride treatment on a late-eighteenth-century shirt that was heavily stained. The stains included corrosion stains that tested positive for iron content. Borohydride succeeded in reducing all stains on this shirt significantly, although it did not remove them entirely (Figs. 3, 4).

Of particular interest was the ink signature on one of the cotton undersleeves that was treated. The signature was somewhat brown and faded. The stability of the ink was pretested using a minute quantity of borohydride solution applied and monitored under a microscope to insure the signature's safety. Pretesting suggested that the signature would actually be enhanced by the borohydride, and subsequent treatment proved this to be true.

## COLOR REVERSION STUDY

In order to gain some indication of the long-term stability of the bleaching effect of borohydride, accelerated aging tests were undertaken on borohydride-treated swatches, with hydrogen peroxide-bleached swatches aged for purposes of comparison.

### Sample Sources

Because aged cellulose has very different properties from new cellulose, naturally aged textiles were selected as test sample sources. These included:

a) A cotton curtain lining which had been exposed at a sunny window for seven years, and had then been stored in conditions of extreme humidity and temperature fluctuation for twenty-five years (Cotton B—Fig. 5).

b) A cotton curtain lining exposed at a sunny window for an undetermined number of years, and then stored in conditions of extreme humidity and temperature fluctuation for thirty-two years (Cotton W—Fig. 6).

c) A portion of linen curtain lining of unknown history but showing degradation discoloration, supplied through the generosity of the Winterthur Museum Textile Conservation Department. This sample was of particular interest for the opportunity it afforded to observe the effect of bleaching on natural colorant (Linen—Fig. 7).

An iodine test for sizing proved negative for all three sources.

### Protocol

The study consisted of four sample groups. Each group consisted of three swatches from each sample source, making a total of nine sample swatches in each group.

- Group 1: Controls—no bleaching treatment, no aging.
- Group 2: Bleached with hydrogen peroxide and aged.
- Group 3: Treated with sodium borohydride and aged.
- Group 4: Left untreated but aged.

Color measurements were made of all study swatches at three points in the study: (a) after washing, (b) after bleaching procedures, and (c) after aging.

### Washing Procedure

Each test sample was washed in anionic surfactant and rinsed thoroughly using distilled water. The samples were then cut into 2-inch-square swatches and each swatch was labeled with a number stitched into the lower proper-right corner using white thread. From this point on, the swatches were randomized for each step of the study.

### Bleaching Procedure

A. Hydrogen peroxide bleaching. A stock bleach solution was prepared using 20 g sodium metasilicate anhydrous, 12 g sodium carbonate anhydrous, and 100 ml 35 percent hydrogen peroxide, brought to 1 l with distilled water. The

Fig. 5. CIE whiteness scale: value shifts on samples from Cotton B. (a) control samples, (b) peroxide-treated samples, (c) borohydride-treated samples, (d) untreated, aged samples.

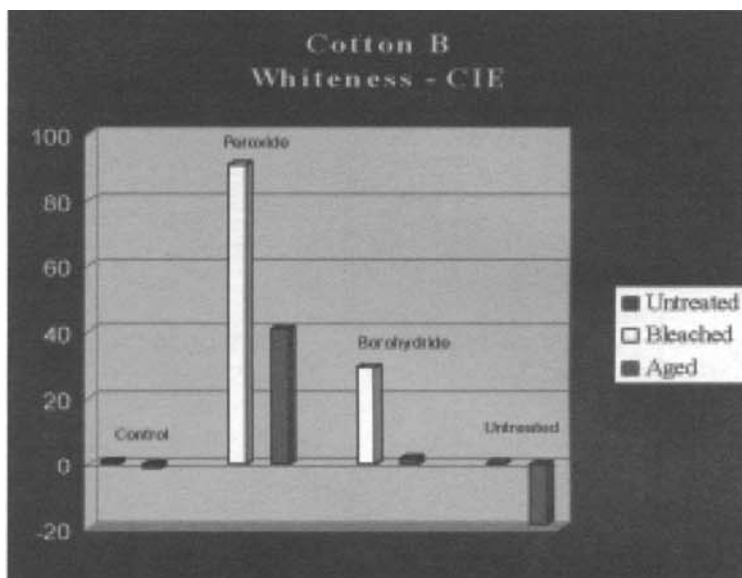


Fig. 6. CIE whiteness scale: value shifts on samples from Cotton W. (a) control samples, (b) peroxide-treated samples, (c) borohydride-treated samples, (d) untreated, aged samples.

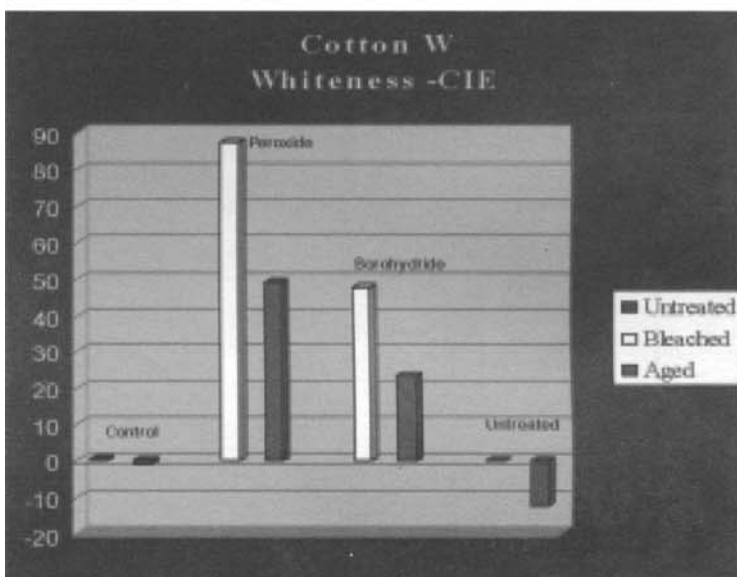
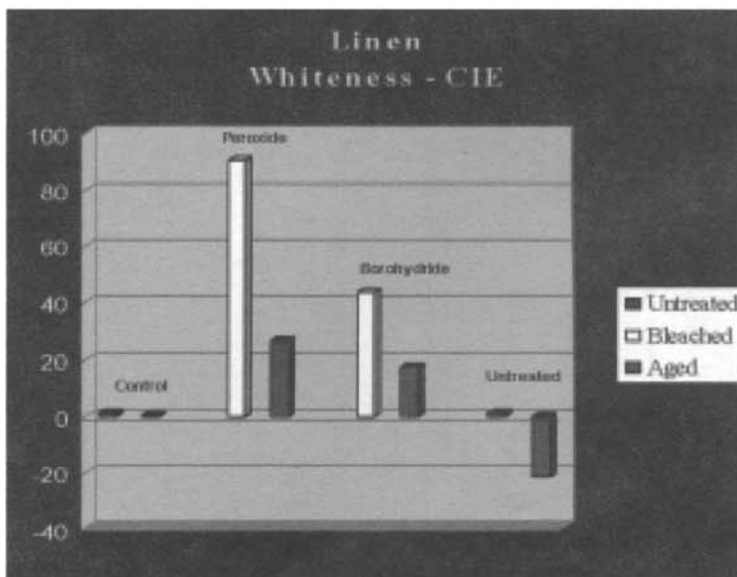


Fig. 7. CIE whiteness scale: value shifts on samples from the linen fabric. (a) control samples, (b) peroxide-treated samples, (c) borohydride-treated samples, (d) untreated, aged samples.



solution was pH 10 (as measured by 0-13 pH paper). A bath ratio of 10 ml:1 g fabric was used. Swatches from each source were bleached separately from swatches of the other sources, but using solution from a single stock. Swatches were immersed for five minutes, then blotted and placed between sheets of polyester film for three hours. The swatches were then rinsed thoroughly and allowed to air dry.

B. Borohydride bleaching. A stock solution was prepared of 0.1 percent sodium borohydride in distilled water. The solution was pH 9 (as measured by 0-13 pH paper). A bath ratio of 40 ml:1g fabric was used. Swatches of each source were treated separately from swatches of the other sources, but using solution from a single stock. Swatches were immersed in the bleach solution for three hours with intermittent light agitation to remove hydrogen bubbles. The swatches were rinsed thoroughly and allowed to air dry.

#### Aging

Aging was carried out at low humidity for six weeks at 80°C. Swatches to be aged were stitched to spun-polyester slings and preconditioned to fifty percent humidity. They were then suspended over the rack of a laboratory oven. The oven was vented by opening the door at two-week intervals and allowing air exchange. A low humidity level was maintained by placing a moistened piece of cotton flannel in the oven after each air exchange.

#### Color Measurements

Color measurements were made using the Hunter Lab MiniScan XE, model LAV, port size 31.8 mm, 45°/0° geometry. The MiniScan was linked to the Hunter Lab EZ Match Textile QC software program, which recorded each reading as tristimulus values, as well as by its value on each of several standardized scales. Two readings were made of each sample and averaged by the instrument for the recorded reading.

The instrument was calibrated against a perfect reflecting diffuser. Each reading was taken on a single thickness of fabric backed by a porcelain enamel white tile for consistency. A registration mark was stitched onto each sample swatch simply to insure consistency among repeat measurements.

For the purpose of comparing the effect of bleaching and aging on cellulosic samples, two

color scales were selected: (1) Whiteness as defined by CIE standards (corresponding to ASTM E313-96), and (2) Yellowness as defined by ASTM E313. Values on both these scales are calculated by the EZ Match Textile QC software program.

#### Results

Color measurements for all samples at each stage in the study are listed in Table II. Measurements include the L\*a\*b\* values as well as the CIE Whiteness and ASTM Yellowness values calculated from them.

The results are summarized in the graphs in Figures 5 through 7. Each graph displays the CIE Whiteness values for the samples from a given source. Values are presented as deviations from the initial readings, so that each pair of bars displays the color shift after bleaching (or at the second reading if untreated), and after aging (or at the third reading if not aged) for each procedure studied. The values represent the average whiteness readings of the three swatches in the study group. Shifts in yellowness values after treatment and after aging are comparable to the shifts in whiteness values.

#### Discussion

The discoloration of cellulose due to aging and oxidation is an ongoing process. Treatment with borohydride is not able to halt the process, but does in effect move it back significantly. The rate of discoloration in borohydride-treated samples from all three sources is similar to the rate of discoloration in untreated samples. The color shifts in samples treated with peroxide are more exaggerated, showing a greater degree of whiteness after bleaching, but a greater rate of discoloration with aging. This suggests that the functional groups affected by peroxide are more vulnerable to subsequent oxidation than those affected by borohydride.

The color shift seen in the linen samples gives an indication of the effect of peroxide on the natural colorants. A high degree of whitening after bleaching is followed by a high rate of discoloration with aging, suggesting that peroxide has affected the natural colorants, and that the resulting products are not stable. The pattern of color shift in borohydride-treated linen, however, is very similar to borohydride-treated cotton. Again the rate of discoloration of borohydride-treated linen is very close to that of untreated linen.

Table 2. Colorimeter Readings

Source	Treatment	Reading	Sample	L*	a*	b*	White	Yellow
Cotton B	Control	1st	B-11	84.82	2.53	19.46	-30.57	39.13
			B-8	85.94	2.12	18.2	-21.32	36.28
			B-12	85.88	2.15	18.12	-21.10	36.20
		2nd	B-11	85.53	2.52	19.41	-28.27	38.80
			B-8	86.56	2.12	18.15	-19.34	36.02
			B-12	86	2.36	18.56	-22.86	37.09
		3rd	B-11	84.78	2.54	19.68	-31.80	39.53
			B-8	85.94	2.05	18.38	-22.20	36.53
			B-12	85.64	2.17	18.32	-22.74	36.62
	Peroxide	1st	B-9	85.03	2.5	19.18	-28.63	38.57
			B-3	85.7	2.32	17.73	-19.69	35.73
			B-4	85.59	2.22	18.24	-22.49	36.54
		2nd: after bleach	B-9	93.82	-0.71	4.66	63.42	8.34
			B-3	94.11	-0.5	3.23	70.75	5.79
			B-4	93.93	-0.55	3.98	66.86	7.17
		3rd: after aging	B-9	90.77	-0.58	13.27	15.30	24.34
			B-3	90.98	-0.53	12.99	17.21	23.85
			B-4	91.05	-0.59	12.75	18.53	23.38
	Borohydride	1st	B-6	85.73	2.22	18.25	-22.13	36.52
			B-1	86.46	1.97	16.65	-12.37	33.36
			B-10	84.76	2.47	18.77	-27.40	37.94
		2nd: after bleach	B-6	88.99	0.67	14.35	5.47	27.63
			B-1	89.76	0.64	12.37	16.97	23.96
			B-10	88.84	0.72	14.83	2.77	28.54
3rd: after aging		B-6	86.57	1.61	18.72	-22.13	36.52	
		B-1	87.12	1.47	17.42	-14.35	34.06	
		B-10	86.67	1.6	18.51	-20.85	36.13	
Untreated	1st	B-7	85.1	2.24	18.59	-25.63	37.33	
		B-5	85.52	2.32	18.41	-23.50	36.95	
		B-2	86	2.17	17.13	-15.96	34.49	
	2nd	B-7	86.05	2.32	18.81	-23.94	37.46	
		B-5	85.92	2.43	18.73	-23.90	37.46	
		B-2	86.08	2.28	17.39	-16.98	35.01	
	3rd: after aging	B-7	84.35	2.9	21.73	-42.94	43.39	
		B-5	84.18	2.93	21.59	-42.76	43.25	
		B-2	84.25	2.78	20.12	-35.39	40.66	
Cotton W	Control	1st	W-12	82.81	4.5	21.24	-44.63	44.58
			W-8	82.54	4.46	20.61	-42.29	43.60
			W-6	83.13	4.27	20.32	-39.23	42.72
		2nd	W-12	83.29	4.56	21.41	-44.01	44.72
			W-8	83.3	4.6	20.98	-41.88	44.05
			W-6	83.53	4.36	20.58	-39.31	43.07
		3rd	W-12	82.88	4.47	21.41	-45.25	44.81
			W-8	82.87	4.49	20.98	-43.14	44.11
			W-6	83.12	4.25	20.53	-40.30	43.06
	Peroxide	1st	W-4	83.7	3.99	20.39	-38.01	42.38
			W-7	82.78	4.42	20.65	-41.82	43.54
			W-3	83.66	3.94	20.2	-37.18	42.02
		2nd: after bleach	W-4	94.22	-1.2	8.02	48.99	14.04
			W-7	94.3	-1.26	8.46	47.21	14.76
			W-3	94.15	-1.18	8.03	48.78	14.08
		3rd: after aging	W-4	91.35	-0.37	14.6	10.77	26.65
			W-7	91.05	-0.16	15.62	5.15	28.62
			W-3	91.28	-0.4	14.57	10.68	26.60
	Borohydride	1st	W-9	82.91	4.45	20.72	-41.76	43.63
			W-5	83.23	4.16	20.37	-39.22	42.66

Table 2. Colorimeter Readings cont.

Cotton W	Borohydride	2nd: after bleach	W-1	81.85	4.8	21.74	-49.81	46.07
			W-9	89.57	0.84	15.03	3.90	28.79
			W-5	89.77	0.58	14.36	7.56	27.39
		3rd: after aging	W-1	88.96	0.91	15.61	-0.57	30.00
			W-9	86.75	2.32	18.58	-20.77	36.83
			W-5	87	2.04	18.14	-18.03	35.79
	Untreated	1st	W-1	86.21	2.4	18.69	-22.86	37.27
			W-11	83.31	4.28	20.61	-40.14	43.15
			W-2	82.54	4.42	20.83	-43.42	43.94
		2nd	W-10	83.23	4.34	20.68	-40.65	43.33
			W-11	83.79	4.33	20.78	-39.53	43.28
			W-2	82.78	4.57	21.18	-44.36	44.55
3rd: after aging	W-10	83.78	4.39	20.84	-39.84	43.44		
	W-11	81.72	4.98	22.36	-53.20	47.31		
	W-2	81.63	4.92	22.37	-53.55	47.32		
Linen	Control	1st	W-10	81.97	5.02	22.68	-54.05	47.78
			L-3	68.92	7.09	22.84	-91.89	56.51
			L-12	68.91	6.79	22.35	-89.36	55.32
		2nd	L-9	68.69	6.85	22.33	-89.80	55.47
			L-3	69.42	7.14	23.08	-91.77	56.70
			L-12	69.65	6.7	22.27	-86.84	54.67
		3rd	L-9	69.46	6.83	22.42	-88.11	55.17
			L-3	69.02	7.11	22.98	-92.39	56.72
			L-12	69.12	6.69	22.3	-88.50	55.01
	Peroxide	1st	L-9	68.95	6.75	22.35	-89.25	55.26
			L-1	69.49	6.81	22.43	-88.12	55.16
			L-11	68.83	6.68	22.16	-88.53	54.90
		2nd: after bleach	L-4	69.91	6.79	22.26	-85.96	54.58
			L-1	89.49	-0.83	15.09	3.06	27.55
			L-11	88.6	-0.51	15.14	0.38	28.12
		3rd: after aging	L-4	89.65	-0.91	14.78	4.95	26.92
			L-1	82.85	3.37	25.38	-65.25	50.28
			L-11	82.91	2.9	23.63	-56.63	47.04
Borohydride	1st	L-4	83.45	2.94	24.94	-61.37	48.95	
		L-8	69.65	6.68	22.12	-86.00	54.37	
		L-10	68.9	6.76	22.21	-88.58	55.04	
	2nd: after bleach	L-2	69.06	6.82	22.37	-88.97	55.29	
		L-8	77.5	3.3	18.17	-44.25	40.25	
		L-10	77.1	3.25	17.92	-44.05	39.91	
	3rd: after aging	L-2	77.33	3.41	18.23	-45.00	40.53	
		L-8	74.74	4.96	21.84	-70.76	49.55	
		L-10	74.52	4.91	21.49	-69.54	48.99	
Untreated	1st	L-2	74.67	5.17	22.02	-71.84	50.10	
		L-5	69.42	6.69	22.16	-86.87	54.58	
		L-7	69.23	6.56	21.88	-85.89	54.04	
	2nd	L-6	69.7	6.59	21.94	-84.91	53.93	
		L-5	70	6.71	22.3	-85.98	54.53	
		L-7	69.92	6.59	21.99	-84.52	53.88	
	3rd: after aging	L-6	70.34	6.63	22.06	-83.72	53.83	
		L-5	67.74	7.52	25.26	-108.60	61.96	
		L-7	67.49	7.4	25.19	-109.00	61.87	
			L-6	68.34	7.38	24.88	-104.80	60.78

These studies have looked at the reversion of color due to degradation. Discoloration due to stains involves different chemical processes, and may water. The solution was pH 9 (as measured by 0-13 pH paper). A bath ratio of 40 ml:1 g fabric was used. Swatches of each source were treated separately from swatches of the other sources, but using solution from a single stock. Swatches were immersed in the bleach solution for three hours with intermittent light agitation to remove hydrogen bubbles. The swatches were rinsed thoroughly and allowed to air dry.

## CONCLUSIONS

Sodium borohydride is a convenient, economical, and effective means of treating discoloration in undyed, aged cellulosic textiles. Treatment with sodium borohydride contributes to the long-term stability of the cellulose fiber. It consistently results in even, overall mellow whitening of the aged textile, and is effective in reducing a wide spectrum of extraneous stains as well. Borohydride treatment does not interfere with natural colorants as peroxide bleaching does. The degree of color reversion of borohydride-treated cellulosic textiles is less than that observed for peroxide-treated textiles. The rate of discoloration of borohydride-treated textiles appears to parallel closely the rate of discoloration in untreated textiles.

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## REFERENCES

- Block, I., and H. Kim. 1986. Accelerated Aging of Cellulosic Textiles at Different Temperatures: The Effect of Tetrahydridoborate Reduction. In *Historic Textile and Paper Materials*, ed. H. L. Needles and S. H. Zeronian. American Chemical Society. 411-425
- Block, I., and A. M. Roy. 1987. Treatment of Cellulosic Textiles with Sodium Borohydride. *ICOM Preprints*, Eighth Triennial Meeting, Sydney, Australia. 345-351.
- Burgess, H. D. 1982. The Bleaching Efficiency and Colour Reversion of Three Borohydride Derivatives. *AIC Preprints*, Tenth Annual Meeting, Milwaukee, Wisconsin. 40-48.
- \_\_\_\_\_. 1988. Practical Considerations for Conservation Bleaching. *JIIIC-CG* (13): 11-26.
- Burgess, H. D., and J. F. Hanlan. 1979. Degradation of Cellulose in Conservation Bleaching Treatments. *JIIIC-CG* (4): 15-21.
- Feller, R. L. 1971. Notes on the Chemistry of Bleaching. *JIIIC-AG* (1): 39-50.
- Hey, M. 1977. Paper Bleaching: Simple Chemistry and Working Procedures. *The Paper Conservator* (2): 10-23.
- Leene, J. E. 1972. Bleaching. In *Textile Conservation*. London: Butterworth.
- Morton International, Inc. Safe Use and Handling of Sodium Borohydride. Morton Performance Chemicals.
- Nevell, T. P. 1985. Oxidation of Cellulose. In *Cellulose Chemistry and Its Applications*. ed. T. P. Nevell and S. H. Zeronian. New York: John Wiley and Sons. 243-265.
- Nevell, T. P., and S. H. Zeronian. 1985. Cellulose Chemistry Fundamentals. In *Cellulose Chemistry and Its Applications*, ed. T. P. Nevell and S. H. Zeronian. New York: John Wiley and Sons. 15-29
- Poot, A. H. H. 1964. Chemical Bleaching of Ancient Textiles. *IIC Preprints*, Conference on the Conservation of Textiles, Delft, Netherlands. 53-64.
- Ringgaard, M. Borohydride Bleaching. Notes from the National Museum of Denmark, Department of Conservation.
- Steinmiller, W. G. and D. M. Cates. 1976. Bleaching Cellulose Part II: Effect of Impurities. *Textile Chemist and Colourist* 8 (1): 30-34.



Taher, A. M. M. and D. M. Cates. 1975.  
Bleaching Cellulose Part I: A Free Radical  
Mechanism. *Textile Chemist and Colourist*  
7 (12): 30-34.

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# DISASTER RECOVERY: TEACHING TEXTILE SALVAGE TECHNIQUES TO THE FIRST RESPONSE TEAM

KATHY FRANCIS

**ABSTRACT**—At small museums and historical societies, conservators are not often first on the scene after a disaster, but are soon after called upon for expertise in recovery techniques. Staff and volunteers, who are likely to make up the first response team, need to know salvage procedures for various materials in their collection. Material-specific response and recovery training provides conservators, collections staff, and volunteers with an opportunity to focus on particular problems they are likely to confront in an emergency, and aids in disaster planning. Training gives the response team the information needed to prevent or alleviate damage. Hands-on practice sessions and training using mock disasters increase confidence, allow refinement of technique, and demonstrate how various recovery methods effect options for subsequent conservation. This paper presents some techniques critical for the salvage of fire- and water-damaged textiles, and suggestions for teaching the techniques of emergency response to the team of museum staff and volunteers.

## INTRODUCTION

It is shocking to see what happens to museum buildings, collections, and staff during emergencies. Disasters, large or small, are contrary to all the normal, careful museum collections care and conservation procedures. Emergencies are by definition unpredictable: the objects that museum staff have been entrusted to protect are threatened or damaged; equipment may be out of service; we feel like we don't have time to think.

The problems encountered in an emergency can seem like a waking nightmare of possible museum collection damages. Learning to identify and anticipate types of artifact damage is an essential aspect of disaster preparedness, and in the event of an emergency, leads to appropriate emergency handling routines and correct choice of salvage technique. For textile collections, the problems confronted may include heavy soils, soot and plaster deposits; structural damage such as tears, splits and fabric losses; significant loss of fabric strength; dye bleed and transfer; and growth of microorganisms.

As conservators, we are especially well suited to train disaster response teams in emergency preparedness and response. An understanding of materials allows us to predict how objects will respond to hazards like water, mud, and oily airborne soils, as well as various methods of packing and moving. Also, experience with lab recovery treatments makes us keenly aware of how handling and treatment during the immediate post-disaster-recovery period effects

the options for subsequent conservation treatment. Seeing artifacts in the lab following a disaster we may think: if only more support had been given while moving this rug; if only this silk banner had been rolled rather than folded; if only an interleaving barrier had been used to prevent transfer of bleeding dye; if only workers had worn gloves and respirators, and so on. Lab treatment can inform recovery practice, and conservation information makes up much of the foundation of good disaster response. By anticipating possible damage, and teaching museum staff how to respond, conservators can help prevent hazards and alleviate damage.

My early experiences with disaster recovery at the Textile Conservation Center included working with fire-damaged and water-damaged textiles that arrived at the Center for treatment. It became clear early on that the handling methods and treatments used during the immediate post-disaster-recovery period significantly effected the options for subsequent conservation treatment. For example, careful handling and packaging of needleworks, which had been exposed to sooty soils, helped prevent deep smudging of soot into the fabric. These textiles were much more successfully cleaned than items that were not as carefully packed, and which had more deeply embedded soot. A variety of these textiles were surface cleaned with a HEPA vacuum cleaner and the dry sponges used for fire clean up (Hackett 1999, Moffatt 1992).

The purpose of this article is to set forth specific disaster recovery techniques and to emphasize the importance of teaching salvage

methods that are specific to the collection type. The information included focuses on textile materials and is only part of the guidelines needed for a disaster response effort.

#### SALVAGE PRINCIPLES AND PROCEDURES

Training for material-specific response offers guidelines and experience for dealing with specific artifact concerns. Each material type (furniture, textiles, photographs, etc.) will have individual needs and salvage procedures, although training in a variety of materials will demonstrate obvious parallels that provide reinforcement. For textiles, the salvage procedures that I've found to be the most important are:

- Establishing priorities
- Handling and moving techniques
- Working with limited resources
- Dealing with soil, soot, and smoke damage
- Removing water from soaked items
- Drying techniques
- Minimizing dye staining
- Preventing soil transfer

#### ESTABLISHING PRIORITIES

More a principle than a salvage procedure, establishing priorities is a logistical necessity. While somewhat difficult to teach in a lecture or demonstration, the importance of establishing priorities is immediately obvious in a mock disaster. Building security is a priority. Stabilization of the building environment may be less obvious, but is also essential. If building security and a stable environment can be accomplished, it may not be necessary to move artifacts at all! Once the need to move artifacts has been ascertained, it is essential to establish clear passage and efficient moving routes. Moving fragile artwork cannot go smoothly if there is broken glass covering the main path to the truck.

People on the first-response team must be able to make order of what may be a very chaotic situation. In teaching the team to establish artifact priorities, asking questions will help determine some of the most important curatorial

and conservation concerns. What artifacts are the most important or rare? Which are the most fragile? Thousands of items may be wet, but are they equally wet? Perhaps some things are not wet at all. What can be safely air dried? What can be frozen? This type of mental sorting will help to establish order, and can be made a part of training exercises and discussions, as well as mock disaster exercises. It is essential in a real disaster.

#### HANDLING AND MOVING TECHNIQUES

The basics of careful artifact handling are a critical part of salvage training. Throughout lectures, demonstrations, and practice sessions, participants should be reminded of the obvious: old fabrics are fragile even when they are dry, and are much more fragile when wet. In an emergency, the supply of recovery materials may be meager compared with usual array of preservation supplies that are available to assist with handling and moving collections. The response team must learn to identify the needs of fragile materials and respond with ingenious solutions. As part of training, problem solving exercises should allow participants opportunities to predict how materials in their collection will respond to various stresses, and what type of handling and protection will prevent damage.

In general, object handling should be minimized in order to prevent damage. Textiles that were in storage when the disaster occurred should be examined for degree of wetness, but can often be moved in their boxes even if the boxes are wet. If boxes or rolls are intact, they should not be disturbed, except to check contents and log the accession numbers. All textiles should be adequately supported for moving, using boxes, trays, and platforms. If larger items are found without storage boxes or tubes, two people can move them safely to the packing area using a length of sturdy canvas (much the same way that an injured person is moved with a litter). If fragile items must be folded, pad the folds with tissue paper or blank newsprint to prevent splitting.

In demonstrations and disaster drills it is important to have a variety of materials to represent the range of textile collection problems. Delicate items that have been folded, once wet, may be far too fragile to attempt unfolding. Some items (i.e. hooked rugs) may be thought to be among the sturdiest, but will readily split and shred if folded or moved without support. These

<b>Structural Damage Loss of Strength Fabric Tears, Splits, Losses</b>	
<u>Recovery Methods</u>	<u>Recovery Materials</u>
<ul style="list-style-type: none"> <li>• <b>Limit handling</b></li> <li>• <b>Provide structural support</b></li> <li>• <b>Prevent crushing, abrasion</b></li> <li>• <b>Prevent stretching</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Rigid trays</b></li> <li>• <b>Platforms</b></li> <li>• <b>Fabric slings (canvas)</b></li> <li>• <b>Tubes</b></li> <li>• <b>Boxes</b></li> </ul>

Table 1.

hidden weakness are impressed upon the response team trainees once they have a chance to see it for themselves. In one exercise, after participants seriously damaged a hooked rug by folding and moving it in haste, we moved it a second time without damage, by carrying it to the drying area supported on a cotton sheet.

Heavy items like tapestries and carpets are especially susceptible to structural damage because of their weight. Five or more strong people may be needed to roll and move a large carpet, and caution is needed to avoid injury to team members. If possible, large tubes should be used to support the weight of these items (Table 1).

#### WORKING WITH LIMITED RESOURCES

Working with limited resources is a subject that can be addressed in a lecture, or illustrated in demonstrations, but it becomes most meaningful in a disaster exercise. For textile salvage, absorbent blotting materials will usually be at a premium. The response team needs to learn specific ways to economize: extremely soaked carpets might be drained on the side of a hill, or water might be removed with a sponge before using precious cotton sheets, toweling, or other blotting materials.

The issue of working with limited resources also presents an opportunity to discuss what one might do in cases of very extreme emergencies. Through a salvage exercise we learn that, if necessary, we can wring the water out of our (recovery supply) cotton sheets and use them repeatedly. But what if we have no sheets? Would we be willing to use a bedspread from the museum's collection to save another invaluable item? These possibilities (and the judgement calls about possible dye and soil transfer) should

come up for discussion in disaster response training.

The issue of what materials can be used as salvage resources will also come up. One training exercise, which involved salvage operations at a historic house following a fire, was chaotic at the beginning of the day. Certain concerns about the building environment were overlooked in the confusion. Finally in the afternoon a trainee noticed that more windows should be opened to increase ventilation. When we did, several things were realized: (1) We did need the ventilation. It was warm, humid, and somewhat smelly inside the house. Some people had complained of slight nausea from the smoke odor; (2) It was realized that we had been carrying boxes the long way out the front door, when we could have been passing them right out the front window; (3) One participant realized that, with the addition of a paper or plastic barrier, we could use the window screens as carrying trays, which were in very great demand.

This idea of using parts of the building as salvage "resources" is something that came up again later in workshop discussions following this disaster recovery exercise. A number of curators felt that it would not be appropriate at some historic houses. But when it is, countless possibilities follow: with a couple make-shift saw horses, a door can become a work table, screens become carrying trays, and so on. The salvage team is always great at brainstorming the possibilities following an exercise, and such postmortem discussions are invaluable.

A question about teaching methods comes up regularly during discussions about the subject of working with limited resources. Trainers continue to debate the amount of salvage information and direction to be given to the response

<b>Soil, Soot &amp; Smoke Damage</b>	
<b>Recovery Methods</b>	<b>Recovery Materials</b>
<ul style="list-style-type: none"> <li>• <b>Limit handling</b></li> <li>• <b>Avoid smudging soil into fabric</b></li> <li>• <b>Interleave &amp; wrap to prevent soil/soot transfer</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Blank newsprint</b></li> <li>• <b>Clean sheets</b></li> <li>• <b>Clean muslin</b></li> <li>• <b>Brown paper</b></li> </ul>

Table 2.

team during training exercises. Some feel that trainers should hold back and let the response team discover things (like the window screens) for themselves, reasoning that when trainees make these discoveries themselves they will remember them forever. While that is perhaps true, it is also important to recognize that disaster drills are costly, and waiting too long to share good ideas wastes valuable training time. Trainers must find the appropriate balance.

#### SOIL, SOOT, AND SMOKE DAMAGE

Handling and packing techniques are very significant factors in the success of subsequent cleaning treatments for the removal of sooty soils. In conservation treatments, these fine particle soils are remarkably difficult to remove, and whatever can be done to limit smudging them into the fabric is good. Many types of interleaving materials can be used, including old sheets, muslin, paper and rolls of polyethylene. The goal is to use the barrier to prevent the transfer of soils from one area of a textile to another, and to prevent transfer between different pieces. For larger textiles (i.e. bedcovers or quilts) the entire surface should be covered before folding or rolling. Large sheets are ideal in this case, and hopefully there are some stored with the salvage materials.

Furnace backups are smaller-scale emergencies, but with similar problems. After a furnace backup, absolutely every surface will be covered with soot, and will require cleaning. Success in removing the soot will depend in part on whether it is smudged into the fabric. Examples from past disasters, and before and after photographs of treated textiles, help to illustrate this point (Table 2).

#### DRYING TECHNIQUES

Many appropriate techniques for removal of water from fabrics are possible. Some, such as draining and blotting to absorb excess liquid, are within the direct experience of most people. Other techniques come from conservation treatment, and require explanation and practice. If the number of textiles wetted in the emergency is manageable for available staff and resources, then air drying can be considered. Otherwise, the salvage operation will include packing in preparation for freezing. In either case, fabrics that are soaked with water will be heavy and vulnerable to structural damage. An attempt should be made to drain or absorb excess water before trying to open them up for drying.

Wet garments can be especially difficult to work with. Demonstration and practice helps disaster-response trainees see the problems in handling wet items, and identify appropriate recovery options. A soaked dress can be lifted out of its box onto some absorbent paper or muslin, and left without handling for fifteen to twenty minutes until water wicks out into the paper or muslin. Afterwards, the dress is lighter and can be more safely moved. Sometimes (if the paper is clean enough) it is possible to dry the paper to use again.

Techniques that are more difficult to understand require additional explanation and reinforcement in disaster training sessions. For example, I teach a technique for removing water from soaked chairs or sofa upholstery, and have made a set of slides to illustrate the technique. The slides simplify the technique into a set of steps and show trainees the intended outcome as follows:

1. Examine the fragility of the fabric surface and determine specific needs.

<b>Water Soaked Textiles</b>	
<b><u>Recovery Methods</u></b>	<b><u>Recovery Materials</u></b>
<ul style="list-style-type: none"> <li>• <b>Drain</b></li> <li>• <b>Absorb excess water</b></li> <li>• <b>Blot</b></li> <li>• <b>Use of drying cloths</b></li> <li>• <b>Padding out 3D items</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Absorbent toweling &amp; sheets</b></li> <li>• <b>Sponges</b></li> <li>• <b>PVC tubes</b></li> <li>• <b>Long handled squeegee</b></li> </ul>

Table 3.

2. Remove loose cushions and use absorbent cotton sheets or toweling to blot as much water as possible from both the cushions and upholstery.
3. Apply a one hundred percent cotton drying cloth (hopefully an available salvage supply). Carefully cover the entire upholstery fabric, and gently press the drying cloth into contact with the upholstery fabric. The goal is for the cloth to be in direct contact with the upholstery fabric for the duration of the drying period. The drying cloth should be placed flat (without wrinkles) in flat areas, and tucked deeply into the folds of the upholstery so that it will act as a wick, thereby moving water from wetter areas to drier ones. The water carries stains, soils, and degradation products with it, depositing them on the drying cloth.
4. After the upholstery is dry, remove the drying cloth.

During training, the participants ideally will see each technique three separate times: first, the technique is described in a lecture

illustrated by slides; then the disaster exercise presents an opportunity for participants to use the technique on a real piece of upholstered furniture; finally there is a demonstration using the same piece and reviewing the salvage goals and steps (Table 3).

#### MINIMIZING DYE STAINING AND PREVENTING DYE TRANSFER

Conservation treatment experience shows that drying methods can be expanded and refined to control dye staining and soil transfer that occurs as a result of uncontrolled drying. These techniques can be simplified and taught to disaster-team members. If textiles are air dried, the use of a drying cloth (described above for upholstery) placed in direct contact with colored fabrics, will wick bleeding dye into the drying cloth and help avoid staining. Evaluation of artifacts after the training exercise will highlight the importance of using absorbent cotton drying cloths, and maintaining contact between the textile artifact and the drying cloth. When good contact is achieved, staining will be on the drying cloth and not (or to a lesser degree) on the

<b>Water Damage Dye Bleed/ Transfer Bleeding of Soluble Inks/Markers</b>	
<b><u>Recovery Methods</u></b>	<b><u>Recovery Materials</u></b>
<ul style="list-style-type: none"> <li>• <b>Minimize spreading: blot</b></li> <li>• <b>Minimize transfer: interleaving barriers</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Absorbent toweling and sheets</b></li> <li>• <b>Wax paper</b></li> <li>• <b>Freezer paper</b></li> <li>• <b>Polyethylene</b></li> </ul>

Table 4.

textile artifact. Without contact, the textile artifact is likely to be stained.

When textiles are being packed and moved, attention to the issue of bleeding dye will lessen damage. Along with draining and blotting to remove water, interleaving barriers such as wax paper or freezer paper can be used to keep bleeding dyes from transferring to other textiles. If items are being prepared for freezing this is especially useful (Table 4).

#### GOALS OF DISASTER RECOVERY TRAINING

What is the best preparation for an emergency? Ultimately, salvage techniques for textiles and other art must be placed within the context of a whole disaster recovery effort, which includes identification of staff roles, security, basic services for the response team, health and safety issues, building concerns, acquisition of supplies, artifact priorities, and salvage. The techniques described in this paper are specific to textiles, nonetheless they demonstrate the usefulness of "material-specific" disaster training that is needed for all specialties.

Ideally, training should be planned as part of emergency preparedness, but it can also take place during a crisis, and some instruction can even be given over the telephone. The training that builds the most confidence incorporates hands-on practice sessions that provide real experience. The firsthand experience gained in an emergency drill provides the best opportunity to learn and refine salvage techniques, increase confidence, and demonstrate how recovery methods effect the options for subsequent conservation treatment. While salvage exercises expose the very real limits of what can be done in an emergency, participants also realize that they may be able to do more than they thought.

#### ACKNOWLEDGMENTS

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#### REFERENCES

Francis, K. 1990. Disaster Prevention, Preparedness and Recovery: Special Concerns for Museum Textile Collections. Federation

Files. Troy, New York: The Federation of Historical Services.

Hackett, J. 1999. Observations on Soot Removal from Textiles. *AIC Textile Specialty Group Postprints*, Twenty-sixth Annual Meeting, Arlington, Virginia. 63-69.

Moffatt, E. 1992. Analysis of "Chemical" Sponges Used by the Commercial Fire Clean-Up Industry to Remove Soot from Various Surfaces. *IIC-CG Bulletin* 17(3): 9-10.

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# DISASTER RECOVERY AT THE UNIVERSITY OF ALBERTA, OR EVERY FLOOD HAS A SILVER LINING

SHIRLEY ELLIS

**ABSTRACT**—The Clothing and Textiles Collection at the University of Alberta successfully recovered from a flood which had occurred in December of 1996. Staff, students, and volunteers worked effectively throughout the salvage and recovery stages. During the salvage operation, both air drying and freezing techniques of the artifacts were utilized while documenting the damage and other diagnostic information. This documentation, as well as existing reports, proved a valuable resource throughout the recovery. Treatment techniques were explored and adapted to the needs of the artifacts in order to achieve a high level of success. The flood-damaged clothing and textiles provided numerous challenges throughout the salvage operation and recovery, whereby positive solutions were found. In the end, the flood afforded many with employment, experience, and a platform for the sharing of knowledge and techniques.

## INTRODUCTION

One very cold Alberta morning, Sunday December 22, 1996, an emergency call went out to staff, students, and volunteers. A flood had occurred in the University of Alberta Clothing and Textiles Collection some time during the weekend. During renovations to the building, a fitting had broken on a pipe two floors above. Needless to say, significant damage had occurred to the Collection, with dirty water pouring from the ceiling into the compactor storage unit. The salvage team worked efficiently making the salvage operation a success. Clothing and textile artifacts were either bagged and frozen if soaked, or allowed to air dry if only slightly damp. Detailed lists of objects and their locations, as well as photographs of the entire operation, assisted with recovery treatments and insurance claims. Following the aftermath, a review of the damage and plans for the treatment of over 300 textile artifacts began. Contract and volunteer conservators were hired throughout the course of the flood recovery.

Treatments varied from wetcleaning, to spot removal using suction and blotting techniques, to altering the pH of the solution to attempt the reversal of dye transfer. Successful techniques were discovered for the spot removal of tidelines, particularly on water-sensitive objects. We found ourselves having to treat soaked textile and clothing artifacts that normally would not be wetcleaned. The results of these treatments were often successful.

## SALVAGE

The exact time that the pipe burst on that -35°C morning was never established, but given the fact that some of the artifacts were already dry, we can only speculate that it had happened that weekend. The flood water was light brown in colour, which may have come from the golden coloured insulation material of the ceiling tiles, as well as from the dirt it picked up along its travels. The water was later analyzed but the cause of the colour was inconclusive. The Gas Chromatography/Infrared, or GCIR, showed trace organics including phthalates and long-chain acids such as oleic acid. Small amounts of calcium and magnesium were revealed in the Inductively Coupled Plasma Emission Spectroscopy, or ICP, analysis.

The salvage team, headed by Suzanne McLean, Curatorial Assistant, worked efficiently making the salvage operation a success. Artifacts were removed from the storage unit and dealt with according to their degree of wetness. With only two domestic chest freezers available space was limited, so only those clothing and textile artifacts that were soaked were contained in clear polyethylene bags and frozen. Those that were only slightly damp were moved to tables or hanging racks and allowed to air dry.

A number of rolled textiles were amongst those soaked. The largest chest freezer available in the Home Economics Building was not long enough to accommodate these rolls, so an alternative for frozen storage was sought. Fortunately, the Provincial Museum of Alberta has a walk-in freezer used for their natural history



collection. Several long, rolled textiles were transported to the Provincial Museum for interim storage.

Detailed lists of artifacts were generated throughout the salvage and recovery stages, as well as photographs of the entire operation. Both assisted with recovery and insurance claims. Recording the artifacts' temporary location, condition as to degree and location of wetness, and dye transfer were found to be invaluable sources of information in their recovery. Throughout the recovery process a tally was kept which recorded the accession number, object name, and treatment hours, both proposed and actual. This tally was found to be useful to keep track of complete and incomplete treatments, as well as for insurance purposes.

Once the immediate crisis was over that Sunday, a review of the damage and plans for the treatment of the artifacts began. A global time estimate for all damaged artifacts was produced for the insurance adjusters and to determine staffing needs. Those artifacts that were moved to the tables or hanging racks to dry were examined so that a time estimate for treatment could be established. Proposing a time estimate for the frozen artifacts was more difficult, since many were bagged and frozen before a conservator could examine them. For these artifacts, an estimate was established by viewing the frozen artifact through the bag, and by reviewing the initial artifact tags and lists. In most cases the estimates were completed in haste, so the time proposed for treatment of all artifacts was doubled to allow for treatments that would inevitably go over time. In the end it was found that the actual treatment hours were only fifty percent greater than the original estimate total.

A few weeks following the flood, those artifacts left out to dry were moved back into the storage compactor unit. At this time it was noticed that there were more flood-damaged artifacts than originally identified. A thorough examination was needed of all objects. Two staff members and one volunteer reexamined each artifact and found an additional 184 possible casualties. Note that only 136 were retrieved during the salvage operation. This is likely attributed to the urgency of the situation. Water was still pouring into the compactor unit when the first of the salvage team arrived; they needed to work quickly. Time to thoroughly examine

each and every object was simply not available. As well, numerous volunteers with varying levels of expertise were helping. Their ability to properly identify water damage varied. But even with the second survey of the Collection, damaged artifacts continued to be found throughout the recovery process.

With the list of damaged artifacts now totaling just over 300, a priority system was developed and objects treated accordingly. Priority One objects generally received treatment first, and included the frozen artifacts and those that exhibited dye transfer. Priority Two objects, which generally had obvious tidelines, were next. Priority Three objects were treated last. It was questionable as to whether all the damage seen on these final objects resulted from the flood.

Contract and volunteer conservators were hired throughout the course of the flood recovery. In order to maintain some consistency with the treatments, guidelines were established for photography and handling of the treatment procedure including retrieving previous conservation and/or student documentation reports, and utilizing standardized condition and treatment forms which were adapted for the flood (Fig. 1).

## RECOVERY

The recovery operation of the flood-damaged clothing and textiles included treatments such as wetcleaning; spot removal using suction, absorption, and blotting techniques; and altering the pH of the solution in order to attempt the reversal of dye transfer. To illustrate some of the techniques employed to treat these water-damaged textiles I will present them as case studies.

Certain procedures were followed when treating the frozen artifacts. Any existing records were retrieved prior to removing them from the freezer, since it was close to impossible, in most cases, to view the artifact properly. Time was of the essence. These records included student documentations or earlier conservation reports. They provided information such as descriptions, fibre and material identification, and diagrams and/or photographs, whereby the potential for unexpected surprises was reduced. If the artifact was dry, low-suction vacuuming generally preceded treatment.

GUIDELINES FOR DOCUMENTATION/TREATMENT PROCEDURES  
OF  
FLOOD DAMAGED TEXTILES

1. Prior to treating the textile, retrieve any existing documentation that may elaborate on dimensions, method of manufacture, fibre ID, or anything else that may help in the decision making for treatment.
2. Once the decision for treatment is made, prepare the work area, as other conservators may be using the equipment and/or space.
3. Record as much information as possible on the Condition/Treatment Report provided. Without going into great detail, record the overall condition of the object even though it may not be related to the water damage, i.e. tears, holes, etc. These aspects of the object may be affected by the subsequent treatment. Try to follow the worksheet provided.
4. If possible, do a fibre ID, or record your assumption(s) followed by a "?".
5. Photodocument the object before and after treatment, and during if deemed necessary.
6. Dry textiles should undergo vacuuming prior to any wet treatments.
7. Secure any holes, weaknesses, tears, etc. with netting prior to cleaning.
8. Record as much information as possible about the wetcleaning/drying procedure, i.e. pH, temperature, detergent concentration, time spent in baths, colour of bath (soil removal, dye loss), use of fans, drying cloths, or dye migration.
9. Record procedure, and solution concentration and pH of any spot treatments.
10. Any other observations should be noted on the worksheet in the space provided, i.e. Was the treatment successful, did anything unusual occur, how were the objects found (frozen?).
11. Record the time spent for documentation and treatment.

Fig. 1.

#### CASE STUDY I: ACCESSION NO. 79.8.8

An off-white, low-twist crepe silk, 1920s dress with black silk embroidery floss suffered from dye transfer. The dress had been frozen but was only damp when retrieved from the freezer. The black embroidery floss was not fast in water and subsequently transferred a purple-coloured dye to the off-white ground fabric. The transfer was evident in many areas throughout and near the embroidered sections. For this reason spot cleaning did not appear to be an option. Full immersion also did not appear to be an option because the black dye was so obviously not fast. With testing, it was found that the dye was easily removed with an anionic detergent solution of 0.2 percent Orvus WA Paste in distilled water. The curator was called for a consultation. Given the positive results of the spot test it was decided to proceed with a full immersion wetclean.

In anticipation of unfast dyes, the drying area was prepared with fans and hand-held blow dryers set out so that the dress could be dried quickly. The dress was immersed in the bath and major dye loss was evident only toward the end of the process. In an attempt to encourage the dye away from the dress, the bath water was swirled by hand. The dress was removed from the bath and blotted with white cotton towels, where dye transfer was visible. Once blotted, the dress was immediately hung on a polyethylene-covered, padded hanger, and drying was accelerated by the fans and blow dryers set on a cool setting.

Results of the wetcleaning were very positive. The dye transfer which had occurred during the flood, in most areas, was removed from the white silk with only two lightened stains remaining. There was no additional transfer of dye to the white silk. Despite gentle stretching during drying, there was some shrinkage of four percent in the lengthwise direction due to the tightening of the crepe yarn.

The fact that the transferred dye was relatively easily removed with wetcleaning might be explained because the conditions for dye uptake were less than ideal. And the fact that newly bled dye did not penetrate or diffuse into the white silk fibres upon drying might be explained because the embroidery was dried quickly. Given the sample size, simple testing methods noted in Trotman's "Dyeing and Chemical Technology of Textile Fibres" (1970, 603-4) were inconclusive except to say that the black dye is not of a basic

class but possibly an acid, premetallized or mordanted dye. Further investigation is warranted.

#### CASE STUDY II: ACCESSION NUMBER 77.5.101

A 1930s, beige crepe silk dress with a multi-coloured floral pattern was frozen due to water damage along the back hem. Fugitive dyes on this dress included the navy blue, green, yellow, and magenta. The dye transferred into both the beige areas and the adjacent dyed areas. When this dress was retrieved from the freezer it was still wet. In order to prevent those areas from drying that were not being treated immediately, they were covered with polyethylene sheeting.

There were two objectives for the treatment of this dress. The first was to remove or reduce the dye transfer that had occurred, and the second was to prevent the formation of a tideline along the wet edge. In attempting the removal of the dye transfer, the most innocuous solution of water was tried first. Water was discriminantly sponged only onto the areas of dye transfer, with disposable diapers beneath to absorb the water. Finding no success, a 0.2 percent anionic detergent solution of Orvus was sponged on in the same manner. Still no success. A more aggressive approach was taken.

With the fibre content of this dress being silk, assumptions were made that the dye might be of an acid class. An alkaline solution, therefore, might be successful in stripping the unwanted dye. An alkaline solution was prepared using a 0.1 percent solution of sodium carbonate in distilled water. The pH was lowered to 8.9 by adding 4:1 glacial acetic acid in water dropwise. This alkaline solution was applied onto the areas of dye transfer using a dropper and absorbed in a disposable diaper beneath. While the diapers worked reasonably well in pulling the liquid directly downward so as not to spread it to adjacent areas, the suction table was also tried but was found to have an inadequate draw for this purpose. Removal of the navy blue and magenta dyes was moderately successful. The yellow and green dyes tended to leave a yellow halo around the motif that only lightened with repeated applications of all three solutions, but did not disappear.

Areas which were wet but had no dye transfer were sponged with the distilled water and detergent solutions as above. They were dried quickly using hand held blow dryers set on a cool setting. A slight tideline formed upon

drying, so an attempt to remove this by sponging with only a slightly dampened sponge while feathering the edge was tried. There was some success with this technique, however applying the same solutions while using the suction table resulted in greater success. The tideline could be moved to the seam line or hidden by a motif. Treatment on the suction table also prevented the crepe yarn from further twisting and promoted a flattened texture.

#### CASE STUDY III: ACCESSION NUMBER 84.40.1B

An unweighted, shot silk bustle skirt and drape in brick red and teal, dated from the mid 1880s, was damaged in the flood. The front hem area of the skirt was wet and dark tidelines were evident on the right side of the skirt where it had been stained with the flood water but had already dried. The right corner of an additional skirt drape was also wet. Both had been frozen. The skirt drape was easily wetcleaned in a bath of distilled water and a 0.2 percent anionic detergent solution using Orvus. The skirt, however, was not so easily cleaned due to its multiple layers.

Two techniques were used to flush the wet area and reduce the formation of tidelines. With the first technique, the wet areas were sponged with distilled water through to a disposable diaper which was placed beneath each section of pleats and with the second, the suction table was used. Where there were layers of fabric, as with the pleats, the diaper technique was more successful, however with only single layers of fabric the suction table worked well.

Initially a saturated wet sponge was used to supply a greater quantity of distilled water to flush the area. This area was blotted with white cotton towels then encouraged to dry quickly using a hand held blow dryer set on a cool setting. Meanwhile, the perimeter of the stain was feathered out by using a slightly damp sponge. The black tideline softened but continued to move. It appeared as if more than a water mark was staining the fabric. The interfacing beneath the pleats was found to be composed of a black cotton of which the dye exhibited very poor wash-fastness. It was thought that this was likely the source of the black tideline.

#### CASE STUDY IV: ACCESSION NUMBER 73.15.16 A-D

A second silk twill-weave bodice and skirt with a brown cotton interfacing, believed to be dated from the mid 1880s, was frozen in a solid block following the flood. The salvage comments read "Bodice soaked entirely, upper half and all of skirt back soaked, two of the three small fragments are wet, one fragment dry, brown dye fugitive, boning in bodice". These comments, as well as the experience gained from the previous treatment, were found to be very useful for proposing a treatment strategy.

The degree of wetness of all the garment components was extensive, so it was decided that an immersion might be the best treatment to remove the flood water and eliminate the formation of tidelines. A number of the pieces had cream-coloured silk insets decorated with metallic threads so it was decided to test only one fragment first with the full immersion. It was known from the salvage comments that the brown dye was fugitive. The treatment of the fragment in the test immersion was successful. Although the golden brown dye did discharge as expected, it did not transfer.

The bodice and skirt were immersed in a bath of distilled water at 33°C. Initially, there was the golden brown dye discharge as had been seen with the fragment. However, once the lining on the skirt thawed and became wetted there was a severe dark brown dye discharge. It seemed that "clouds" of dye were moving into the bath. The bodice was quickly removed and blotted with white towels. In an attempt to minimize the after effects of the dark brown dye from the skirt, distilled water was allowed to run into the bath while it was draining. The skirt was soon removed and blotted with white cotton towels.

Both the bodice and the skirt were set up to dry quickly with the aid of numerous fans. Because the bodice had iron-based metal stays, which had been identified by the previous rust stains on the inner bodice and by a magnetic pull, rapid cool air from blow dryers assisted the fans with drying. There was no additional iron corrosion evident and no dye transfer to the cream-coloured silk. The positive results of being able to hasten the drying process of a wet treatment on an object with iron-based findings has led to subsequent treatments of such objects—also with positive results.

The skirt treatment was less successful, however. The cream-coloured silk had greyed somewhat and there were numerous tidelines throughout the skirt. It appeared that the dye from the dark brown cotton lining had transferred to the silk. Further treatment strategies were reviewed at this point. Removal of the greying seen on the cream-coloured inset showed some success with a controlled sponging with the anionic detergent solution (0.2 percent Orvus in distilled water) followed by a rinse with distilled water. Detaching this inset and wet-cleaning with detergent was contemplated, however it was decided that subjecting the metallic threads to a second wet treatment was not justified. The improvement to the cream-coloured silk would only be moderate, and damage to the metallic threads a higher risk. There was a possibility of a loss of adhesion of the metallic foil to the paper substrate that would be caused by the detergent solution and agitation of the sponging action.

The skirt required further treatment to reduce the tidelines. A systematic approach was taken by isolating the skirt pleats with disposable diapers beneath for absorption of the wet solutions. Removal of the black tidelines was only successful by flushing with the 0.2 percent anionic detergent solution of Orvus in distilled water, followed by a distilled water rinse over the entire area. Removal also required that the entire pleat be rewet. Basically, the tideline was moved into the seam or buried beneath the next pleat.

Treatments of the above two artifacts exhibited similar results with regards to the black tidelines. The dye from the dark brown or black cotton interfacing had extremely poor washfastness and when in direct contact or close to the outer fabric the dye migrated to the silk. Because further treatment to the tideline did exhibit removal or movement, it is likely that it could be removed if the two layers could be separated. Identification of this dye is not confirmed, however it is suspected to be either a direct dye due to its poor washfastness, or possibly be a mordanted basic dye.

#### CASE STUDY V: ACCESSION NUMBER 89.26.1

A green and beige plaid, silk taffeta dress with a dark beige cotton lining dated from the 1860s suffered water damage along the back sleeve edge and proper left back hem. This dress was missed during the initial salvage operation

so had dried, leaving crisp tidelines in these areas and a softened hand below them.

In testing for colourfastness, the green dye from the dress's outer fabric and skirt lining did transfer in both distilled water and a 0.2 percent anionic Orvus detergent solution. The skirt lining had no tidelines visible, while that of the sleeve did. The treatment objective for this artifact was to remove the tidelines in a controlled manner, while not causing the green dye to transfer, nor excessive wetting of the lining. Therefore, flushing was not an alternative.

Conservator Yolanda Olivotto perfected a tamping technique using blotting paper. Where the tideline was faint, only distilled water was applied by using a slightly damp corner of a small square of blotting paper (only 2 mm square). The moist blotting paper was pressed against the silk, which was then immediately blotted with dry blotting paper to absorb all the water. Where the tideline was darker, the technique incorporated a 0.2 percent anionic Orvus solution followed by a distilled water rinse. This technique successfully removed the tidelines while not wetting out the lining. The crispness of the line was also removed.

#### CASE STUDY VI: ACCESSION NUMBER 87.13.7

A late-19th-century silk diamond-patterned quilt was water damaged along one side. It had been frozen in the walk-in freezer at the Provincial Museum of Alberta. A conservation team treated some of these rolled textiles at the museum within weeks of the flood. However, when the team examined this quilt they decided it required a more time-consuming, specialized treatment, and returned it to the freezer. Once transported to the university, another team of conservators examined the quilt and proceeded to treat it with success.

This quilt was fragile with many silk patches in a degraded state. There was dye transfer from the flood and a student documentation report had noted preexisting areas of dye transfer as well. Full-immersion wetcleaning was not an option.

The tideline, and slightly beyond in the patterned portion of the quilt and to the edge of the border, were flushed with the anionic detergent solution followed with distilled water. The perimeter of the flushed area was feathered out using just slightly dampened blotting paper, as

with the previous treatment. Alternatively, clean white cotton gloves were used instead of blotting paper. Fans were positioned nearby to hasten drying. Once the recto was treated, tidelines on the verso were reduced by using sparingly dampened blotting paper, as with the previous case study.

#### CASE STUDY VII: ACCESSION NUMBER

85.15.1

A turn-of-the-century, wool weft and cotton warp cream-coloured dress with an embroidered net trim over the yoke and cuffs, had water damage along the proper-left back hem. The water damage had left a brown tideline with a crisp edge.

Treatment of this dress proceeded as a standard wetcleaning in a 0.2 percent Orvus anionic detergent solution in distilled water at 27°C. The tideline was easily removed, resulting in a successful treatment.

#### OBSERVATIONS AND RECOMMENDATIONS

##### Salvage

- Volunteers poses varying levels of expertise. Have those with greater levels play more critical roles during the salvage operation, i.e. handling the artifacts and noting the damage.
- In freezing wet artifacts, ensure that they are either bagged separately in clear polyethylene bags or with a similar barrier placed between layers.
- Record all that you can about an artifact given the time you have, i.e. visible damage, fugitive dyes, materials which require special treatment such as baleen boning or iron alloyed findings. The more information the better.
- Good indicators of water damage include stains to the wrappings around the textiles such as cotton muslin and tissue paper, as well as the presence of tidelines, dye transfer, and alteration of texture.

##### Recovery

- Retrieve existing records such as condition reports, documentation records, donor records, photographs, etc. prior to

beginning your treatment. This helps to prepare you, especially if the artifact is frozen and not easily visible.

- Only unroll or unfold frozen artifacts once they have thawed. If there are no indications of fugitive dyes, they can be placed in a cold bath to let them thaw quickly so they can be easily unrolled or unfolded. If time permits they could thaw at room temperature or cooler.
- Clothing objects with metal or organic findings such as baleen boning or iron alloyed boning can be wetcleaned but require special attention during the drying process. For organic materials, the wetcleaning should proceed as quick as possible to reduce the likelihood of thorough wetting. Weights or tension may need to be applied during drying to prevent warping. For metals, dry quickly by blotting well and use fans and blow dryers set on a cool setting.
- Wetcleaning a clothing object with bias trim can often pose a challenge in finishing, as the trim, if pulled off grain in sewing, may not easily lie flat and may tend to buckle.

#### CONCLUSIONS

The University of Alberta Clothing and Textiles Collection survived a flood disaster that was a crisis with a silver lining. The Collection was fortunate to survive this flood relatively unscathed. In the end, only three percent of the artifacts suffered irreparable damage. While not to say this is of no consequence, because some of those artifacts were in excellent condition with good provenance, it is to say, however that it could have been worse. In many cases the damage caused by the flood was “reversible” and the artifact was able to receive a cleaning treatment it desperately needed. When presented with a wet object that would be considered a high-risk or poor candidate for a wet treatment, techniques were explored and often found to be successful. A better understanding of the treatment procedure and results when using water based systems was gained.

Many conservators of institutions suffer from the same woes—too few staff, lack of funding, time constraints, etc. Fortunately, a team of conservators could be hired for this flood

recovery; the insurance guaranteed funding; and, although there was some pressure by the insurance adjusters to finish the work quickly, reasonable time was given to successfully treat the artifacts as needed. While this flood was an unwelcome disaster, as all are, it afforded many with employment, experience and a platform for the sharing of knowledge and techniques.

#### REFERENCES

Gohl, E. P. G. and L. D. Vilensky. 1983. 2nd ed. *Textile Science*. Melbourne, Australia: Longman Cheshire Pty. Ltd.

Johnson, A. ed. 1989. 2nd ed. *The Theory of Coloration of Textiles*. West Yorkshire, G.B.: Society of Dyers and Colourists.

Kerr, N. 1998. Personal communication. Department of Human Ecology, University of Alberta, Edmonton, Alberta, Canada T6G 2M8.

Trotman, E. R. 1970. 4th ed. *Dyeing and Chemical Technology of Textile Fibres*. High Wycombe, G.B.: Charles Griffin & Company Ltd.

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# THE EFFECT OF FREEZE-DRYING ON SELECTED PROPERTIES OF WOOL FABRIC\*

SHAWN GARDNER FISCHER

**ABSTRACT**—Textile collections may become water soaked as a result of natural or man-made disaster. Air-drying, the traditional method, may not be practical when large numbers of textile artifacts are affected. Freeze-drying is the preferred method for drying most water-soaked archival materials. Archaeological textiles recovered from wet sites have been successfully freeze-dried. An appropriate drying method must preserve the aesthetic quality and structural integrity of the artifact. The purpose of this study was to determine how freeze-drying effects selected properties of new, wool fabric. Samples of undyed wool flannel were submerged in deionized water and either air-dried, frozen and air-dried, or frozen and freeze-dried. Analysis compared two levels of preparation temperature, three levels of drying temperature, the interaction of the main effects among the air-dried and freeze-dried samples, and the effect of preparation temperature. Scanning electron micrographs were used to analyze fiber surfaces. The treatment variables caused no change in the tensile properties of the fabric. Shrinkage of samples frozen and freeze-dried was greater than samples air-dried from a nonfrozen condition. Scanning electron microscopy revealed the frozen and freeze-dried samples sustained minor damage to fiber surfaces. Air-drying without freezing caused the least dimensional change and fiber-surface damage.

## INTRODUCTION

Disasters such as floods, fires, and broken water mains may cause water damage to large collections of cultural artifacts. Prompt stabilization and efficient drying methods are required to minimize loss. The choice of drying methods depends not only on the magnitude of the disaster, number of items affected, cause and extent of damage, but also on available resources: facilities, personnel, funds and services. Knowledge of drying methods and their effect on the variety of materials found in historic textile collections is essential to the recovery of water-soaked collections. The salvage of water-soaked collections requires the preservation of the aesthetic appearance of the artifact and removal of excess moisture without causing degradation to the structure of the material (Cunha 1977). This study examined the effect of vacuum freeze-drying on the appearance, dimensions, and physical properties of new, undyed wool fabric. The ultimate goal was to provide fundamental information about freeze-drying as a mass-drying method for large textile collections.

## DRYING METHODS FOR WATER-SOAKED HISTORIC TEXTILE COLLECTIONS

The problems that attend water-soaked textile collections vary with the type and magnitude of the disaster. Most textiles are weaker when wet; some become fragile. This can result in tears, splits, and fabric loss. Finishes, such as glazing, may be damaged. Bleeding dyes from textiles, water-soluble markers, or colored tissue may cause staining. Framed textiles, such as samplers, may be mounted on nonarchival material that also may cause staining. As moisture evaporates, stretching and (differential) shrinking of multiple-component items will cause physical distortion (Francis 1990).

Water-soaked textile artifacts must be dried within forty-eight hours to prevent further damage from mold growth. Two drying methods are recommended in the literature on recovery of water-soaked textile collections: air-drying and freeze-drying (AIC 1994, Francis 1990). Air-drying is a comprehensive drying method; textiles may be wetcleaned and problems such as staining and distortion can be addressed.

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However, air-drying is labor intensive and requires space in a low-humidity environment. A wet textile can be frozen to prevent further damage from water-soluble components (such as dyes), control mold growth by inducing a dormancy state, and provide time to organize drying strategies (Ellis 1999).

The literature on freeze-drying textiles is limited to the recovery of artifacts from archaeological wet sites. Few studies have been done to determine if freeze-drying is an appropriate drying method for water-soaked historic textile collections. Mass-drying techniques may not be suitable for historic textile collections that include a variety of materials and multi-component artifacts. This research project provides information about the effect of freezing temperatures and drying procedures on textiles, which must be further explored before alternative drying techniques, like freeze-drying, can be recommended.

#### THE FREEZE-DRYING PROCESS

In the freeze-drying process, the wet artifact is frozen and ice is removed by sublimation. Sublimation is the conversion of a solid (ice) into a gas (water vapor) without going through a liquid phase. The artifact remains stabilized in a frozen state throughout the drying process. Sublimation occurs at temperatures below 0°C and when the vapor pressure around the frozen artifact is lower than the vapor pressure of the ice in the artifact. Atmospheric freeze-drying, for example, occurs in nature when cold, dry air passes over ice (Mellor 1978).

A method of freeze-drying known as vacuum freeze-drying can be used. The driving force of sublimation, the pressure differential, is increased when the vapor pressure around the frozen artifact is lowered. The frozen artifact is placed in the chamber of a vacuum freeze-drier, and the door is sealed. The vapor pressure within the chamber is lowered by means of a vacuum pump. Molecules escape from the surface of the frozen artifact to form water vapor. Vapor is collected on a refrigerated condenser where it converts back to ice. The artifact dries from the surface toward the center. As drying proceeds, molecules diffuse through the dry layer from the frozen interface within the artifact. As the thickness of the dry layer increases and the rate of molecules escaping from the surface of the artifact decreases, the drying

process slows. To maintain a flow of diffusing molecules, the temperature of the artifact can be raised using radiant-heat platens. Pressure and temperature are variables in vacuum freeze-drying applications (Mellor).

The success of freeze-drying depends on the use of appropriate freezing and drying rates. Rate-determining factors such as temperature, pressure, apparatus, and load size can be controlled. Artifact structure, surface area, moisture content, and position within the chamber also determine freezing and drying rates. In large-system freeze-drying these rates will vary among individual artifacts and may be difficult to predict (Mellor).

#### Conservation Freeze-drying

Vacuum freeze-drying has been used to dry textiles recovered from archaeological wet sites. Archaeological artifacts are freeze-dried with platen temperatures below freezing (Morris and Seifert 1978, Jenssen 1983, Jakes and Mitchell 1992). Vacuum freeze-drying is also used extensively in the disaster recovery of library collections. Salvage freeze-drying methods for books and paper may use platen temperatures above freezing. Higher temperatures reduce the drying time and the cost of freeze-drying (Waters 1993).

Textile conservators developing drying strategies for large textile collections are confronted with practical issues, such as availability of facilities and services, and cost. Optimal process temperatures for freeze-drying textiles can be determined in laboratory studies. The method used for this study was a vacuum freeze-dry using platen temperatures above freezing. Freeze-drying methods used to salvage library collections should be studied to determine whether they should be used for textiles.

#### METHOD

New, undyed wool fabric (Testfabrics Wool Flannel #527) was cut into samples measuring 38 cm by 19 cm. The samples were arranged in seven-layer stacks to represent a folded or rolled textile. Two seven-layered sample groups were randomly assigned to one of seven treatments outlined below (Table 1). Two control sample groups, which received no treatment, were also tested. All treatments were performed twice.

Prior to treatment, each sample group was soaked for twelve hours in 6 l of deionized water with 0.4 g/l wetting agent (C.N.C. gel

concentrate). Immediately before treatment, the sample group was lifted from the water and placed between two plastic screens. The sample was allowed to drain in a horizontal position for twenty seconds, then the screens were lifted and turned over to allow the sample to drain horizontally on the other side for twenty seconds. Air-dried samples were dried in the same seven-layer configuration as freeze-dried samples to determine dimensional change at each phase of the freeze-drying process. Final measurements were made on conditioned samples in a standard-conditioning room (65 percent RH and 20°C).

TREATMENTS

- a. Air-Drying. Sample groups, wet but not frozen, were air-dried on a screen in a standard-conditioning room. Drying took four days. Dryness was determined by weighing at intervals.
- b. Freezing to -20°C and Air Drying. Wet sample groups were placed uncovered on a tray in a -20°C walk-in food-storage chamber for twenty-four hours. Air-drying took six days in a standard-conditioning room.
- c. Freezing to -85°C and Air Drying. Sample groups were frozen uncovered on a tray to -85°C in a chest freezer for twenty-four hours. Air-drying in a standard-conditioning room took seven days.
- d. Freezing to -20°C and Freeze-drying to 18°C. Sample groups were frozen uncovered on trays in a -20°C walk-in food-storage chamber for twenty-four hours. Samples were freeze-dried in thirty hours at a pressure of 0.2 mm Hg, to a final shelf temperature of 18°C. A stem thermometer placed into the middle layers of the sample group, was used to measure sample temperature. Dryness was determined by sample temperature and feel.
- e. Freezing to -85°C and Freeze-drying to 18°C. Sample groups were frozen uncovered on trays to -85°C in a chest freezer for

treatment	Preparation				Drying		
	wet	RT	frozen		RT	Freeze-dry	
			-20°C	-85°C		18°C	30°C
<b>a</b>	X	X			X		
<b>b</b>	X		X		X		
<b>c</b>	X			X	X		
<b>d</b>	X		X			X	
<b>e</b>	X			X		X	
<b>f</b>	X		X				X
<b>g</b>	X			X			X

RT = room temperature

Table 1. Treatments.

twenty-four hours. Samples were freeze-dried at a pressure of 0.2 mm Hg, to a final shelf temperature of 18°C, in thirty hours.

- f. Freezing to -20°C and Freeze-drying to 30°C. Sample groups were frozen uncovered on trays in a -20°C walk-in food-storage chamber for twenty-four hours. Samples were freeze-dried at a pressure of 0.2 mm Hg, to a final shelf temperature of 30°C, in twenty-four hours.
- g. Freezing to -85°C and Freeze-drying to 30°C. Sample groups were frozen uncovered on trays to -85°C in a chest freezer for twenty-four hours. Samples were freeze-dried at a pressure of 0.2 mm Hg, to a final shelf temperature of 30°C, in twenty-four hours.

TESTS

Tensile Properties

Tensile strength tests can indicate changes in molecular bond breakage and formation in the fiber (Carter 1971). Significant decreases in tensile strength are an indication of degradation (Slater 1991). The average of five measurements was used to determine the peak load and the elongation of each sample layer. Specimens were tested in random order with a Q-Test Constant Rate of Extension apparatus.

Dimensional Change

Dimensional change was determined by measuring the outer dimensions of each sample layer before and after treatment. The percent of dimensional changes in length, width, and area were calculated. The typical percent relaxation dimensional change for Testfabrics Wool Flannel

#527 was determined using AATCC Test Method 99-1995 *Dimensional Changes of Woven or Knitted Wool Textiles: Relaxation, Consolidation and Felting*.

#### Moisture Content

The formation or breakage of bonds may cause a change in the sorption behavior of textile fibers. The weight of each sample layer at equilibrium in standard conditions was determined before and after treatment. Percentage change in weight was calculated using the formula:  $(A - B)/B \times 100$ , where A is the conditioned weight of the sample layer after treatment and B is the conditioned weight of the sample layer before treatment (ASTM 1992).

#### Statistical Analysis

The significance of the quantitative results was tested with one- and two-factor analysis of variance (ANOVA). The two sets of independent variables were preparation temperature at three levels (room temperature,  $-20^{\circ}\text{C}$ , and  $-85^{\circ}\text{C}$ ) and drying condition at three levels (room temperature, freeze-dried to  $18^{\circ}\text{C}$ , and freeze-dried to  $30^{\circ}\text{C}$ ). The dependent variables were tensile strength, percent elongation, dimensional change, and weight change. Two-factor analysis compared two levels of preparation temperature, three levels of drying condition, and the interaction of the main effects among the air-dried and

freeze-dried samples. One-factor ANOVA represented all the air-dried samples for the effect of preparation temperature.

#### Fiber Surface

Scanning electron micrographs of representative fibers from the top layer of each treatment group were taken at 800X magnification. The top layer of each sample was analyzed because it was exposed to longer drying times than other layers. A blind evaluation of the micrographs indicated three general categories of fiber surface condition; micrographs were ranked according to degree and type of damage.

### RESULTS AND DISCUSSION

#### Tensile Properties

No statistically significant change in the tensile strength was found in any of the samples (Table 2). No degradation occurred that could be measured by this tensile test.

#### Dimensional Change

Significant dimensional change (shrinkage) on the basis of freezing temperature among the air-dried samples (Fig. 1). Samples air-dried from a nonfrozen condition shrank less than those air-dried after being frozen. The greatest dimensional change was found in the samples

<u>Treatment</u>	<u>Peak Load</u> lbsf	<u>Elongation</u> at Break %	<u>Dimensional</u> Change *	<u>Weight</u> Change **
Air-dried	25.53 (0.88)	55.24 (1.65)	4.42 (0.79)	1.86 (0.77)
Frozen $-20^{\circ}\text{C}$ /Air-dried	25.40 (0.63)	55.6 (2.13)	6.82 (0.74)	-1.21 (1.51)
Frozen $-85^{\circ}\text{C}$ /Air-dried	26.28 (3.07)	55.08 (1.33)	6.781 (0.51)	0.00 (0.91)
Frozen $-20^{\circ}\text{C}$ /Freeze dried $18^{\circ}\text{C}$	25.20 (0.72)	55.73 (1.25)	7.98 (0.55)	-3.01 (0.14)
Frozen $-85^{\circ}\text{C}$ /Freeze dried $18^{\circ}\text{C}$	26.01 (0.49)	55.63 (1.41)	7.6 (0.73)	-0.24 (0.32)
Frozen $-20^{\circ}\text{C}$ /Freeze dried $30^{\circ}\text{C}$	25.90 (0.80)	56.31 (2.26)	7.07 (0.84)	-0.45 (0.10)
Frozen $-85^{\circ}\text{C}$ /Freeze dried $30^{\circ}\text{C}$	25.78 (0.87)	55.26 (1.66)	7.84 (0.82)	-1.70 (0.39)

\* Dimensional change = the area dimensional change, a percentage change from the before treatment area

\*\* Weight change = the mean percent change from before-treatment weight of the sample layers. A minus sign indicates weight loss. Standard deviations noted in parentheses.

Table 2. Means of Tensile Properties, Dimensional Change, and Weight Change by treatment.

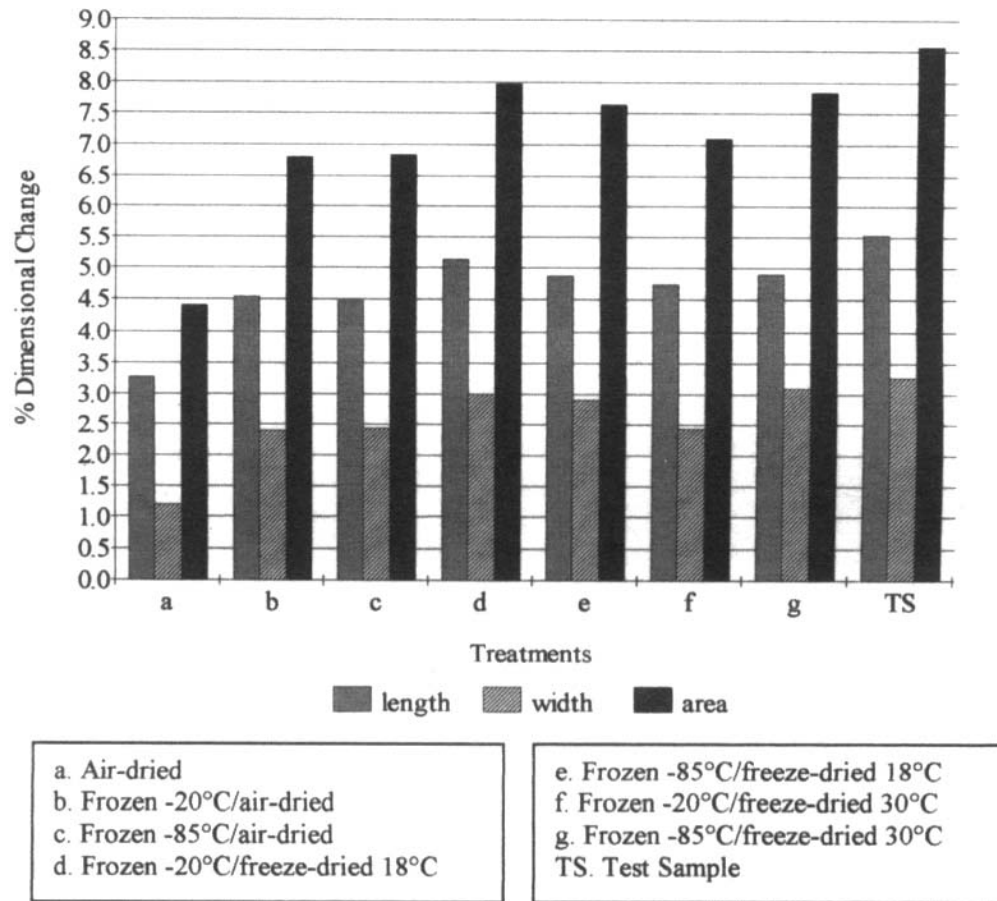


Fig. 1. Dimensional Change by Treatment.

frozen at -20°C and freeze-dried to 18°C. The greater degree of shrinkage in the freeze-dried samples compared to the air-dried samples was unexpected.

The greater degree of shrinkage of warp yarns is an indication of relaxation shrinkage. Yarns stressed during manufacturing relax when the textile is wet. This result is dimensional change, especially in the warp yarns (AATCC 1995). The greater degree of shrinkage in the test fabric may have been due to being dried in single layers. The experimental samples were dried in a group; this may have prevented individual layers from shrinking to the same extent as the test fabric. The high moisture content of the samples contributed to dimensional change when water between yarns expanded as it froze. Frozen samples were thicker when dry than those dried from a nonfrozen condition.

#### Moisture Content

Significant changes in conditioned weight after treatment (moisture content) were found throughout the experimental samples. Most of the moisture-content changes may have been due to a two to three percent hysteresis. Samples conditioned from wet to dry, such as air-dried samples, may maintain higher moisture content under the same conditions than samples that are conditioned with lower moisture content. This difference in moisture content is called hysteresis (Zeronian 1984). Weight changes in the frozen and air-dried samples were inconsistent; more tests will indicate whether weight changes were due to damage.

#### Fiber Surface

A blind evaluation of the scanning electron micrographs indicated three general categories of fiber surface condition. The first category

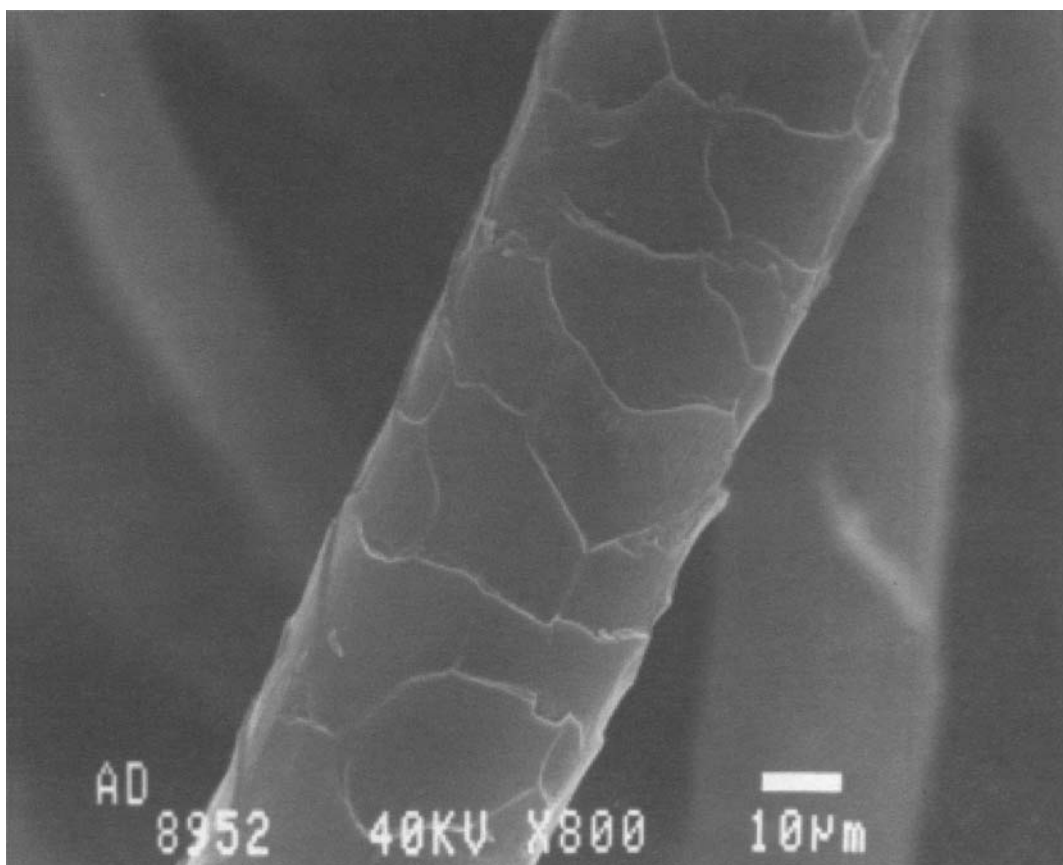


Fig. 2.  
Scanning Electron  
Micrograph of air-  
dried sample.  
800X.

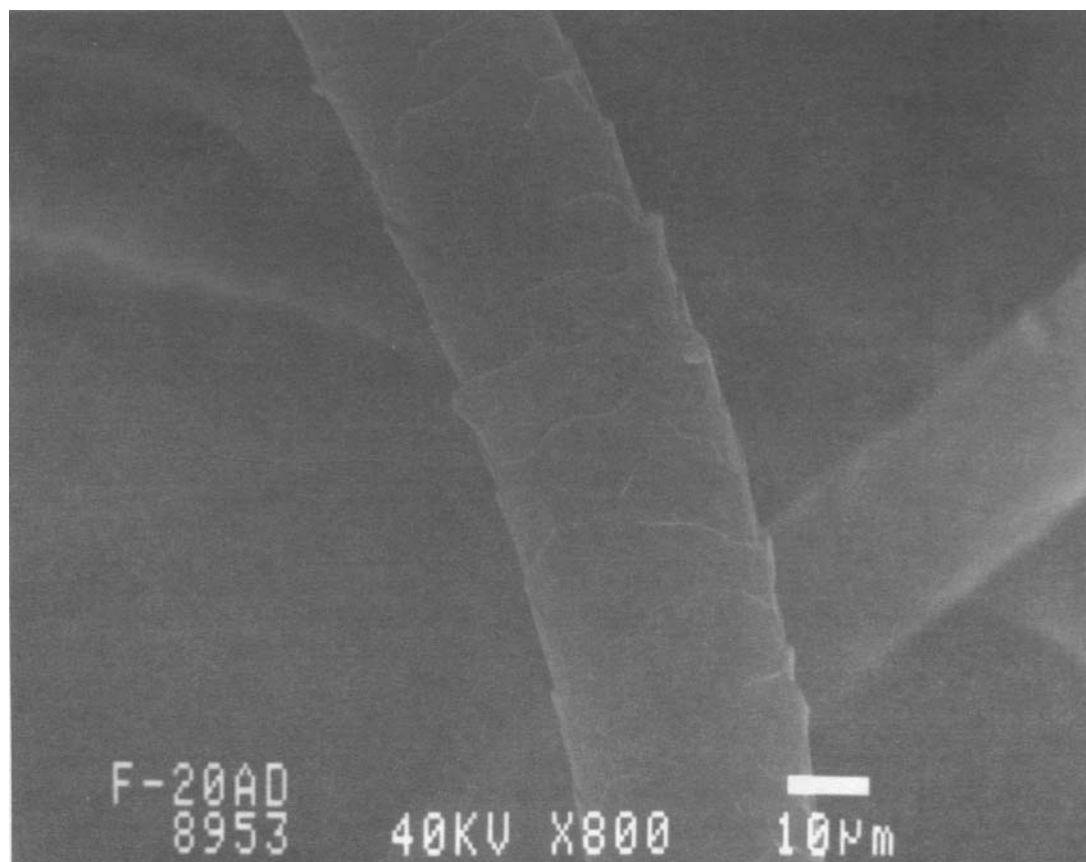


Fig. 3.  
Scanning Elec-  
tron  
Micrograph of  
sample frozen to  
-20°C and air-  
dried. 800X.

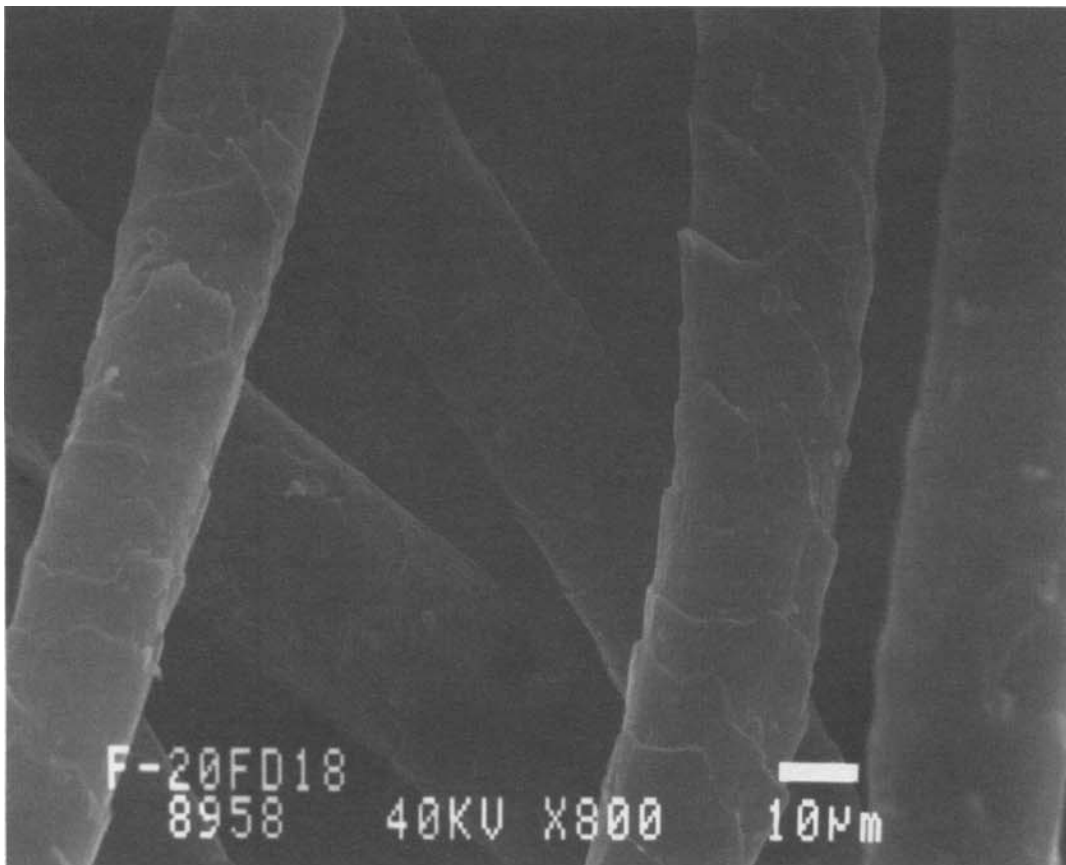


Fig. 4. Scanning Electron Micrograph of sample frozen to  $-20^{\circ}\text{C}$  and freeze-dried to  $18^{\circ}\text{C}$ . 800X.

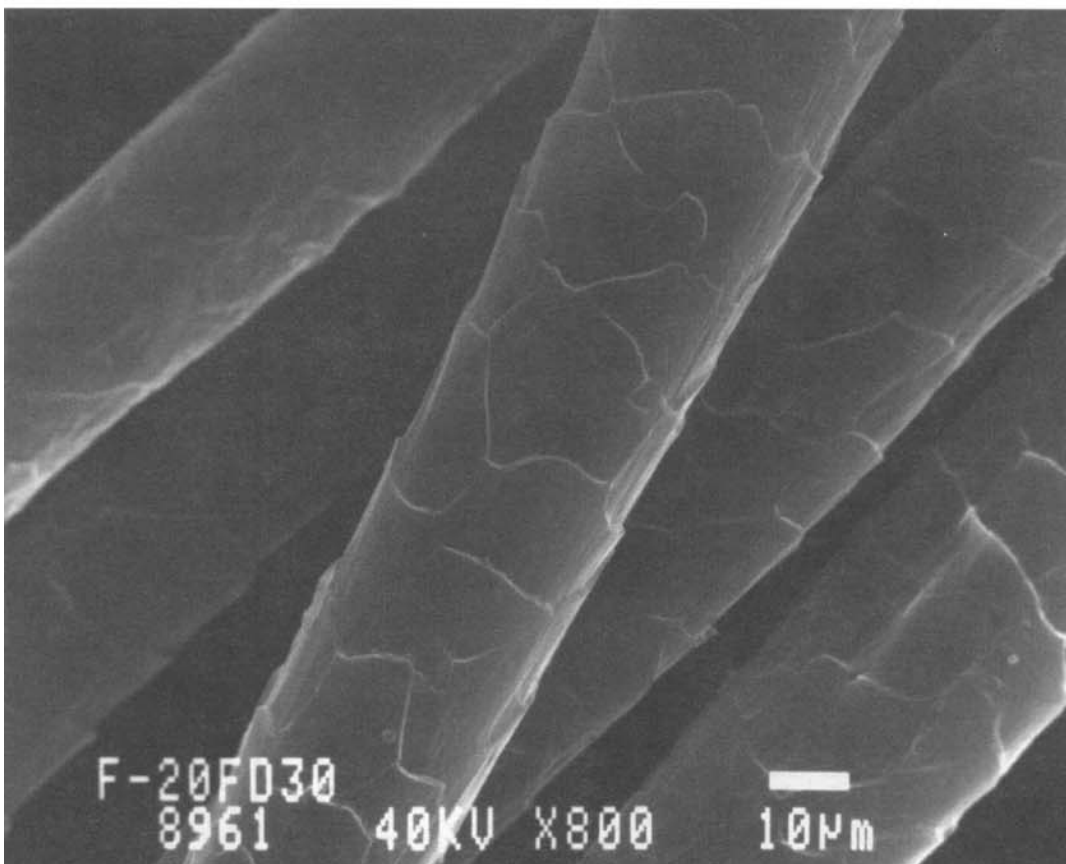


Fig. 5. Scanning Electron Micrograph of sample frozen to  $-20^{\circ}\text{C}$  and freeze-dried to  $30^{\circ}\text{C}$ . 800X.

showed little or no damage; this group included fibers from nonfrozen, air-dried samples (Fig. 2). Fibers from samples frozen to  $-20^{\circ}\text{C}$  and air-dried had some broken scales and some scales slightly opened (Fig. 3). Fibers from samples frozen to  $-20^{\circ}\text{C}$  and freeze-dried to  $30^{\circ}\text{C}$  had similar damage (Fig. 4).

The second category, fibers from samples frozen to  $-85^{\circ}\text{C}$  and freeze-dried to  $30^{\circ}\text{C}$ , showed some broken scales and scales standing out from the fiber surface.

The third category includes fibers from samples frozen to the lower temperature and air-dried, or freeze-dried at lower temperatures and longer drying times. Typical examples of damage on fibers in the third group were: scales standing out from fiber axis; and many small fragments of broken scale edges; damage all along the scale margin on some fibers. A few fibers had vertical damage crossing more than one scale.

Damage to fiber surfaces was caused by water freezing around fiber; fibers may become more susceptible to further damage from chemical attack and fluctuations in relative humidity. The sample frozen to  $-20^{\circ}\text{C}$  and freeze-dried at  $18^{\circ}\text{C}$  shows particles around fibers from the top layer (Fig. 5). Some migration of particles to the surface in vacuum freeze-drying and has been observed in other studies (Buchanan 1994, Jakes and Mitchell 1992, Tarleton and Ordoñez 1995). In the recovery of water-damaged collections, contaminants and debris deposited on the surface of the textile during vacuum freeze-drying may need to be removed by further treatment, such as wetcleaning.

## CONCLUSION

Scanning electron micrographs revealed at least some fiber surface damage in all frozen samples. This suggests that freezing treatments may compromise the longevity of the some textiles. The benefits of stabilization by freezing should be weighed against the possibility of fiber surface damage, however. This study indicated that air-drying from nonfrozen condition yielded the most satisfactory results compared to other treatments. Vacuum freeze-drying at platen temperatures above freezing did not adversely effect the properties of wool fabrics as tested in this study.

Freeze-drying is a complex procedure; several other studies need to be done. The contribution of dyes and contaminants to the freezing and drying characteristic of textiles during the vacuum freeze-drying process (especially methods using platen temperatures above freezing) needs to be considered.

Similar freeze-drying studies should be done using other types of textiles found in historic collections. Historic textile collections typically include a complex variety of materials and multicomponent artifacts. Laboratory studies can provide fundamental information about freeze-drying textiles, however many problems arise with practical application; appropriate preparation, packing and handling methods need to be determined. The results of this research project can help textile conservators understand the freeze-drying process. More research needs to be done to enable textile conservators to specify appropriate freeze-drying methods for salvaging textile collections.

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## REFERENCES

- American Association of Textile Chemists and Colorists (AATCC). 1995. *Technical Manual*. North Carolina: American Association of Textile Chemists and Colorists.
- American Institute for Conservation (AIC). 1994. *Salvage of Water-Damaged Collections: Salvage at a Glance*. Chart compiled by the American Institute for Conservation, Washington, D.C.
- American Society for Testing and Materials (ASTM). 1992. Textiles. *Annual Book of ASTM Standards* Vols. 7:1 & 7:2. Philadelphia: American Society for Testing and Materials.
- Buchanan, S. 1994. Drying Wet Books and Records. *Northeast Document Conservation Center Technical Leaflet*. Andover,

Massachusetts: Northeast Document Conservation Center.

Carter, M. 1971. *Essential Fiber Chemistry*. New York: Marcel Dekker, Inc.

Cunha, G. 1977. An Evaluation of Recent Developments For the Mass Drying of Books in *The Preservation of Paper and Textiles of Historic and Artistic Value*. American Chemical Society 72nd meeting, Washington, D.C. 95-104.

Ellis, S. 1999. Disaster Recovery at the University of Alberta, or Every Flood Has a Silver Lining. *Textile Specialty Group Postprints*, Twenty-Sixth Annual Meeting, Arlington, Virginia. 45-52.

Francis, K. 1990. Disaster Prevention, Preparedness and Recovery: Special Concerns for Textile Collections. *Federation Files*. New York: The Federation of Historical Services.

Jakes, K., and J. Mitchell. 1992. The Recovery and Drying of Textiles from a Deep Ocean Historic Shipwreck. *JAIC* 31: 343-353.

Mellor, J. D. 1978. *Fundamentals of Freeze-Drying*. New York: Academic Press.

Morris, K., and B. Seifert. 1978. Conservation of Leather and Textiles From the Defence. *JAIC* 8: 33-43.

Slater, K. 1991. Textile Degradation. *Textile Progress* 21(1/2) P.W. Harrison, ed. Manchester, England: The Textile Institute.

Tarleton, K., and M. Ordoñez. 1995. Stabilization Methods for Textiles from Wet Sites. *Journal of Field Archaeology* 22 (1): 81-94.

Waters, P. 1993. *Procedures for Salvaging Water Damaged Library Materials*. Extracts from unpublished revised text, the Library of Congress, available at [www.nih.gov](http://www.nih.gov).

Zeronian, S.H. 1984. Analysis of the Interaction Between Water and Textiles, in *Analytical Methods for a Textile Laboratory*. North Carolina: American Association of Textile Chemists and Colorists. 117-128.

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# OBSERVATIONS ON SOOT REMOVAL FROM TEXTILES

JOANNE HACKETT

**ABSTRACT**—This paper describes the cleaning of a variety of textiles damaged by soot during a domestic house fire. The characteristics of soot are described, as well as the methods used previously by conservators to clean soot-damaged museum objects. Various methods used in the cleaning of the soot-damaged textiles are described, including nonpolar solvent poultices, aqueous poultices, wet cleaning with solvent and surfactant solutions, and the removal of particulate soot with vacuum cleaners and vulcanized rubber sponges. A brief investigation into the composition and treatment characteristics of vulcanized rubber sponges is also included.

## INTRODUCTION

On Christmas Eve 1996, the Higley family of Delaware returned from a church service to find their house on fire. An insufficiently extinguished candle had caused a fire that destroyed much of their house and belongings, and severely damaged what remained. Their neighbor, Gregory Landrey, Director of Conservation at the H. F. duPont Winterthur Museum, offered to help salvage some of their treasured possessions. He felt that this would not only benefit the Higley family, but would also provide a useful learning experience for the students and conservators at the Museum. Among the objects he brought in for treatment were furniture and frames, a collection of Victorian valentine cards, family photographs, and textiles.

The textiles arrived interleaved in newsprint, inside boxes wrapped in plastic. The textiles smelled very strongly of smoke, and were blackened with soot. Some of the textiles were also scorched, and some had candle wax melted into them. A quick inventory revealed around thirty textiles including lace table clothes and doilies, an embroidered picture, sailing pennants and awards, Christmas stockings, souvenir hats, and the Christmas tree angel.

## CHARACTERISTICS OF SOOT

The composition and characteristics of soot largely depend on the types of materials that have been burnt. Soot is a mixture of particulate carbon, organic tars, resins, and inorganic materials. Depending on the type of materials burned, and the type of combustion, the tarry component of the soot can be over twenty-five percent by weight of the soot (Gunn et al. 1983). Typically, what we think of as soot (particulate

carbon) accounts for less than fifty percent of the weight.

In the Higley family house fire, the burning of synthetics such as carpeting, upholstery, electronic equipment, and paints, resulted in smoke and soot deposits, which were particularly sticky and tenacious. A similar type of soot could be expected from the combustion of materials typically found in museum galleries and storage areas. The analysis of the soot deposited after the 1985 fire at the Huntingdon Art Gallery, which developed in an elevator shaft, revealed a composition of fifty percent elemental carbon and fifty percent organic carbon—a greasy material (Verheyen 1987). The soot deposited on the Higley family textiles had a slightly acidic pH of 5.8, and this appears to be typical.

The significance of the very sticky soot deposited on the Higley family textiles was that it did not respond well to the vacuum cleaner, and when the particulate matter was removed, the textile below was discolored with yellow and brown staining.

## PREVIOUS TREATMENT STRATEGIES

Vacuuuming has always been advocated as a first step in the removal of soot from artifacts. This method was found to be highly effective in the cleaning of the objects damaged during the 1990 fire at the Saskatchewan Museum of Natural History (Spafford and Graham 1993). A micro-adapted vacuum nozzle was found to be the most effective way of removing soot from the fur and feathers of the natural history specimens. The vacuuming was followed by dry cleaning with eraser-type products, and wiping with aqueous and solvent-based systems. Ethanol, and a one percent solution of Vulpex in trichlorethylene, were found to be the most

effective materials for removing the remaining residues, depending on the type of material being cleaned and the degree of soot coverage.

Vacuuming was again the most effective treatment for the textiles damaged in 1980 due to a furnace puff back at the History Museum at the Museums at Stony Brook (Gray Armstrong et al. 1981). Due largely to the more particulate nature of the soot generated from the furnace (though it did have an oily component), and the fact that objects far away from the furnace outlet had only a very light dusting of soot, this was the only treatment carried out on the majority of the textiles damaged in this incident. The textiles on display in the galleries were the most damaged, and these were wetcleaned in the conventional manner where possible. Textiles that could not be wetcleaned were referred to commercial dry cleaners, though it was found that the effectiveness of the dry cleaning was largely proportionate to the amount of agitation possible.

The textiles damaged in the Huntingdon Gallery fire were first vacuumed without any surface contact at all. Large, complex objects such as upholstered chairs and carpets, were then treated with rice-hull ash and Freon solvent poultices. Textiles that could be washed were washed in a conventional way (Verheyen 1987).

Vulcanized rubber sponges (or dry-chem sponges as they are sometimes called) are widely used in the commercial fire and flood business for cleaning all kinds of surfaces. This type of sponge was used after the Saskatchewan Museum fire to clean dioramas and other smooth surfaces (Spafford and Graham 1993). They were also used by the staff of the Jenkins Publishing Company in Austin, Texas following a disastrous fire in their rare book room. The sponges were used with success to clean bindings, and proved especially effective on smooth cloth, though the sponges were found to leave a residue and smell (Etherington 1986).

It has been reported that earlier brands of dry-chem sponges were chemically impregnated, hence the name. This may account for the residue and smell experienced by the staff of the Jenkins Publishing Company (Mowery 1991).

## CLEANING THE HIGLEY FAMILY TEXTILES

Preliminary testing of the Higley family textiles showed that vacuuming, even at high suction, was going to be of little use in removing the particulate soot. Vulcanized rubber sponges were tested next with gratifying results. These had been found to be most useful in cleaning the soot from the valentine card collection salvaged from the Higley's house (Price 1997). The brand of sponge used to clean the valentine cards, "Dry Magic Wallpaper Cleaner", was tested on one of the textiles and was found to remove the majority of the surface soot. The sponges were gently wiped over the surface, using a clean sponge surface as soon as one side was dirty. The sponges can be washed in plain water, and reused when dry, though they tend not to pick up soot as effectively after washing. It is therefore a good idea to cut the sponges into small flat rectangles to provide the largest surface area possible for cleaning.

Once the surface soot had been reduced, the residue below was tested with a variety of solvents. Those tried were: tetrachloroethylene; xylene; Stoddard Solvent; 50/50 acetone/2 percent Orvus WA Paste in deionized water; acetone; ethanol; 2 percent Triton in deionized water; 0.2 percent Triton XL-80N in deionized water; and deionized water. Acetone and Stoddard Solvent were most effective in moving the yellow/brown residue from the textile. The 50:50 Acetone/2 percent Orvus in deionized water combination was also effective in removing the yellowing, and removed more of the particulate soot. Ethanol was also effective, but less so than other combinations. Both tetrachloroethylene and xylene were quite effective in moving the yellow/brown staining, but were felt to be too noxious to be used for such large scale cleaning as the Higley textiles would require. The surfactant and water combinations were not effective in moving the yellow/brown staining, but did show signs of reducing the particulate soot further.

A general strategy was developed for the cleaning. First, particulate soot would be reduced using the vulcanized rubber sponges. After removing the soot, the level of discoloration in the textile would be assessed, and depending on the degree of discoloration in the textile, it would be treated with a sequence of solvents. Proceeding from nonpolar to polar, the solvents would be applied in a variety of ways. The final step would be to wet clean the textile if possible.

## CELLULOSIC TEXTILES WITH LITTLE SOOT

Three identical doilies were treated first to evaluate the treatment of cellulosic textiles with little soot accumulation, as many of the Higley family textiles fell into this category. The circular lacy doilies were made of crocheted heavy-weight cotton. All had light soot accumulation on one side only, with clear patches where objects had stood on them during the fire. Two were initially treated. The first was wiped all over with a vulcanized rubber sponge, and then wetcleaned inside a fume hood in a solution of 50:50 acetone/one percent Orvus in deionized water. Solvent and surfactant mixture do not foam very much at first, due to the depressing effect of the solvent on the efficiency of the surfactant, but as the solvent evaporates from the mixture the surfactant becomes more effective. The doily was agitated with sponges and a stiff brush during soaking. The doily was then rinsed in deionized water and dried beneath a clean cotton muslin cloth. The second doily was wiped with the sponge, wetcleaned with one percent Orvus in deionized water only, rinsed, and dried. The doily that had been washed in Orvus solution only was very slightly more yellow after drying, and so the third doily was cleaned with the 50:50 acetone/Orvus solution.

A rectangular piece of cotton with a batik design of a head was treated in a similar way to the doilies. Particulate soot was removed from the surface with a vulcanized rubber sponge. Less soot was removed from this textile in this way than any of the other textiles treated. The soot seemed to be particularly stuck to the surface, possibly due to wax residue remaining from the batik process. Dyes used in the batik design proved to be fugitive to acetone, and so a 25:75 ethanol/1 percent Orvus in deionized water solution was used to wetclean this textile, and proved to be very effective.

## CELLULOSIC TEXTILES HEAVILY COATED WITH SOOT

Two identical round, embroidered cotton doilies with a heavy coating of soot were treated in slightly different ways to evaluate the effectiveness of the treatments. One was wiped with the vulcanized rubber sponge and then laid in a shallow photographic tray lined with blotting paper. Stoddard solvent was applied to the top of the textile with an eyedropper, blotter was laid on top, and all layers were weighted down with Plexiglas blocks to keep close contact between

the textile and the blotters. The whole package was then placed in the fume hood and left until the Stoddard Solvent had evaporated. The blotters were considerably yellowed when removed. The textile was then washed in 50:50 acetone/one percent Orvus in deionized water, rinsed and dried. The second doily was treated in the same way except for the omission of the Stoddard Solvent and blotting-paper poultice. The results in both cases were good, but with a slight yellowness noted on the doily that was not treated with Stoddard Solvent.

A rectangular cotton cloth edged with fine bobbin lace was one of the most heavily soot-coated objects treated. The piece was totally blackened with soot except for very bright spots where objects had stood on the surface during the fire. One edge of the bobbin lace was also scorched and partially burnt, and there were tidelines from the water used to extinguish the fire. The lace was in fragile condition generally with some small tears and losses. In the interests of saving as much of the Higley's possessions as possible, this textile was given a more thorough and aggressive treatment.

The top surface of the doily was wiped with vulcanized rubber sponges, which had little effect. The textile was then treated with Stoddard Solvent in the manner described above. It was then washed in 50:50 acetone/one percent Orvus in deionized water, though with no agitation of the delicate bobbin-lace edges. After rinsing and drying, it became clear that the bobbin lace was still quite heavily soiled with soot, though the central cotton portion of the textile was quite clean. The textile was laid on a sheet of Mylar on the countertop. A thin layer of cotton wadding soaked in one percent Orvus in deionized water was laid over the soiled bobbin lace, and then covered with a thick layer of cotton. The textile was allowed to dry overnight. It was then removed and rinsed again in deionized water. The cotton and Orvus-solution poultice was very effective in removing the soot trapped in the bobbin lace. The areas of scorching in the lace edging were treated locally with a three percent solution of hydrogen peroxide. This effectively minimized the jarring appearance of the scorching. The torn lace was then repaired with fine cotton thread.

## SYNTHETIC TEXTILES

On the whole, synthetic textiles responded poorly to treatment. Two nylon yachting

pennants with moderate soot coverage and yellow staining proved the most difficult to treat. The particulate soot was fairly easy to remove using vulcanized rubber sponges and mechanical action, while cleaning the pennants with solvents and then solvent and surfactant mixtures. One pennant was treated with a Stoddard Solvent and blotting-paper poultice prior to wet-cleaning. A solution of 50:50 acetone/0.2 percent Triton XL-80N was used to wetclean both of the pennants. However, the yellow/brown understaining did not respond well to any of the solvents used, and some staining remained despite all efforts to remove it.

A synthetic lace tablecloth with only a very light dusting of soot responded in a similar way to the pennants: the particulate soot was easily removed by washing, but the yellow staining below remained. Clear circles where objects had stood on top of the tablecloth during the fire could still be seen after treatment, though the textile did not appear to be badly soot-damaged prior to treatment.

#### WOOLEN TEXTILES

Three wool felt hats were treated by wiping them with vulcanized rubber sponges, and then rolling cotton swabs moistened in Stoddard Solvent over them. Much of the particulate soot was removed using this treatment, though the hats still smelled strongly of smoke. In an attempt to minimize the smell, the hats were wrapped in activated charcoal cloth and left for several days. This had limited success.

Commercial dry cleaning was recommended for one of the hats, an English naval cap, which remained soiled after treatment.

#### RESULTS OF TREATMENT

The results of the treatments were mixed. Generally, cellulosic textiles responded very well to cleaning: particulate soot was easily removed with mechanical means, and the yellow staining could be removed if treated rather aggressively with solvents. Many of the treatment steps require more mechanical action than would be usual when treating delicate museum objects.

Poulticing, though time consuming, was effective in removing both soot and staining, and would probably be a better way to approach the cleaning of delicate textiles. Poultices of solvents

and of surfactant solutions were tried on the Higley textiles, and both were effective.

Wools and synthetics proved harder to clean. The fibers seemed to have more of an affinity with tarry and oily components of the soot, and efforts to remove the staining using a variety of methods and materials met with limited success.

No silk items were included in the textiles salvaged from the fire. Given the chemical similarity between silk and nylon one could expect that silk might respond in a similar manner to the nylon sailing pennants.

Objects that could not be wetcleaned in some way retained a strong smell of smoke after treatment, and while this does not effect the aesthetic value of the object too badly, it does indicate that products of the fire were still present.

The treatment of composite objects, such as the family Christmas stockings (which were made from recycled antique cotton quilts trimmed with synthetic lace, ribbon, and metal bells) also had mixed results. The cotton quilt body of the stocking responded well to cleaning, but the synthetic ribbon and lace trimming did not, and so the overall appearance of the stocking after treatment was disappointing. Another composite object, the Christmas tree angel, had to be partially disassembled to allow cleaning of the textile portions without destroying painted paper elements and metallic trimming.

#### THE TIME FACTOR IN CLEANING SOOT-DAMAGED TEXTILES

The majority of the textiles were cleaned five months after the fire, in May and June of 1997. A number of textiles were not cleaned at that time, but were left in the original cardboard boxes, interleaved with newsprint, until April 1998—some sixteen months after the fire. While the particulate soot was as easy to remove after sixteen months as it was after five months, the yellow/brown staining below the soot was not. In the more heavily soot-coated textiles, this understaining could not be entirely removed after sixteen months using the same methods used earlier.

## TESTING OF THE VULCANIZED RUBBER SPONGES

Vulcanized rubber sponges proved invaluable in the preliminary cleaning of the Higley family textiles, by removing particulate soot from all kinds of surfaces without leaving any visible residue. Most of the textiles treated with the sponges were consequently washed in some way, and so the concern about residue from the sponges was less of a concern. However, some of the Higley family textiles treated with these sponges were not subsequently wetcleaned and so I felt it would be useful to investigate some of the properties of these sponges.

Previous research carried out at CCI had shown the sponges used in the Saskatchewan Museum of Natural History fire cleanup, and other brands commonly available in Canada, to be composed of vulcanized cis-1, 4-polyisoprene, with calcium carbonate fillers. They also contained a trace amount of oil, probably from the manufacturing process, and the trace elements S, Al, Si, Fe, Zn, and Na (Moffatt 1986, 1991, and 1992).

Six brands of vulcanized rubber sponges available from conservation supply houses in the United States were tested at the Museum of Fine Arts, Boston, using FTIR microspectroscopy. All brands were found to be composed of poly(isoprene), 1, 4-cis, with a calcium carbonate filler in almost identical proportions.

The concern for conservators using these sponges is the sulfur used to vulcanize the poly(isoprene) and make it into a solid material rather than a sticky liquid. The question of whether the sponges crumble when used, or leave behind a sulfur-containing residue, was investigated next.

Following the guidelines laid out for Oddy testing for off-gassing of materials, the possibility of leaving behind residue when using vulcanized rubber sponges was tested for in the following way. Three strips of washed cotton muslin were cut from the same piece of fabric. One strip was put aside as a control and the other two were wiped ten times on each side with a "Wonder Sponge" brand vulcanized rubber sponge. One of the treated strips was then vacuumed carefully on both sides using a dental aspirator. Three small squares were cut from the center of each of the strips and assigned a random number. Each of the pieces was placed in a

glass container with a small vial of deionized water and three small metal coupons, one each of copper, silver and lead. The glass containers were stoppered, labeled with their randomly assigned number, and placed in an oven at 60°C for twenty-eight days.

The tarnishing found on all of the samples was very slight, and some of the metal coupons were not tarnished at all. The metal coupons were evaluated by four independent observers who ranked them from least tarnished to most tarnished. No difference was noted in the tarnishing of the coupons in the untreated group compared with the group of samples that had been wiped with the sponge and then vacuumed. The independent observers consistently reported more tarnishing on the metal coupons in the group of samples that had been wiped with the sponge but not vacuumed. This would seem to indicate that vacuuming the samples removes particles that cause the coupons to tarnish. It must be remembered that the Oddy test is not a sensitive test, and that the sample group was small.

Three other strips of washed cotton muslin were cut from a different piece of fabric. One piece was set aside and the other two were wiped ten times on both sides with a "Wonder Sponge" brand vulcanized rubber sponge. One of the treated samples was carefully vacuumed with a dental aspirator. A square was cut from the center of each piece and they were labeled as 'untreated', 'treated', and 'treated and vacuumed'. Each sample was examined using a Scanning Electron Microscope, and no difference could be seen between the untreated sample and the two treated samples. No residue of a particulate nature could be seen on any of the samples.

## CONCLUSIONS

In the light of the investigations mentioned in this paper, and the successful removal of soot from the Higley family textiles, vulcanized rubber sponges appear to be a good choice in the cleaning of soot-covered but sturdy textiles, particularly when vacuuming makes little impact on the soot.

The use of nonpolar solvent poultices in conjunction with wetcleaning using polar solvent and surfactant solutions proved successful in the cleaning of even heavily soot-covered cellulosic textiles. While particulate soot could be removed from synthetic materials and wool using

similar methods, the tar and organic resins deposited with the soot resisted removal by all methods tried.

Textiles that were not cleaned shortly after the fire proved much more difficult to clean after having been left for a year. Particulate soot could be removed, but the tar and organic resins in the soot could not be completely removed. This suggests that soot-damaged articles be cleaned soon after a fire if permanent damage is to be avoided.

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#### REFERENCES

- Etherington, D. 1986. 1985 Rare Book Fire. *Abbey Newsletter* 10 (5): 72.
- Gunn, E. F., P. H. Johnson, C. A. Hau, and R. H. Toeniskoetter. 1983. Distinguishing Features of Soots and Carbon Blacks. *Dangerous Properties of Industrial Materials Report* 3 (2): 11–13.
- Gray Armstrong, J., D. Ganloff Dowd, M. V. Pike, and S. Stitt. 1981. A Furnace Puff-back: The Unique Problem of Soot on Objects and Costumes. *AIC Preprints*, Ninth Annual Meeting, Philadelphia, Pennsylvania. 10–19.
- Moffatt, E. 1986. Analysis of Smoke-Off Sponge. *Conservation Material Report Summary* ARS 2445. Ottawa: CCI.
- Moffatt, E. 1991. Analysis of Rosco Sponge. *Conservation Material Report Summary* ARS 2928. Ottawa: CCI.

- Moffatt, E. 1992. Analysis of Wallmaster Chemical Sponge. *Conservation Material Report Summary* ARS 3100.1. Ottawa: CCI.
- Moffatt, E. 1992. Analysis of "Chemical" Sponges used by the Commercial Fire Clean-up Industry to Remove Soot from Various Surfaces. Technical Notes, *Bulletin IIC-CG* 17 (3): 9–10.
- Mowery, F. 1991. Chemical Sponges. Products and Services. *Abbey Newsletter* 15 (7).
- Price, L. O. 1997. Personal Communication. Book and Archive Conservation, H. F. duPont Winterthur Museum, Winterthur, Delaware. 19735.
- Spafford, S., and F. Graham. 1993. Fire recovery at the Saskatchewan Museum of Natural History: Part 1, Description of Events and Analysis of Recovery. *ICOM-CC Postprints*, Tenth Triennial Meeting, Washington, D.C. 413–419.
- 1993. Fire recovery at the Saskatchewan Museum of Natural History: Part 2, Post-Disaster Cleanup and Soot Removal. *ICOM-CC Postprints*, Tenth Triennial Meeting, Washington, D.C. 420–426.
- Verheyen, C. Y. 1987. Renovation of the Huntingdon Art Gallery Following the 1985 Fire. *WAAC Newsletter* 9 (2): 2–5.

#### SOURCES OF MATERIALS

Vulcanized rubber sponges:

Absorbene "Dirt Eraser": Conservation Resources, 8000-H Forbes Pl., Springfield, Virginia 22151; 800-634-6932; and Gaylord Bros., Box 4901, Syracuse, NY 13221-4901; 800-634-6307.

The Gonzo Corporation "Wonder Sponge": Hardware stores, and bed-and-bath emporiums.

Sparkle Plenty "Dry Magic Wallpaper Cleaner": hardware stores.

No Brand Name: Talas, 68 Broadway, New York, NY 10012; 212-219-0770; Conservation Support Systems, 924 West Pedregosa Street, Santa Barbara, CA 93101; 800-482-6299; and University Products, P.O. Box 101, 517 Main Street, Holyoke, MA 01041; 800-532-9281.

Activated charcoal cloth: Charcoal Cloth Ltd.,  
East Wing, Bridgwater Lodge, 160 Bridge Road,  
Maidenhead, Berkshire, SL6 8DG, U.K.

Orvus WA Paste: Talas, 568 Broadway, New  
York, NY 10012; 212-219-0770.

Triton XL 80-N: Conservation Support Systems,  
924 West Pedregosa Street, Santa Barbara, CA  
93101; 800-482-6299.

Stoddard Solvent, acetone, ethanol, xylene and  
tetrachloroethylene: all available from Fisher  
Scientific and other chemical supply houses.

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# FROM ARCHIVE TO DATABASE TO RESEARCH TOOL: THE TRANSFORMATION OF AN UNCATALOGUED SAMPLE COLLECTION INTO AN ACCESSIBLE DATABASE

ROBIN HANSON

**ABSTRACT**—For over twenty years, objects that have been treated in the textile conservation laboratory at the National Park Service, Division of Conservation, at Harpers Ferry Center (HFC) in Harpers Ferry, West Virginia, have routinely been sampled for fiber identification. While these samples have been duly mounted on microscope slides, and methodically filed in microscope slide boxes with a zeal approaching religious fervor, the tales these fibers have to tell have remained, up to now, locked inside the fibers themselves. Although this unparalleled resource has grown exponentially, it remains virtually inaccessible. The goal of this database creation project is to integrate data from the many paper documents and multiple files in which it is presently stored, into a single, readily available computer record. Through the use of a relational database—Microsoft Access—information extracted from the fiber samples themselves will be easily retrievable. The database will provide invaluable knowledge about deteriorated and degraded fibers, as well as about fabrication technologies and techniques in historic textiles. It is hoped that this project will serve as a model for those wishing to set up their own microscope slide fiber reference library.

## INTRODUCTION

Since 1976, objects that have passed through the textile conservation laboratory at the National Park Service, Division of Conservation, at Harpers Ferry Center (HFC) in Harpers Ferry, West Virginia, routinely have been sampled for fiber identification. Today the textile lab's archive of microscope slides with fiber specimens has grown to a compendium of nineteen boxes, containing nearly 2,000 slides and over 2,500 fiber specimens. The entire collection occupies only a portion of one shelf in a cupboard in the textile lab (Fig. 1). Not a standard reference set of idealized, perfect specimens of select fiber types, rather this archive is a collection of fiber samples from historic artifacts in varying states of degradation, and from National Park collections throughout the country. The specimens are primarily cotton, bast, silk, and wool fibers, although some synthetic fibers are certainly represented.

In an attempt to provide access to the information contained in this archive, the Division of Conservation (DOC) is in the process of creating a database that will compile, in one location, information that currently is recorded on a Fiber Analysis Form (Fig. 2) and dispersed in numerous paper files. In so doing, a collection of virtually inaccessible samples will become a true



Fig. 1. Microscope slide archive housed in the textile conservation laboratory, National Park Service, Division of Conservation, Harpers Ferry Center, Harpers Ferry, West Virginia.

**FIBER ANALYSIS**

Park:  
Object:  
Catalog No.:

HFC Reg. No.:  
Date:  
Examined By:

SAMPLE LOCATION	WEAVE STRUCTURE		COLOR	COUNT	MAKE-UP	SLIDE #	RESULTS	NOTES
		WARP						
		WEFT						
		WARP						
		WEFT						
		WARP						
		WEFT						
		WARP						
		WEFT						
		WARP						
		WEFT						
		WARP						
		WEFT						
		WARP						
		WEFT						

COMMENTS:

Fig. 2. Fiber analysis form currently in use in the textile conservation laboratory.

reference library of fiber specimens and a powerful research tool.

**PROJECT GOALS**

Because this project is still in its formative stages, the many ways in which this information may be used in the future, and by whom, is not yet entirely clear. As a result, the goal of flexibility in database creation necessarily was of utmost importance. In order to design a database that is as flexible as possible, considerable time was spent on the planning phase. Information was gathered from various sources with comparable databases, including from the field of forensic science. While equipment and space needs for establishment of a similar resource are minimal, another crucial goal in this project is the retrieval and systematic storage of information extracted from the fibers themselves.

archiving specimens has changed little. One or two fiber samples are preserved on each microscope slide, which is labeled with basic information (Fig. 3) including the unique number assigned by the registrar to each object that enters the Division for treatment. Inclusion of this number allows fiber specimens to be traced back to specific objects, albeit not easily. In addition, the four-letter acronym specific to the park owning the object is recorded on the slide, along with the slide number—a unique number assigned consecutively.

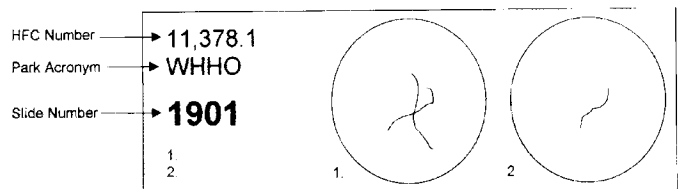


Fig. 3. Microscope slide format including basic information recorded on the slide itself.

**FIBER ARCHIVING PROCEDURES**

The DOC's microscope slide archive was simple to initiate and has been equally easy to maintain. Over the years, the system for

The technique used at the DOC to archive fiber specimens is quite straightforward. A minute fiber sample is taken from an object and placed on a microscope slide containing a drop of water. With the aid of needles or probes, and a stereo binocular microscope if necessary, the sample is teased apart to separate it into individual fibers. The sample is then covered with a glass cover slip, viewed under the polarized light microscope to enable identification, and then set aside to allow the water to evaporate. At this point the slide is made permanent by applying two small drops of clear nail polish to opposite edges of the cover slip. If the specimen needs to be viewed at a later date, water can be injected under the cover slip with a hypodermic needle, eyedropper, or capillary pipette.

The use of nail polish to secure cover slips is the one aspect of this project that has changed materially in the last two decades. Initially, Aroclor, Canada balsam, or cellulose nitrate was used to secure cover slips, in a traditional, permanent-mount format. In the intervening years, the first 100-plus microscope slides have turned white and cloudy, and the fiber specimens are no longer visible. Another eighty specimens have yellowed considerably, but the specimens remain viewable. An additional 270 slides are “permanently” mounted in the traditional format. Since the mid-1980s, the use of two dots of nail polish has been the standard.

The materials and equipment needed to begin an archive such as the one at the DOC are few and, with the exception of the microscope itself, not expensive. While the textile lab now has at its disposal a new Olympus BX50 polarized light microscope equipped with a PM-30 automatic photomicrographic system, this has not always been the case. As designed, this project is certainly one that can proceed in phases, with equipment added or upgraded as budgets allow. Even without a resident microscope,

samples can be archived for analysis by an outside concern, or saved for a later date when equipment is available. Other than a microscope, supplies needed include microscope slides and cover slips; water; sampling tools (such as scissors, tweezers, and a probe); nail polish; permanent marking pens; and a slide storage box (Fig. 4).

#### COMPUTERIZATION OF DATA

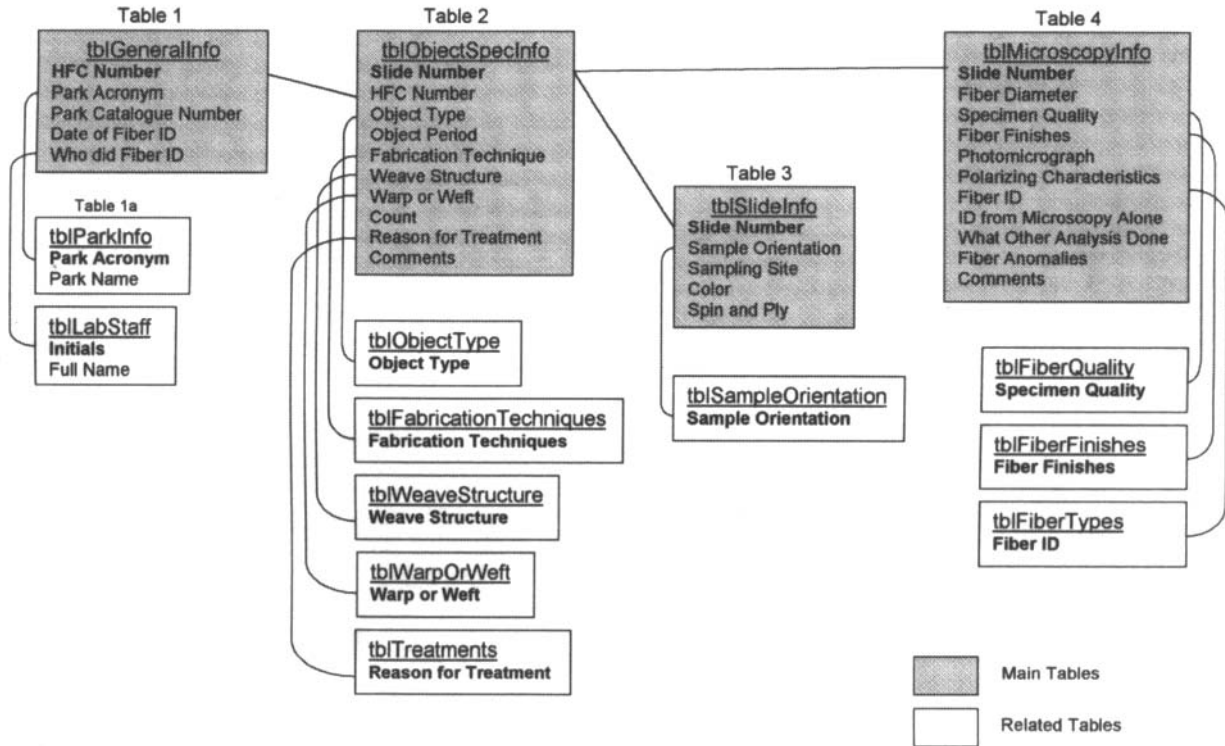
The software chosen for this database project was Microsoft Access, a relational database program. Access belongs to a suite of software programs called Microsoft Office, which is standard for the National Park Service, and many other institutions. Access also is an extremely powerful and flexible program, and easily will serve the needs of this database well into the future.

As outlined in Figure 5, this database is organized into four main tables with eleven related tables (Tables 1, 2, 3, and 4, shaded gray) with eleven related tables. This model is certainly neither the only, nor necessarily the best, configuration of the data. Rather it is a starting point, and as such will provide those who choose to duplicate HFC's database with a place to begin and a model to improve upon. The rationale for



Fig. 4. Tools and supplies needed to archive fiber specimens on microscope slides.

## Database Tables and Relationships



12/08/98

Fig. 5. Chart showing database tables and their relationships for Microsoft Access fiber reference library database.

organizing information in this manner is described below.

The first main table, Table 1 in Figure 5, is referred to as the General Information table. It records basic information about an object and includes five fields:

- HFC Number—a unique number assigned by the registrar
- Park Acronym—a unique, four-letter abbreviation assigned to each park site
- Park Catalog Number—a number assigned by a park site to each object in its collection
- Date of Fiber Identification

- Who Performed Fiber Identification—initials of the textile lab staff person undertaking fiber analysis

The second main table, Table 2 in Figure 5, is referred to as the Object Specific Information table. It is linked to the first main table (the General Information table) through the HFC Number field. This link is represented by the solid black line connecting the field HFC Number in Table 1 and the field with the same name in Table 2. This table includes ten fields:

- HFC Number Slide Number—a unique consecutively assigned number
- Object Type—standardized nomenclature such as quilt, sampler, civil war uniform, etc. to be determined by lab staff

- Object Period—can be as specific as a year, or as general as “late 18th century”
- Fabrication Technique Weave Structure—this field is only completed if the response to the prior field is “woven”
- Warp or Weft—is the sample a warp or a weft fiber, or neither
- Count—the number of warp or weft yarns per cm
- Reason For Treatment—why is the object in the lab, was it wetcleaned, or was something done to it which may alter the fiber
- Comments—a field to incorporate information not included in any of the above fields

The third and fourth main tables, Tables 3 and 4 in Figure 5, are both linked to the second main table through the Slide Number field, but are not linked directly to each other. These links again are represented by the solid black lines connecting Tables 3 and 4 to Table 2 through the Slide Number field. The Slide Information table includes five fields:

- Slide Number Sample Orientation—is the sample longitudinal or cross sectional
- Sampling Site—where on the object was the sample taken
- Color
- Spin and Ply

Finally, the Microscopy Information table (Table 4) includes eleven fields:

- Slide Number
- Fiber Diameter
- Specimen Quality—a subjective classification as to level of deterioration
- Fiber Finishes
- Photomicrograph— a yes/no field indicating whether or not a photomicrograph was taken
- Polarizing Characteristics

- Fiber Identification
- Identification From Microscopy Alone—a yes/no field indicating whether or not other analysis was necessary to identify the fiber
- What Other Analysis Was Done—if microscopy alone was not enough to identify the fiber, what other analysis, i.e. FTIR, was performed
- Fiber Anomalies
- Comments

The eleven related tables, located below the four main tables in Figure 5, contain preentered menu-accessible information. They serve as look-up tables which allow nomenclature to be standardized throughout, thereby avoiding inconsistent terminology and inefficient searching. They also speed up the data entry process by providing lists of options from which to choose. Table 1a, the Park Info table (Fig. 5) for example, contains a pulldown menu listing the names and acronyms of all 378 parks. When the Park Acronym field in the General Information table is reached during data entry, the related table can be directly accessed and the correct acronym for the park owning the object in question entered. From these tables, myriad forms, queries, and reports can be created. Several prototype forms have been designed for both retroactive data entry and fiber analysis, and to answer hypothetical questions posed by the textile historian and conservator. In addition, the Fiber Analysis form currently in use in the lab has been redesigned within the Access format (Fig. 6). Access’s inherent flexibility allows the creation of additional forms, queries, and reports as specific questions are asked and needs arise.

While some of the retroactive data entry is routine and can be done by anyone with basic computer skills, other aspects of the data entry are more subjective, and require input by someone with extensive experience in microscopy and fiber identification. Information to be entered into the Specimen Quality field, for example, is highly subjective and comparative, and necessitates the individual physical reexamination and evaluation of each specimen in the archive. From this reexamination, quantification of levels of deterioration is possible, with each fiber “graded” on a scale from one to ten, corresponding to a specific level of deterioration. Once

## Fiber Analysis Report

HFC Number: 11378.001  
 Object Type: creche figure  
 Object Period: 18th century

Park Acronym: WJHO  
 Park Catalogue Number: 967.607.10

Date of Fiber ID: 10/2/97  
 Who did Fiber ID: RJ1

Sampling Site	Weave Structure	Warp or Weft	Color	Count (per cm)	Spin and Ply	Slide Number	Fiber ID	Comments
cape - area of darned mend	plain	warp	yellow	42	S singles	1900.1	silk	Italian
cape - area of darned mend	plain	weft	yellow	42		1900.2	silk	Italian
headscarf hole	plain	warp	translucent	42	Z singles	1901.1	silk	Italian
headscarf hole	plain	weft	translucent	42	Z singles	1901.2	silk	Italian
skirt center back seam	3/1 twill	warp	light blue	47	S singles	1902.1	silk	Italian
skirt center back seam	plain	weft	light blue	40	S singles	1902.2	silk	Italian
apron raw edges	plain	warp	green	98	S singles	1903.1	silk	Italian
apron raw edges	plain	weft	green	36	S singles	1903.2	silk	Italian
blouse raw edges	plain	warp	off-white	35		1904.1	cotton (unmercerized)	Italian
blouse raw edges	plain	weft	off-white	41		1904.2	cotton (unmercerized)	Italian

Fig. 6. Fiber Analysis report created in Microsoft Access.

information for the entire collection is entered into this field, it alone becomes a major component of what makes this archive useful for conservators.

Testing will be undertaken to determine the feasibility of importing digitized images of the archived specimens themselves, within the Access program. It is not yet clear whether resolution of digitized images will be high enough to be useful. If not, the digitization process will remain a phase of the project to be completed in the future, when resources exist within the Park Service for such.

### CONCLUSION

Wholesale data entry has not yet occurred; however, information on approximately eight artifacts has been entered for beta testing purposes, to work out bugs and remove glitches. Once computerization is complete, it is anticipated that this resource will serve a number of functions both internally and externally, for conservators and historians alike. Within the Division, the database will be a readily available

reference tool, able to answer questions from National Parks about specific objects treated. In cases where retreatment of an object is anticipated, samples taken during prior treatment will be readily accessible and will obviate the need for resampling. Information extracted from the fibers themselves may assist in the dating of an object. Ultimately, the database will serve as both a research and reference tool regarding fiber types and stages of deterioration. It may assist in setting up a protocol for differentiating between bast fiber types, and in investigating weighted silk, to name but a few. It is also expected that digital images of the fibers will eventually be transmitted electronically, thereby further increasing the utility of this resource. An inaccessible archive will have been transformed into a true reference library of deteriorated fiber specimens.

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#### REFERENCES

- Alden, H. 1998. Personal communication. Microscopist, Smithsonian Center for Materials Research and Education, 4210 Silver Hill Road, Suitland, MD 20746.
- Carroll, G. R. 1992. Forensic Fibre Microscopy. In *Forensic Examination of Fibres*, ed. James Robertson. New York: Ellis Horwood. 99-126.
- Carroll, G. R., W. C. Lalonde, B. D. Gaudette, S. L. Hawley, and R. S. Hubert. 1988. A Computerized Database for Forensic Textile Fibres. *Canadian Journal of Forensic Science* 21 (1& 2): 1-10.
- Goodway, M. 1987. Fiber Identification in Practice. *JAIC* 26: 27-44.
- Laing, D. K., A.W. Hartshorne, R. Cook, and G. Robinson. 1987. A Fiber Data Collection For Forensic Scientists—Collection and Examination Methods. *Journal of Forensic Sciences* 32 (2): 364-369.
- Padama, A. D. 1998. Personal communication. President, Advance Business & Computer Training Center, 9055 Comprint Court, Suite 320, Gaithersburg, MD 20877.
- Thomsen, F. 1998. Personal communication. Textile Preservation Association, P.O. Box 606, Sharpsburg, MD 21782.





# A DISASTER? INJURING OURSELVES THROUGH THE WORK WE LOVE

PATRICIA SILENCE

**ABSTRACT**—One of the worst disasters faced by textile conservators is that of personal injury due to repetitive motions and sustained positions. Conservators are often reluctant to talk about this problem; there is some stigma involved. They are afraid injuries may impact future employment. They are afraid injuries may impact current employment. This article identifies symptoms of musculoskeletal disorders, and risk factors for these types of injuries. Equipment and techniques used at the Textile Conservation Center to provide safe working conditions for the conservator are discussed. A copy of the “Ergonomics Survey for Textile Conservators” taken of attendees of the 1998 Textile Specialty Group Meeting in Arlington, Virginia, is included.

## INTRODUCTION

In considering the 1998 American Institute for Conservation Meeting theme of Disaster Preparedness, Response and Recovery, it behooves us to consider the disaster of personal injury. The goal in disaster preparedness is to be primed to handle an emergency situation. Planning and foresight is rewarded by inconvenience, as opposed to a full-blown catastrophe. Personal safety necessitates the same degree of preparedness. Conservators are often reluctant to talk about this problem; there is some stigma involved. They are afraid injuries may impact future employment. They are afraid injuries may impact current employment. This presentation addresses some of the ways in which injuries can be prevented by applying sound ergonomic practices. Ergonomics is the study of the natural laws of work. We need to learn about ergonomics as it applies to textile conservation work.

This information is not a comprehensive investigation into the topic. It is based on personal experiences that have resulted in awareness of

these issues. Just as we go far afield to find tools and techniques to accomplish conservation in the best possible way, we must also go outside our tiny world to gather ergonomics information that applies to textile conservation work. There is no “Textile Conservators Guide to Working Safely”. There is, however, published information on ergonomics for computer users, dental hygienists, artists, meat packers, musicians, sewing machine operators, dancers, and even tapestry weavers. The articles reviewed for this presentation offered similar medical information regarding the risk factors to, and disorders of, the musculoskeletal system.

## DISORDERS OF THE MUSCULOSKELETAL SYSTEM

Musculoskeletal disorders may be as simple as a stiff neck or hand fatigue (Fig. 1). Symptoms are so common that one may not necessarily know when to pay attention. These injuries can be general, but belie the seriousness of the situation. Aching, stiffness, tingling, tenderness, pain, swelling, numbness, crackling, and poor circulation are all common symptoms of musculoskeletal disorders. Weakness, joint-movement loss, and decreased coordination are very alarming evidence that one’s body is being harmed (McCann 1998).

Any one of these symptoms may impede the control required to perform delicate treatments. These are indicative of strain injuries or cumulative trauma disorders, resulting from trauma, overuse, or working in awkward positions (Fig. 2). These injuries have many medical names and manifest in symptoms in various body parts. Tendons (including joint linings), muscles, and



Fig. 1



Fig. 2.

nerves are usually the sites of these problems (McCann). One can recover from these ailments. One can also be permanently disabled by them.

#### RISK FACTORS FOR INJURIES

Normal textile conservation activities expose conservators to commonly cited risk factors. Frequent repetition of a sequence of motions puts one at risk of an overuse syndrome. Repeating a sequence more than twice a minute can be considered high repetition (McCann). Activities such as stitching, vacuuming, or cleaning with swabs, typing, microscopy, or measuring with pipettes employ repetitive motions.

Awkward postures can also contribute to musculoskeletal disorders. These include hand positions, head angle, and asymmetrical posture while sitting or standing. Ergonomic specialists advise against holding ones arms out past sixteen inches for extended lengths of time. They further advise against bending forward while grasping light objects within this sixteen-inch work space. Maintaining arms extended above shoulder height is not recommended for long periods of time, nor is bending the elbow more than ninety degrees (Babin 1994, McCann, Stavroudis 1993). Are safe positions always possible during tasks such as tapestry conservation?

Another risk factor for cumulative trauma disorders is extended work time with insufficient rests. Four hours a day at a repetitive task, even with breaks, is considered excessive. Occupational therapists advise brief postural breaks

every fifteen to thirty minutes. Stretching activity during these breaks allows for recovery. Carol Battan, author of "Tapestry and Ergonomics" discusses a weaver winding thread off of a bobbin in a circular motion as providing "tension relief and a boost to circulation" (1997).

Several other practices have been cited as having significant risk factors. High force activities, such as hammering and lifting may come to mind immediately. One must also consider how pinching a small needle to maintain control stresses muscles and tendons in the hand and wrist. Pressure from arms resting on sharp table edges, or legs pressed against a chair seat, can contribute to injuries. Working in cold temperatures and vibration from tools are also risk factors. The final contributor to injury cited by ergonomic health care professionals is stress. Stress often accompanies a tight deadline, a project with no margin for error, or a big work load (McCann).

#### WORKING SAFELY

Observing how other professions have solved similar problems, and adopting or



Fig. 3.

adapting this information, is one way in which textile conservators can develop some safer techniques. We can draw from ergonomics information as well as professional journals for computer users, dental hygienists, or performing artists.

There are a number of ways that our work methods can be modified to prevent injuries. The science of ergonomics adapts the job to the worker, not the worker to the job. To this end, colleagues at the Textile Conservation Center have developed methods to care for textiles and accommodate personal safety at the same time.

#### Equipment

An auto mechanic's dolly serves to allow two people to stitch cooperatively on a well supported textile (Fig. 3). The upright person must



Fig. 4.

take a postural break between stitches in order to prevent holding the weight of her head and upper torso cantilevered in an awkward position for too long. She is relieved by her colleague of the awkward position required to place a proper perpendicular stitch from under the textile.

A bridge over a textile also provides access to all parts of a fully supported textile (Fig. 4). Reclining on the padded bridge eliminates leaning forward and provides a better view of the work in progress.

When seated, proper chairs are critical to comfortable posture. The conservator must be able to modify the seat height and tilt, footrest height, and back support pressure as needed. Chair adjustments should be made throughout the day to make subtle changes in body position. Standard office-type work chairs do not provide desirable lumbar (lower back) support required when the worker must lean forward. A conservator may need to sit in her chair backwards (with the back rest supporting her chest and upper arms) for periods of time, again in order to change position during reaching activities (Fig. 5). Dental assistants use special chairs that support their bodies from the front as they work leaning forward.

Work space can be reconfigured quickly, easily, and safely when treatment tables, wash tables, and tapestry frames are on wheels. This relieves conservators of heavy lifting and awkward pushing.



Fig. 5.

**Ergonomics Survey for Textile Conservators**

1. Have you had any of these physical symptoms of overuse during and/or following conservation activities?
- |                                     |   |   |
|-------------------------------------|---|---|
| <input type="checkbox"/> Aching     | <input type="checkbox"/> Swelling         | <input type="checkbox"/> Joint movement loss    |
| <input type="checkbox"/> Stiffness  | <input type="checkbox"/> Numbness         | <input type="checkbox"/> Decreased coordination |
| <input type="checkbox"/> Tingling   | <input type="checkbox"/> Crackling        | <input type="checkbox"/> Other                  |
| <input type="checkbox"/> Tenderness | <input type="checkbox"/> Poor circulation |   |
| <input type="checkbox"/> Pain       | <input type="checkbox"/> Weakness         |   |

---

2. Which body parts have been affected? (i.e. hands, arms, eyes, etc.)

---

3. If you have had symptoms, what have you done about them?

- |   |  |
|---|--|
| <input type="checkbox"/> Seen a health care provider (what type)? | <input type="checkbox"/> Ignored the symptoms?   |
| <input type="checkbox"/> Taken medication?                        | <input type="checkbox"/> Stretched or exercised? |
| <input type="checkbox"/> Rested the affected part(s)?             | <input type="checkbox"/> Other?                  |

---

4. Do certain activities or positions cause you to have particular symptoms? What activities and / or positions? What symptoms?

---

5. Have you found or modified specialized tools or equipment to allow you to work more comfortably?

---

6. Has an ergonomics specialist visited your work place to offer suggestions on safe working habits?

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7. Do you regularly exercise or engage in physical activity programs? What do you do?

---

8. Do you regularly use physical therapies such as massage, chiropractic, etc.?

---

9. Do you work full-time or part-time?

---

10. Are you in private practice, at a museum or institution, a regional center, and/or other?

---

11. Is your job primarily hands-on conservation or administration?

---

12. Would you like to see more information on this subject?

---

13. Do you think that the Health and Safety Group of the AIC should address the topic of ergonomics?

The results of this survey will be presented to the AIC Textile Specialty Group and the AIC Health and Safety Group. If you have questions or comments, please contact Patty Silence, Assistant Conservator, Textile Conservation Center, American Textile History Museum, 491 Dutton Street, Lowell, MA 01854, (978) 441-1198, [psilence@athm.org](mailto:psilence@athm.org). **Please return this completed survey by June 20, 1998.**

Fig. 6.

## Physical Activity

It is important to stretch heavily used muscles throughout the work period. Textile conservators may have very strong pectoral or hand muscles, due to constant exercise. If these are not kept in balance with surrounding muscle groups, injury can result. Weight training, yoga, swimming, and isometric muscle work are employed by conservators to maintain strength and flexibility. This preventive conservation of one's body is rewarded by quick recovery when we do overuse certain parts.

## SURVEY RESULTS

In order to make some generalizations about health problems related to textile conservation work, the "Ergonomics Survey for Textile Conservators" was taken of attendees of the 1998 Textile Specialty Group Meeting in Arlington, Virginia (Fig. 6). The results of this survey are still being tallied, and will be presented at the 1999 Textile Specialty Group Meeting in St. Louis, Missouri.

## CONCLUSION

We often work with textiles that we perceive as being more fragile than our own bodies. This can cause us to push ourselves to the point of injury. Preparing for rigorous work by understanding one's limits, modifying tools and equipment, and staying strong and flexible will allow us to continue the work we love.

## REFERENCES

- American Physical Therapy Association. 1993. Hand and Wrist Relief. *Vitality in Motion* 3: 4.
- Babin, A. 1994. Ergonomics in Conservation. *AIC News* 19(1): 1-3.
- Battan, C. 1997. Tapestry and Ergonomics. In Conversations (by S. Troon). *International Tapestry Journal* (Winter): 20-23.
- Benton, M.L. 1989. Ergonomics: Adapting the Job to Fit the Person. *Job Safety & Health Quarterly* (Fall): 4-9.
- Brody, J. 1992. Epidemic at the Computer. *New York Times Science Times* (March 3): B1, B9.
- Carson, R. 1995. How to Select a Proper Workbench. *Occupational Health and Safety* (April): 53-56.
- Kroemer, K. 1992. Avoiding Cumulative Trauma Disorders in Shops and Offices. *American Industrial Hygiene Association Journal* 53 (September): 596-604.
- McCann, M. 1998. Art-Related Musculoskeletal Disorders. *Art Hazards News* 21(1): 3-6.
- Mital, A. 1997. Recognizing Musculoskeletal Injury Hazards in the Upper Extremities and Lower Back. *Occupational Health and Safety* (August): 91-99.
- Occupational Safety and Hazard Association (OSHA). 1998. On-Site Consultation Job Design Reduces Back Injuries. *Safeworks* 12.
- Ostrem, T. 1995. Strong, Balanced Muscles Can Prevent CTS. *Occupational Health and Safety* (September): 47-49.
- Stavroudis, C. 1993. Facts About Cumulative Trauma Disorders. *WAAC Newsletter* 15 (2): 39-40.
- Westmoreland, R. 1993. Cumulative Trauma Disorders: Some Cautions for Conservators. *WAAC Newsletter* 15(2): 37-38.
- Wolkomir, R. 1994. When the Work You Do Ends Up Costing You an Arm and a Leg. *Smithsonian* (June): 90-101.

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# REEVALUATING THE CRAFTS TRADITIONS OF TEXTILE CONSERVATION

SARA J. WOLF

ABSTRACT—"Repair" and "mending" are terms associated with the craft of commercial textile restoration, as "stabilization" and "consolidation" are associated with the profession of textile conservation. Are these differences of vocabulary merely semantics—words designed to distance "profession" from "occupation"—or are these differences substantial, philosophical departures? During a one-year research project in Turkey, a study of the craft traditions of rug and kilim restoration were studied to reexamine the techniques used. The major question posed was whether anything has been lost (tools, techniques) from the craft approach that might be useful in the context of today's conservation methodology. Secondary issues included the following: what limits, if any, do the carpet dealers place on restoration; what limits, if any, do the restorers place on restoration; and what is the relationship between the client and the restorer? An additional issue examined was how the techniques of restoration being practiced today will impact the preservation of rugs and kilims that ultimately will end up in museum collections in the next ten to thirty years.

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# Resúmenes en Español

## Cuando poner parches no es práctico: compensación no tradicional por pérdida en un quilt\*

SUSAN R. SCHMALZ

RESUMEN—Los conservadores textiles que exploran técnicas no tradicionales de compensación por pérdida han venido aumentando. Alternativas como la de teñir parches para recubrir abarca una gran variedad de métodos de coloración a mano sobre soportes textiles. Ese artículo se enfocará en una técnica de tratamiento, la cual incorpora pintura acrílica aplicada sobre crepelina, esta técnica fué inventada con el fin de reintegrar visualmente la pérdida masiva en el borde de chintz de un quilt de mitad del siglo diez y nueve.

El quilt forma parte de la colección de Hampton House, Maryland. Este sitio histórico nacional fué habitado durante más de dos siglos por la ilustre familia Rigdley. Los numerosos daños en el borde del quilt hacen que los parches tradicionales sean poco prácticos. El tratamiento propuesto como solución comprende la estabilización del deteriorado chintz color marrón con la crepelina pintada sobrepuesta, la cual oculta las capas que forman el acolchado expuesto. Después de numerosas pruebas con muestras de pinturas, tintas y tinturas fué seleccionada la pintura acrílica "Golden Colors" por su apariencia estética, fácil aplicación, costo, reversibilidad, estabilidad a la fluctuación de calor y humedad. La efectividad de esta técnica provee otra opción válida para los conservadores textiles

\*Quilt—Es un edredón acolchado con capas de lana algodón o plumas, tradicionalmente cosido a mano.

## Infestación por insectos de una tapicería de gran tamaño: fumigación y estabilización para su depósito

BETSY GOULD

RESUMEN—Este artículo discute el tratamiento de conservación, estabilización y preparación para depósito a largo plazo de una tapicería de lana de gran tamaño deteriorada debido a su exhibición en un medio ambiente inapropiado. Este medio ambiente causó daños al textil por su exposición prolongada a la luz y al permitir la infestación por polillas de la ropa. La parte central del tratamiento de la tapicería fué la fumigación por anoxia de oxígeno para eliminar la contaminación de polillas; después la tapicería se estabilizó para depósito permanente, ya que el textil no volvió a su lugar de exhibición original.

## Sobre el tejado: blanqueando por luz de textiles de grandes dimensiones, dos estudios de caso

JOY GARDINER Y  
JOANNE HACKETT

RESUMEN—El uso de la luz día para blanquear textiles es un método tradicional bien conocido. El uso de blanqueo líquido por luz para artefactos históricos de papel ha sido extensamente documentado en la literatura sobre la conservación de papel. Sin embargo, en la literatura sobre la conservación textil hay una pequeña discusión sobre el uso del blanqueo por luz para artefactos textiles.

Este artículo presenta dos estudios de caso en los cuales el blanqueo líquido con agua por luz fué elegido como la opción de tratamiento para dos quilts\* severamente decolorados. La discusión incluye: los pro y los contra de blanquear objetos textiles y el razonamiento para la selección de esta opción sobre otros métodos de blanqueo más comunmente empleados; así como una breve reflexión sobre el mecanismo de blanqueo por medio de la luz el cual se aprendió de la literatura de conservación de papel. Por último, se describe como se llevo a cabo el blanqueo sobre el techo del Edificio de Investigaciones (Research Building) del Museo de Winterthur.

\*Quilt—Es un edredón acolchado con capas de lana algodón o pluma, tradicionalmente cosido a mano.

## Hidruro de boro: una alternativa para el blanqueo de la celulosa textil por oxidación

SUSAN ADLER

RESUMEN—Los conservadores textiles durante largo tiempo han sido reacios al uso de agentes blanqueadores debido a sus efectos dañinos sobre las fibras. Los agentes blanqueadores más comunmente usados en conservación son los agentes oxidantes, los cuales pueden causar daño a las fibras. En contraste el blanqueo con hidruro de boro remueve la decoloración degradada de la celulosa envejecida, mientras que ayuda a estabilizar la fibra compuesta de celulosa. En este artículo son descritos ocho estudios de caso de objetos compuestos de celulosa decolorada, y tratados con hidruro de boro. Estos estudios muestran que los tratamiento con borohidruro de sodio han dado resultados visuales consistentes, produciendo por lo general blanqueos suaves y parejos sobre los textiles de algodón degradado. Los estudios también han demostrado ser efectivos en la reducción de un gran rango de manchas extrañas, y tienen poco o ningún efecto sobre los colorantes naturales en algodón o lino. Estudios acelerados de envejecimiento comparando las muestras tratadas con borohidruro de sodio con las muestras tratadas con peróxido, han indicado que la reversibilidad del color ocurre en un menor grado en las muestras tratadas con hidruro de boro. Los resultados sugieren también que la proporción de decoloración en textiles tratados con hidruro de boro es comparable con la proporción de decoloración en textiles que no han sido tratados.

## Recuperación del desastre: enseñando técnicas de salvamento textil al equipo de primeros auxilios

KATHY FRANCIS

RESUMEN—En los pequeños museos así como en las sociedades históricas, los conservadores casi nunca son los primeros en escena luego de un desastre, pero al poco tiempo son llamados como expertos en técnicas de recuperación. Empleados y voluntarios, son quienes probablemente realizan los primeros auxilios; por lo tanto necesitan conocer los procedimientos de salvamento para los distintos tipos de materiales de los cuales esta compuesta su colección. Entrenamiento en las reacciones específicas de cada material y su recuperación, da a los conservadores, los empleados a cargo de colecciones, y a los voluntarios la oportunidad de enfocarse en problemas particulares los cuales posiblemente encontrarán al momento de enfrentar una emergencia; también podrán ayudar y contribuir en la planificación de desastres. El entrenamiento da a este equipo de primeros auxilios la información necesaria para prevenir o mitigar daños. Las sesiones prácticas y el entrenamiento en casos de desastres simulados, incrementa la confianza permitiendo el refinamiento de las técnicas y demostrando como los varios métodos de recuperación afectan las posteriores opciones de conservación. Este artículo presenta algunas técnicas decisivas para el salvamento de textiles deteriorados por el fuego y el agua, así como sugerencias para la enseñanza de técnicas para casos de emergencia y primeros auxilios al equipo de trabajadores de museos y a los voluntarios.

## Recuperándose del desastre en la Universidad de Alberta, o toda inundación también tiene un lado positivo

SHIRLEY ELLIS

RESUMEN—La colección de textiles y vestuario de la Universidad de Alberta fué exitosamente recuperada de una inundación ocurrida en diciembre de 1996. Los empleados, estudiantes y voluntarios trabajaron efectivamente a lo largo de todas las etapas de salvamento y recuperación. Durante la operación de salvamento de los artefactos, se utilizaron técnicas de secado al aire y congelamiento, mientras que se documentaba la información sobre el daño y el diagnóstico. Esta documentación, así como otros reportes existentes, demostraron ser a través de la recuperación un valioso recurso. Se exploraron y adaptaron distintas técnicas de tratamiento, a las necesidades de los artefactos con el fin de obtener un alto nivel de éxito. Los textiles y el vestuario, dañados por la inundación proporcionaron numerosos desafíos durante la operación de salvamento y recuperación, por medio de los cuales se obtuvieron soluciones muy positivas. Al final la inundación dió a muchos trabajo, experiencia y una base para compartir el conocimiento y las técnicas.

## El efecto de secado por congelación sobre ciertas propiedades de los textiles de lana\*

SHAWN GARDNER FISHER

RESUMEN—Las colecciones textiles pueden empaparse con agua como resultado de un desastre ya sea natural o producido por el hombre. El método tradicional de secar al aire, no es el más práctico cuando un gran número de artefactos textiles han sido afectados. El método preferido para secar la gran mayoría de material de archivo cuando ha sido empapado con agua es el secado por congelación. Textiles arqueológicos recuperados de sitios húmedos han sido secados con éxito por congelación. Un método apropiado de secado debe preservar la cualidad estética y la integridad estructural del artefacto. El objetivo de este estudio fué el de determinar como el secado por congelación afecta ciertas propiedades en los textiles hechos con lana nueva. Muestras de tela de lana tejidas en telar sin tinturar fueron sumergidas en agua deionizada, y secadas al aire y congeladas; secadas al aire solamente; o congeladas y secadas por congelación. El análisis compara la temperatura de dos niveles de preparación, la temperatura de tres niveles de secado, la interacción de los principales efectos entre el secado al aire, y el secado por congelación; así como el efecto de la temperatura de preparación. Microfotografías hechas con el microscopio de barrido electrónico fueron usadas para analizar las superficies de las fibras. Las variables de tratamiento no causaron cambios en las propiedades de tensión de la tela. El encogimiento de las muestras congeladas, y congeladas y secadas por congelación fué mayor que el de las muestras secadas al aire no sometidas a congelación. Microscopía de barrido electrónico reveló que la superficie de las fibras de las muestras congeladas, y de las muestras congeladas y secadas por congelación sufrieron daños menores. El secado al aire sin congelación causó menor daño en la superficie de las fibras, así como en el cambio dimensional.

\*Este artículo recibió un reconocimiento especial del RATS, el Grupo de Investigación y Estudios Técnicos de AIC. Cada año, RATS promueve una ponencia técnica de cada grupo de especialistas la cual represente un estudio científico que sea relevante para las necesidades de la especialidad.

## Observaciones en la eliminación de hollín en textiles

JOANNE HACKETT

RESUMEN—Este artículo describe la limpieza de una variedad de textiles dañados por el hollín durante un incendio doméstico. Las características del hollín son descritas, así como también los métodos usados previamente por conservadores para limpiar objetos de museo contaminados por hollín. Varios métodos usados en la limpieza de textiles deteriorados por hollín son descritos, incluyendo compresas de solventes no-polares, limpieza en húmedo con solventes, soluciones con agentes activos de superficie, y la remoción de partículas de hollín con aspiradoras y esponjas de goma vulcanizada. También se incluye una breve investigación sobre la composición y las características del tratamiento con las esponjas de goma vulcanizada.

## Desde el archivo a la base de datos, y como herramienta de investigación: la transformación de una colección de muestras no catalogadas en una base de datos asequible

ROBIN HANSON

RESUMEN—Por más de veinte años, se les ha tomado rutinariamente muestras para la identificación de fibras, a los objetos que han sido tratados en el laboratorio de conservación de textiles de la División de Conservación del “National Park Service” en el Harpers Ferry Center (HFC) en Harpers Ferry, al Oeste de Virginia. Estas muestras han sido montadas debidamente en porta objetos y metódicamente guardadas en cajas para los mismos, con un celo casi religioso. Las historias que estas fibras tienen que contar han permanecido hasta ahora encerradas dentro de sí mismas. Aunque este recurso sin paralelo ha crecido exponencialmente, permanece virtualmente inasequible.

El objetivo de este proyecto es el de integrar datos de los muchos documentos y los múltiples archivos en los que están actualmente guardados, en un único registro computarizado de acceso inmediato. A través del uso de una base de datos relacionada—Microsoft Access—la información extraída de las propias muestras de fibras textiles será fácilmente recuperada. Esta información proveerá un conocimiento invaluable acerca de las fibras deterioradas y degradadas, como también a cerca de las tecnologías de fabricación de los textiles históricos. Esperamos que este proyecto pueda servir como modelo a quienes estén deseando formar su propia biblioteca de fibras montadas permanentemente en porta objetos.

## Un desastre? Lesionandonos a través del trabajo que amamos

PATRICIA SILENCE

RESUMEN—Uno de los peores desastres enfrentados por los conservadores textiles es la lesión personal debido a los movimientos repetitivos y a las posiciones mantenidas por largo tiempo. Los conservadores son a menudo reacios a hablar sobre este problema debido a cierto estigma. Los conservadores temen que estas lesiones puedan impactar en su actual o futuro empleo. Este artículo identifica los síntomas de los desordenes de los músculos, el esqueleto, así como los factores de riesgo para estos tipos de lesiones. También se discuten equipos y técnicas usados en el Centro de Conservación Textil los cuales proporcionan condiciones seguras de trabajo para el conservador. Se incluye una copia de la encuesta titulada “Reporte ergonómico para Conservadores Textiles” en la cual participaron los asistentes a la reunión del Grupo de Especialistas en Textiles de AIC realizada en Arligton, Virginia en 1998.

## Reevaluando la tradición y el oficio de la conservación textil

SARA J. WOLF

RESUMEN—"Reparar" y "zurcir" son términos asociados con el oficio de la restauración textil comercial, así como "estabilizar" y "consolidar," son términos asociados con la profesión de la conservación textil. Son estas simplemente diferencias semánticas de vocabulario—palabras diseñadas para distanciar "profesión" de "ocupación"—¿o son estas diferencias sustanciales, divergencias filosóficas? Durante un año en Turquía fué realizado bajo un proyecto de investigación un estudio sobre las tradiciones del oficio de la restauración de alfombras y kilims con el fin de evaluar y reexaminar las técnicas usadas. La principal pregunta planteada fué si algo se había perdido en el enfoque del oficio (como herramientas o técnicas,) lo cual pudiera ser útil en el contexto de la metodología de la conservación actual. Temas secundarios incluyeron lo siguiente: ¿que límites, si existe alguno, ponen los comerciantes de alfombras a la restauración; que límites si existe alguno ponen los restauradores a la restauración, y cual es la relación entre el cliente y el restaurador? Un argumento adicional también examinado fué como las técnicas de la restauración que se practican hoy día van a impactar la preservación de las alfombras y los kilims que finalmente terminarán en las colecciones de los museos en los próximos diez a treinta años.