THE TEXTILE SPECIALTY GROUP POSTPRINTS

PAPERS DELIVERED AT THE TEXTILE SUBGROUP SESSION

American Institute for Conservation
of Historic & Artistic Works
37th Annual Meeting
Los Angeles, California
May 2009

Edited by

Joel Thompson
Amanda Holden
Glenn Petersen
Sarah Stevens

VOLUME NINETEEN

POSTPRINTS of the Textile Specialty Group, Volume Nineteen, 2009, is published by the Textile Specialty Group of the American Institute for Conservation of Historic & Artistic Works (AIC). POSTPRINTS is distributed to members of the Textile Specialty Group. Additional copies may be purchased from the American Institute for Conservation of Historic & Artistic Works, 1717 K Street, NW, Suite 200, Washington, DC 20006. http://aic.stanford.edu.

Volume 19

The Textile Specialty Group of the American Institute for Conservation of Historic & Artistic Works
ISSN 1524-3664

CONTENTS

CONTENTS

CONTENTS

PREFACE

The nineteenth volume of POSTPRINTS contains papers presented at the Textile Specialty Group (TSG) session of the annual meeting of the American Institute for Conservation of Historic & Artistic Works (AIC), in Los Angeles, California from May 19-22, 2009.

TSG POSTPRINTS is a non-juried publication. Submission of these papers to juried publications, such as the *Journal of the American Institute for Conservation*, is encouraged. The papers, chosen from abstracts submitted to the Meeting Chair,Patricia Ewer, Textile Specialty Group Vice Chair for 2008-2009, are published as submitted by the authors. Editing of papers was done according to the *Journal of American Institute of Conservation'*s Guidelines for Authors and AIC's best practices for print publications. Materials and methods presented within the papers should not be considered official statements of either the Textile Specialty Group or of the American Institute for Conservation of Historic & Artistic Works.

The Editors wish to thank the contributors to this publication for their cooperation and timeliness. Without their enthusiasm and hard work this publication would not have been possible. Special thanks are extended to Translation Services USA, LLC, for translating the abstracts into Spanish. Thanks also are due to to Joel Thompson, who laid out the volume using Adobe Indesign.

Publication of this volume of the Textile Specialty Group Postprints is made possible with funding from the Harpers Ferry Regional Textile Group, organizer of conferences on textile preservation from 1978 to 1992.

DESIGNING WORKSPACES

PATRICIA EWER

ABSTRACT—This paper serves as an introduction to the presentations given at the Textile Specialty Group of the American Institute for Conservation of Historic and Artistic Works Annual Meeting held in Los Angeles in 2009. Models of related workspaces and personal experiences are discussed as an introduction to papers on lab design given at that meeting.

DISEÑO DE ESPACIOS DE TRABAJO. POR PATRICIA EWER: RESUMEN—Este trabajo sirve como introducción a la presentación realizada en el Grupo Textil de Especialidad de la Asamblea Anual del Instituto Americano para la Conservación de Obras Históricas y Artísticas, realizada en Los Ángeles en 2009. Como introducción a los trabajos sobre la renovación del laboratorio, presentados en dicha asambleas, se analizan modelos de espacios de trabajo relacionados y experiencias personales.

1. INTRODUCTION

In line with the theme of the American Institute for Conservation (AIC) Annual Meeting in Los Angeles in 2009, *Conservation 2.0 - New Directions,* I suggested that the Textile Specialty Group (TSG) address the topic of new conservation laboratories. We have been fortunate that many conservation departments have recently acquired new workspaces. This is a timely topic as there is much interest within AIC membership for this information.

While working at Biltmore House, a challenging historic structure in Asheville North Carolina, I had the opportunity to upgrade an existing conservation workspace. At one point during my tenure at Biltmore Company I was charged with researching the costs of a purpose built structure to house collections storage, a collections processing center and three conservation labs for textiles, furniture and objects. The Biltmore project is where my interest began on this topic; I spent a year doing research and amassing information related to lab design.

Subsequently, the Midwest Art Conservation Center (MACC) was in the planning stages for a new conservation facility. While working there, I was able to design a new textile conservation lab within the limits of the physical space we were being offered by the Minneapolis Institute of Arts (MIA).

I will show models of related workspaces as an introduction to this discussion. At the annual meeting there were six papers on the topic, followed by a panel discussion that addressed more questions. Some of these labs are no longer "new" so an evaluation of the design after time was informative.

2. DESIGNING WORKSPACES: AN EXPLANATION FOR THE DISCUSSION

It was exceptional to have so many colleagues respond to my request to speak about their workspace designs. The presenters included: Harold F. Mailand, Textile Conservation Services; Fenella G. France, Library of Congress; Sarah Gates & Beth Szuhay, Fine Arts Museums of San Francisco; Meredith Montague, Museum of Fine Arts, Boston; Florica Zaharia, The Metropolitan Museum of Art, and Beth McLaughlin, Midwest Art Conservation Center (MACC). This session at the AIC-TSG meeting in Los Angeles was intended to explore "the whys" of workroom designs. What were the conservator's influences, priorities and goals? What did they reference in the design process?

In preparing for the meeting I asked a number of conservation graduates whether or not their programs had time to teach workroom design – most said no. In reviewing the literature two textile conservation texts mention workroom layout and requirements (Finch & Putman 1985 and Landi 1992). A brief search of AATA on-line turned up references on buildings, the "greening" of workspaces (McInnis & Tyler 2005), and the making of a portable analytical lab for photography (Stulik 2005). The most detailed reference was *The design of the decorative arts and sculpture conservation laboratory at the Getty Center* (Considine 1998). This is not a subject that conservators have published on often; our conservators, with this publication, add much needed information on the topic.

Designing a workspace has many challenges. As can be seen in these papers, no institution has unlimited resources and/or space. Many of our workrooms exist within historic structures or in previously inhabited spaces. From new spaces designed by architects to renovations to existing spaces, all projects have their limits or restrictions: whether they are architectural, administrative, political or financial.

We have a tremendous amount of literature and models describing the safe storage of textiles. Anderson, Cocuzza, Heald & McPeek 2001, Fifield & Fiorino-Iannace 2005, Montague 2005, Anderson, Chang & Heald 2005, and French & Pritchard 2005 are just a few examples. While it is generally agreed that our primary concern as textile conservators is preventive conservation in the form of proper storage, the papers presented at this meeting expand our knowledge on an equally important topic, how an object is cared for while in our conservation laboratories.

Finally, there are some amazing spaces in this country but how well do they work, how did the final project come together? Some of these papers share what inspired their design; some relate the challenges of materials, others discuss the limitations of their spaces but almost all discuss the importance of communication with providers.

2.1 COMMON GOALS & OBJECTIVES FOR LAB DESIGN

Several authors of the following papers began by outlining their goals and objectives. This is a brief list I have put together from my experiences: safety for the objects in our workspace by increasing space given to conservation; safety for the conservator in the form of worktables and chairs that are comfortable at a proper working height and are lightweight and movable; and efficiency by utilizing modular tables, large doorways, access to collections storage, or exhibition space. The authors added limitations such as: budget constrains that influence size, materials and equipment; working within historic structures that have preexisting mandates regarding space; and the problem of having other organizations, architects, designers or building stakeholders dictating the use of space.

Many conservators felt that communication with the construction and building teams is paramount and that planning for the future growth of both the lab staff and the collection were essential. A related final issue I must mention, which is addressed outright in Fenella France's paper published in this volume of the TSG Postprints, is the need for museums to go "green". Essentially, that museums should strive to be more efficient, healthier places to work. It is stated "museums are energy hogs" (Merritt & Ledbetter, 2009); if it is in our power, we must consider how to mitigate the over consumption of energy when we are planning new workspaces.

3. THE EVOLUTION OF EARLY WORKSPACES

To begin, what are the spaces we work in called? In the United States we use the term conservation lab. Other terms include studio, workroom, or workshop. Historically, painting conservation studios developed from the painter's studio model. Current painting conservation workspaces are similar, but usually with an added fume hood or fume booth (figs. 1, 2).

Figure 1. Bruce Miller (left), landscape and wildlife artist (photo by author). Figure 2. Joan Gorman (right), Paintings Conservator, Midwest Art Conservation Center (photo courtesy of MACC).

Paper conservation likewise developed from paper making workshops, print studios and/or book manufacturers. Objects conservation laboratories have a multitude of references; furniture manufacturers, sculpture studios, metal shops, pottery workrooms. Today many objects conservation spaces are separated so as to have "clean" and "dirty" spaces (figs. 3, 4).

Figure 3. Scupture studio, Minnetonka Center for the Arts at left (photo by author). Figure 4. Objects Conservation Laboratory, Michael C. Carlos Museum, Emory University at right (photo by author).

What is the historic precedent for the first textile conservation laboratory? Was it a weaving atelier, a tailoring or dressmaking studio? Since many of the early textile conservation departments were created to service tapestries (figs. 5, 6), it is conceivable that the earliest labs may have been modeled on the weaving atelier.

Figure 5. Weaving studio, Minnetonka Center for the Arts at left (photo by author). Figure 6. Sewing lounge, St. Paul, Minnesota at right (photo by author).

I myself came to conservation from a theatre costuming, dressmaking and tailoring background. I opened my own costume design establishment in 1975 and created a workroom based on a theatre costume shop model. Furniture selected consisted of the cutting table, where the cutter or pattern drafter worked, and small tables where their seamstresses sat and preformed handwork (figs. 7, 8). This paper is therefore a reflection of what has influenced me. The spaces I formerly worked in, the workrooms I inherited, and their evolution all affected my first complete lab design at MACC.

Figure 7. Costume shop, Children's Theatre Company (photo by author).

Figure 8. Tapestry work space in Gallery, The Minneapolis Institute of Arts (courtesy of MIA).

4. MY JOURNEY: LOOKING FOR THE IDEAL LAB

When I arrived at Biltmore in 1987, I had the opportunity to enhance an existing conservation workroom in designated areas, not an unusual challenge in an historic structure. We had the main tapestry workroom (a former bedroom), off that was a little office (former dressing room with filing cabinets in the closet), a wet cleaning room in the basement (a former servants dining hall) with a connecting dye lab (former servants kitchen) and another room with a very high ceiling where we could hang the tapestries to do finishing work. (figs. 9, 10). What a luxury all this space was. The down side was that these spaces were located in three separate areas at great distances from one another throughout the house.

Figure 9. Tapestry work room on left, Biltmore House (courtesy of The Biltmore Company). Figure 10. Tapestry dye lab on right, Biltmore House (photo by author).

DESIGNING WORKSPACES

At one point during my tenure at Biltmore Company several of us were charged with researching the needs and costs for a purpose built structure to house collections storage, a collections processing center, as well as the furniture, textile and objects conservation labs. This is where my interest truly began on this topic. I spent a year doing research on lab design and amassed a great body of information by touring major labs in the United States and consulting with those who were in the design process like Susan Heald at National Museum of the American Indian and Deidre Windsor who had just completed the new Textile Conservation Center in Lowell, Massachusetts. It was wonderful to imagine designing the "ideal" collection storage and conservation lab building. Unfortunately, in the end, The Biltmore Company decided to build a hotel instead of the collections and conservation building.

From the start of my career it seems that 'lab tours' were the norm. Soon after my arrival at MIA, Lotus Stack sent me forth to see the textile conservation lab at the Metropolitan Museum of Art; from there I went to Cooper-Hewitt, and the Fashion Institute of Technology. Further on the east coast, I saw The Textile Museum, the Smithsonian Museum of American History, and the Winterthur Textile Conservation Department; in the Midwest I visited the Art Institute of Chicago and on the west coast, the Los Angeles County Museum of Art. While working on object assessments, I saw the facilities at the Museum of Fine Arts Boston and the Philadelphia Museum of Art.

I was granted a Quinque Fellowship in Scotland the summer of 2002; the program scheduled me to visit many textile conservation labs throughout the United Kingdom. This included working at the Burrell Collection in Glasgow, visiting the textile conservation labs in Edinburgh; the Textile Conservation Centre, University of Southampton, Winchester; the Victorian & Albert Museum; Historic Royal Palaces, Liverpool Conservation Centre, the Whitworth Museum and private conservator's studios. Ultimately, this was much more information for me to file away.

Previous to my starting at MACC in 2003, the staff was in the planning stages for a new conservation facility and I was able to contribute to the design of the workspace designated for textiles. This was within the limits of the space we were being offered in the expansion of the Minneapolis Institute of Arts. It was an interesting exercise as I was working on it long distance before I actually started there and it was finished after I left (fig. 11). For the pros and cons of the MACC workspace, see McLaughlin 2009 published in this volume of the TSG Postprints.

Over the years I have had the privilege to work in many exceptional workspaces including those previously mentioned and at Historic Royal Palaces in the lovely workrooms in Hampton Court Palace (HCP). Here the workrooms and facilities, even in the context of a historic building, were exceedingly functional. But at Kensington Palace (KP), which is where the costumes are stored and exhibited, there was no designated conservation workroom. There was a well-outfitted workroom for costume conservation at Hampton Court Palace as there is for furnishing textiles and tapestry. But, for a variety of reasons staff was hesitant to transport costume pieces from KP to HCP for treatment. When I arrived in 2005 the conservators were working on the floor in an auxiliary room at KP. Several of us on the costume team were of an age that working on the floor seemed like a health and safety violation, not to mention inefficient. Occasionally we were able to bring items to the Hampton Court workrooms for conservation. Finally, through much negotiation, cajoling and a team effort we aquired a designated room for conservation at KP.

I mention this story to highlight an area of discussion that needs to be addressed. We have designed many workspaces based on the preservation of our objects, but what about the preservation of conservators (Silence 1999 & 2001)? I have, in the past, had conservators suffer from carpel tunnel syndrome, back problems, and a variety of physical handicaps. Much of our work can be tedious and repetitive. We also end up on odd days at the top of scaffolding. How do we care for ourselves? Good design can promote good health or as Thomas Fisher states "…when it comes to wellness, design matters a great deal" (Fisher 2009).

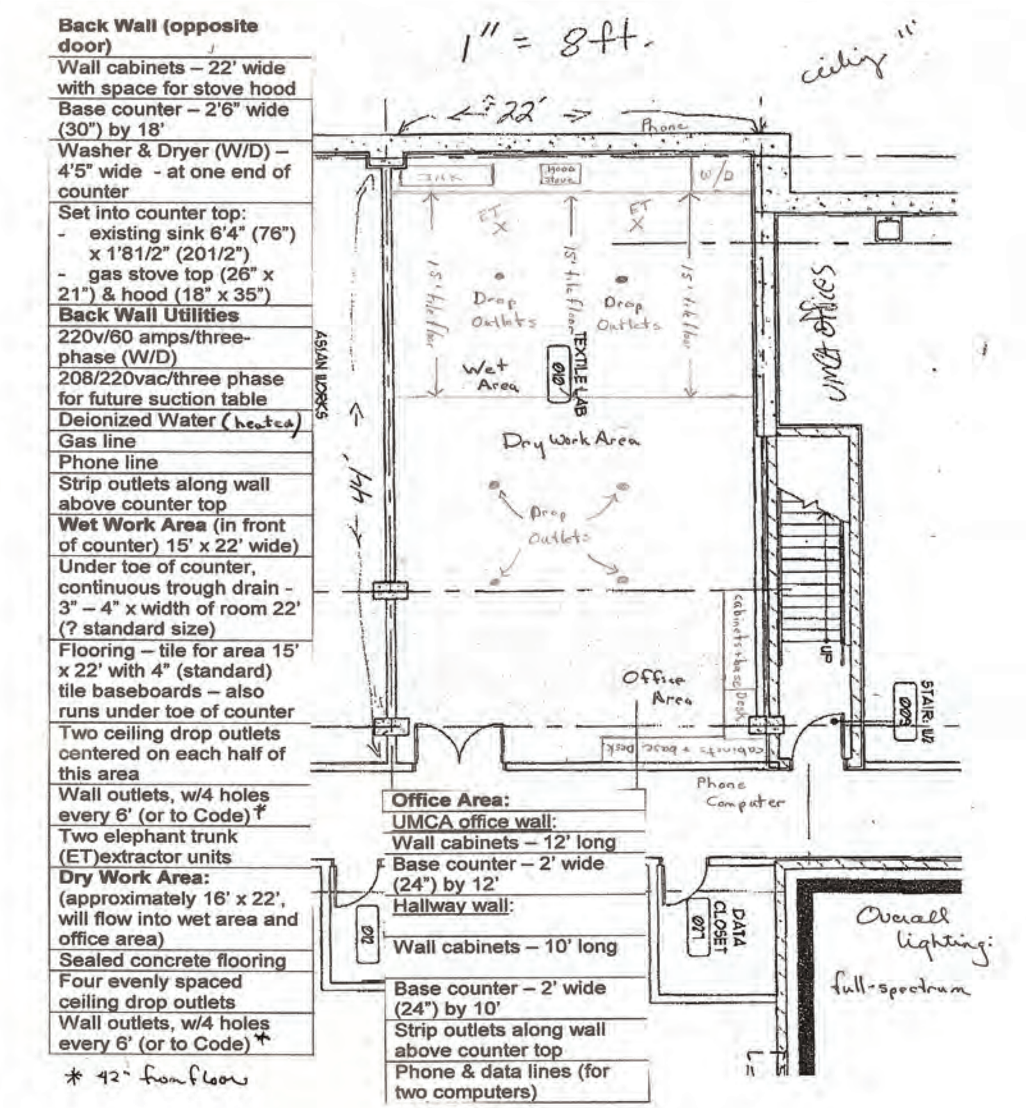


Figure 11. Design for lab at Midwest Art Conservation Center (photo by author).

5. CONCLUSION

The papers that follow in this volume of the Textile Specialty Group Postprints address all of the above topics in some manner or another. The workroom design discussions give useful information about proper work place materials, environmental considerations, desirable tools and equipment. The suppliers' lists within each paper are constructive resources. These papers fill a vital need in the field of textile conservation and will serve future conservators as a valued reference when planning for new or renovated workspaces.

ACKNOWLEDGEMENTS

I want to thank the participants in this session of the Textile Specialty Group meeting: Harold F. Mailand, Textile Conservation Services; Fenella G. France, Library of Congress; Sarah Gates & Beth Szuhay, Fine Arts Museum of San Francisco; Meredith Montague, Museum of Fine Arts, Boston; Florica Zaharia, The Metropolitan Museum of Art, and Beth McLaughlin, Midwest Art Conservation Center.

REFERENCES

Anderson L., D. Cocuzza, S. Heald, and M. McPeek. 2001. A storage system for archaeological textile fragments. *AIC Textile Specialty Group Postprints,* AIC 29th Annual Meeting, Dallas, Texas, June 2001. Washington, DC: The American Institute of Conservation for Historic and Artist Works, Vol. 11. 59-68.

Anderson, L, L. Chang and S. Heald. 2005. Rehousing Archaeological Textiles during the National Museum of the American Indian Collections Move (poster). *Recovering the Past…The Conservation of Archaeological and Ethnographic Textiles*. 5th NATCC, Mexico City. J. Paul Getty Trust. November 9- 12, 2005. 295-298.

Considine, B. B. 1998. The design of the decorative arts and sculpture conservation laboratory at the Getty Center. *AIC Postprints of the Wooden Artifacts Group*. AIC 26th Annual Meeting Arlington, Virginia, June 1998. Washington DC: The American Institute for Conservation of Historic and Artistic Works. 26-33.

Fifield, R. and G. Fiorino-Iannace. 2005. Collections Care at the Antonio Ratti Textile Center, Metropolitan Museum of Art, New York. *AIC Textile Specialty Group Postprints,* AIC 33rd Annual Meeting, Minneapolis, Minnesota, June 2005. Washington DC: The American Institute for Conservation of Historic and Artistic Works, Vol. 15. 78- 90.

Finch, K, and G. Putnam 1977. *Caring for Textiles*. New York: Watson-Guptill Publication. 91-101.

Fisher, T. 2009. Here's to Your Health. *Emerging,* Design & Health Spring 2009 College of Design, University of Minnesota, Vol. 3, No. 2. 2.

French, A. and F. Pritchard. 2005. Easy Access? – Approaches to the care and storage of archaeological textiles at the Whitworth Art Gallery (poster). *Recovering the Past...The Conservation of Archaeological and Ethnographic Textiles.* 5th NATCC, Mexico City. J. Paul Getty Trust. November 9- 12, 2005. 299-301.

Landi, S. 1992. *The Textile Conservators Manual, 2nd edition.* Oxford: Butterworth-Heinemann. 175-186.

McInnis, M. and Tyler, I. R. 2005. The greening of the Samuel T. Dana Building: a classroom for sustainable design. *APT bulletin* 36, no. 4. 39-45.

Merritt, E. E. and E. Ledbetter. 2009. The Future Is Now. *Museum,* May/June 2009. American Associations of Museums. 29-31 & 64.

Montague, M. 2005. Improving Accessibility of a Textile and Fashion Arts Collection at the Museum of Fine Arts, Boston. *AIC Textile Specialty Group Postprints,* AIC 33rd Annual Meeting, Minneapolis, Minnesota, June 2005. Washington DC: The American Institute for Conservation of Historic and Artistic Works, Vol. 15. 62-78.

Silence, P. 1999. A disaster? Injuring ourselves through the work we love. *AIC Textile Specialty Group Postprints*, AIC 26th Annual Meeting Arlington, Virginia, June 1998. Washington DC: The American Institute for Conservation of Historic and Artistic Works, Vol. 8. 79-83.

Silence, P. 2001. Results of an ergonomics survey for textile conservators. *AIC Textile Specialty Group Postprints,* AIC 27th Annual Meeting, Saint Louis, Missouri, June 1999. Washington DC: The American Institute for Conservation of Historic and Artistic Works, Vol. 9. 45-48.

Stulik, D. C.. 2005. Getty Conservation Institute portable analytical laboratory for photograph conservation: the first three years. *14th triennial meeting, The Hague, 12-16 September 2005; pre[romts (ICOM Committee for Conservation).* Verger, I. (ed.) Earthscan Ltd. 556-564.

FURTHER READING

Baer, N. S., Ballard, M. W., and Indictor, N. 1982. Considerations in the development of textiles conservation laboratories. *Conservazione e restauro dei tessili: Convegno internazionale, Como 1980.* Pertegato, F. (ed.). Centro italiano per lo studio della storia del tessuto. Sezione Lombarda. 129-137.

Binkley, C. 2009. Sitting Pretty When You're Hard at Work. *The Wall Street Journal,* Thursday June 11, 2009, D1 & D.

Bloom, P. 2009. Natural Happiness, *The New York Times Sunday Magazine*, April 19, 2009, 11-13.

Diffrient, N. 2009. Career Retrospective (lecture) April 20, 2009. Goldstein Museum of Design, College of Design University of Minnesota, Humanscale (www.humanscale.com).

PATRICIA EWER is the principal conservator of *Textile Objects Conservation*. She is a conservation professional with over thirty years of experience in treating textiles, managing, developing and staffing conservation projects. She has held conservation positions at Historic Royal Palaces (U.K.), Midwest Art Conservation Center (Minneapolis, Minnesota), Biltmore House (Asheville, North Carolina), Textile Conservation Laboratory at the Cathedral Church of St. John the Divine (New York, New York), and The Textile Conservation Workshop (South Salem, New York). She has been a Professional Associate of the American Institute for Conservation of Historic and Artistic Works since 1989. Address: Textile Objects Conservation, 5975 Ridgewood Road, Mound, Minnesota 55364. Phone: 651-263-6899; e-mail: pewer@citlink.net.

INHERITING THE NEW LAB

BETH MCLAUGHLIN

ABSTRACT – The Midwest Art Conservation Center (MACC), a full-service regional art and artifact conservation and preservation center, operates as an independent non-profit organization within space leased from the Minneapolis Institute of Arts (MIA). A major building expansion project at the MIA begun in 2003 provided the opportunity for MACC to be re-housed in a new, custom-designed space. The existing textile lab of the MIA was eliminated and its activities transferred to a new department within MACC. While housed temporarily in MACC's old facilities, the senior textile conservator worked on planning the new facilities, inventorying existing equipment and supplies, and determining what new items were desired. The author replaced the departing conservator in 2005, and took over the remaining space planning, sourcing of new equipment, and subsequent move into the new facilities. The author describes and critiques features of the completed lab, including electrical outlet placement, shared de-ionized water system, provision for mobility of equipment and furnishings, and flexibility in space use. Discrepancies in what was planned and what was actually built had to be addressed, particularly in the construction of a sloped drainage floor, which complicated the installation of other furniture and equipment.

HEREDAR EL NUEVO LABORATORIO POR BETH MCLAUGHLIN, RESUMEN – El Centro de Conservación de Arte de la Región Central (MACC, por su sigla en inglés), un centro de conservación y preservación de arte y artesanías regionales de servicio completo, funciona como una organización sin fines de lucro e independiente dentro del espacio arrendado del Instituto de Artes de Minneapolis (MIA, por su sigla en inglés). Un gran proyecto de expansión del edificio en el MIA comenzó en 2003 proporcionó la oportunidad para que el MACC se reacomodara en un nuevo espacio de diseño personalizado. El laboratorio textil del MIA fue eliminado y sus actividades se transfirieron a un nuevo departamento dentro del MACC. Mientras que se encontraba albergado en las antiguas instalaciones del MACC, el conservador textil superior trabajó en la planificación de las nuevas instalaciones, haciendo un inventario del equipo y suministros existentes, y determinando qué artículos se deseaban. El autor reemplazó al conservador que salió en 2005 y se hizo cargo del resto de la planificación del espacio, abastecimiento de nuevos equipos y mudanza posterior a las nuevas instalaciones. El autor describe y critica las características del laboratorio completo, incluyendo la colocación de la salida de electricidad, el sistema de agua desionizada compartido, la provisión de la movilidad del equipo y mobiliario, y la flexibilidad del uso en el espacio. Las discrepancias entre lo que se planificó y lo que se construyó en realidad se tuvieron que tratar, particularmente en la construcción de un piso con drenaje en pendiente, que complicó la instalación de otros muebles y equipo.

1. INTRODUCTION

Getting a new lab is exciting, even if one was not directly involved in its creation. One can appreciate the effort someone put forth for another's benefit: electrical outlets located every three to six feet and hanging from the ceiling, two new exhaust trunks, clean surfaces, fresh paint, and new storage cabinets for tools and supplies. There is new equipment to be purchased and installed. The placement of most acquisitions is at the conservator's discretion. This process is the focus of this paper presented to the Textile Specialty Group, at the 37th Annual AIC Meeting. The author was fortunate to know well and trust the person who was planning the new textile lab at Midwest Art Conservation Center (MACC). She purged supplies and materials and whittled away at legacy projects before moving into a temporary space.

The less exciting part, however, is reconciling what others planned with what was actually built and installed. A conservator's interpretation of a floor plan is different than that of a contractor or a facilities administrator. Project realization also entails receiving equipment that was selected by facilities staff who did not consult the conservator prior to making purchases. And the list goes on. In addition, the new space of this study is rented to the organization by the Minneapolis Art Institute (MIA); MACC is just a guest here.

2. BACKGROUND

The Midwest Art Conservation Center is a non-profit regional center working for the preservation and conservation of art and artifacts. The center consists of four conservation labs (objects, paintings, paper, and textile) and a department for outreach (Preservation Services). The center was organized in 1977 by area museums including MIA, Walker Art Center, and Neville Public Museum via seed money from National Endowment for the Arts to care for their collections, and was originally named the Upper Midwest Conservation Association (UMCA). In the beginning it was staffed with two full-time paintings conservators and a paper conservator. UMCA grew and later added an objects lab. The organization was renamed the Midwest Art Conservation Center (MACC) in 2005. MACC has grown to become a full service fine arts conservation laboratory serving museums, historical societies, libraries, archives, and other cultural institutions, as well as private and corporate collections. MACC provides conservation and preservation services to hundreds of organizations, mostly in the Midwest region.

In 2003 MACC added the textile conservation lab. Prior to 2001, the MIA had a full-time textile conservator. When that position was vacated in 2001, it remained unfilled for two years. When a large expansion of the MIA was planned, the Institute and MACC worked together to conceive a new option – introducing textile conservation to MACC offerings. MACC hired a full-time textile conservator and initially contracted half of the conservator's time to the MIA. Fortunately for MACC and the MIA, the combined position was first filled by Patricia Ewer. She took over the existing MIA textile conservation lab, supervised the Institute's textile preparator, and continued the volunteer programs within the MIA Textile Department. One of her first tasks was also to begin planning for a new lab.

3. PLANNING PHASE

The old MIA lab was L-shaped with a large main work room and a side room which housed files and miscellaneous storage. Only the essentials for textile conservation (excluding wet cleaning) were in place. All the new conservation labs were designed by MACC and located in the basement of the new expansion. Prior to this move the other labs resided in a large shared space. The expansion allowed for each specialty to have their own designated room, including more floor space, increased ceiling height, a safer spray booth, both clean and dirty rooms, centralized kitchen, director's and business manager's offices, et cetera.

In late summer 2004 the old textile lab had to be relinquished for scheduled reconstruction. The space became one of the loading docks in the new addition. In the temporary space, a former art storage room, the textile lab was combined with two other MACC offices into a significantly smaller space near the other large conservation lab. Operating with only the essentials was a challenge, rather like going camping, which lasted approximately one year. Prior to the temporary move, an inventory was made of the existing equipment and supplies. An edited list was then complied from the inventory including only the necessary and appropriate equipment to be moved to the new lab, and an additional list created of new equipment desired.

The new wing was well under construction when the author came on board in 2005. Her first three months as the new senior textile conservator were spent in a temporary space shared by the director, business manager, a part-time pre-program conservation intern, and MIA's textile preparator. This arrangement proved to be highly beneficial for understanding the organization and forging new work relationships. The new textile conservator was given a list of extant equipment and supplies by MACC, asked to fit them into the new lab layout, and to start finding sources for the larger pieces of new equipment. The MACC staff regularly checked on the construction progress in the new labs. Patricia had worked out the logistics for all the essential mechanicals. In the textile lab, precious square footage was temporarily lost to two restrooms, however to quote the director via correspondence, "Yeah! We got the bathrooms taken out of the space!"

4. DESIGN AND IMPLEMENTATION

Prior to moving in, some modifications were needed to reconcile what was actually built and installed with what had been planned. For example, the wet cleaning portion of the room was designed to have a 16 ft. sloping floor that drains into a covered trough running the full 24 ft. width of the room. This configuration was all well and good, except that the floor was sloped the 3 ft. on the other side of the drain as well. The cabinets and sink, the planned location of the stacked electric washer and dryer, the deionized water tanks, and the water heater then required unplanned leveling bases to prop them up. The new leveling base under the cabinets then created a drainage issue with the cadaver sink used for wet cleaning (a feature transferred from the old MIA lab) which was later resolved. The washer and dryer had to be doubly secured to the back wall after nearly walking off the insubstantial leveling platform after its initial installation.

The deionized water (DI) system is logically housed in the textile lab due to rate of highest use. The textile lab is the only lab with heated DI; the paper and objects lab have non-heated DI. The space designated for the on-demand water heater had to be revisited (vertical vs. horizontal, quantity of output, etc.) several times due to special requirements to heat deionized water. The tanks are located in the corner of the lab farthest from the entry. In retrospect, placement closer to the doors would have been advantageous and is recommended for anyone designing a new lab – dripping tanks would not have to be rolled through the lab and concern for potential damage to both artifacts and equipment could be eliminated.

Other mechanical amenities include electrical outlets located every two feet along counters and every seven feet on the wall, six non-retractable hanging outlets, and two new fume extraction trunks hanging from the ceiling in the back half of the lab (fig. 1). One feature that has yet to be completed is the stove for dyeing. There is space for a stove and the original intent was to have a gas stove and dryer, however building codes and difficulties with proper venting have so far prevented its installation.

The move itself was very efficient. The new lab was first occupied by two full-time employees, the conservator and the preparator, and later by volunteers and an intern. The placement of the equipment was at the conservator's discretion. The staff members of the textile lab and the main offices were the first to occupy the new spaces. While the week before the move was not as productive from the bench-work (billable hours) perspective, it was fruitful in assuring that all the new labs were given a final cleaning and wipe down. Everything from floor to ceiling had clean surfaces. Who but conservators would request (and check) the top of each pipe and light fixture to assure they be construction-dust free?

Previous experience with equipment and work practices helped to inform the design of the new lab. Cabinets from the old space that no longer served a function were not moved. Being accountable for billable hours also helped define inefficient and ineffective equipment. In addition, working with volunteers, in particular aging volunteers, puts a different perspective on the use and viability of equipment.

Figure 1. Textile Conservation Lab at the Midwest Art Conservation Center.

The lab includes two pairs of very serviceable rolling tables of 30 in. by 8 ft. and 3 ft. by 5 ft. However, the tops were unfinished particle board edged with a light-color wood and therefore not suitable for working on a fragile textile such as a mid-19th century silk flag. After some insistence they were covered with light colored laminate. Four built-in computer work stations eliminated the need for keeping the old desks. This is just one example of the type of equipment that was sent to the black hole of off-site storage, hopefully to be lost there, find a new home or, better yet, be recycled.

This author is still undecided about how she feels regarding the open ceiling plan. It is decorative in its own industrial way and it does allow for a 14 ft. wide hoist in the work area which can be raised to a height of approximately 12.5 ft. However, the fluorescent and track lighting and a plethora of pipe features create additional surfaces for dust to collect.

INHERITING THE NEW LAB

Once the lab was set up, the fun of ordering new equipment and installing it began. Fortunately the director of MACC was able to secure funding to purchase capital equipment. The textile lab was able to acquire a 5 ft. by 10 ft. wash table, a 3 ft. by 5 ft. suction table, and two Delta Designs storage cabinets. As is the preference at MACC, much of the new equipment is on wheels rather that bolted to the wall. Not only does this improve accessibility and facilitate sharing between labs, it also adds a degree of portability which makes sense given MACC's unusual situation as an independent lab housed as a tenant within an institution.

5. CONCLUSION

In conclusion, four years later the staff of MACC is still very pleased with its new spaces. The textile lab has been found to be very versatile in its generic rectangular shape. Having virtually all the equipment on wheels is also highly recommended for any new lab. The space is reconfigured almost daily as projects progress, are completed, and new projects arrive. Naturally, each lab would like more space and as with any work or domestic situation, there is never enough storage space.

ACKNOWLEDGMENTS

Sincere thanks go to Colin Turner (Director, MACC), Patricia Ewer (former Senior Textile Conservator, MACC), all the MACC staff and our interns.

SOURCES OF MATERIALS

Textile wash table, suction table and control console
Museum Services Corporation
385 Bridgepoint Drive
South Saint Paul, Minnesota 55075, USA
Tel: (651) 450-8954, 1-800-672-1107
Fax: (651) 554-9217
www.museumservicescorporation.com

Storage cabinets
Delta Designs Ltd.
P.O. Box 1733
Topeka, Kansas 66601, USA
Tel: (785) 234-2244, 1-800-656-7426
Fax: (785) 233-1021
www.deltadesignsltd.com

BETH MCLAUGHLIN

Electric DI water heater
Hubbell Heaters
The Electric Heater Co.
PO Box 288
Stratford, Connecticut 06615-0288, USA
Tel: (203) 378-2659
Fax: (203) 378-3593
www.hubbellheaters.com

Stacking washer and dryer
ASKO North America
ASKO Appliances, Inc.
PO Box 940609
Plano, Texas 75094-0609, USA
Tel: 1-800-898-1879
www.askousa.com

BETH MCLAUGHLIN joined Midwest Art Conservation Center as senior textile conservator in 2005. She was previously a conservator in private practice and chief textile conservator at Biltmore House in Asheville, North Carolina. She has training and experience in the conservation of historic and contemporary textiles and the preservation, care and re-housing of three-dimensional objects. Ms. McLaughlin received a Masters in Fine Arts and a Bachelor of Fine Arts summa cum laude from Ohio University and received advanced training at various institutions in the United States. Ms. McLaughlin is a professional associate of the American Institute for Conservation of Historic & Artistic Works, Textile Specialty Group, a member of the Southeast Regional Conservation Association, and the Textile Society of America. Address: Midwest Art Conservation Center, 2400 Third Avenue South, Minneapolis, Minnesota 55404, tel (612) 870-3067, fax (612) 870-3118, www.preserveart.org, bmclaughlin@preserveart.org.

TEXTILE CONSERVATION TREATMENTS IN A NEW SPACE

HAROLD MAILAND

ABSTRACT—In October 2007, after 21 years of operating out of the author's home, Textile Conservation Services moved to a dedicated treatment space. The nearby property was leased and remodeled to provide a flexible space including customized water and HVAC systems, storage, and service area. Within one year the new facility allowed for the successful treatment of seven tapestries, a pro football jersey, five shattered silk costumes, a severely damaged flag, eight Katrina-damaged embroideries, and a Native American wearing blanket.

Meanwhile, the removal of treatment activity and equipment from the previous home workspace provided a new opportunity for non-treatment activities, particularly the review and indexing of nearly 35-years' worth of records. Client files were examined chronologically and relabeled to a consistent standard. File contents were identified and logged on a spreadsheet, the fields of which the author describes. From these entries, items could then be categorized by type of object to give a picture of the historical volume of work within each category. The use of new technology has helped to streamline the documentation and communication process. Review and indexing of records now provides improved access and usefulness to accumulated knowledge and documentation.

TRATAMIENTOS DE CONSERVACIÓN TEXTIL EN UN NUEVO ESPACIO POR HAROLD MAILAND, RESUMEN—En octubre de 2007, luego de 21 años de operación fuera del hogar del autor, los Servicios de Conservación Textil se mudaron a un espacio de tratamiento dedicado. La propiedad cercana fue arrendada y remodelada para proporcionar un espacio flexible incluyendo sistemas para agua y HVAC, almacenamiento y área de servicios personalizados. Dentro de un año, la nueva instalación representó el tratamiento exitoso de siete tapices, una camiseta de futbol, cinco trajes de seda destruidos, una bandera severamente dañada, ocho bordados dañados por Katrina y una manta gastada de nativo americano.

Mientras tanto, el retiro de la actividad y el equipo de tratamiento del espacio de trabajo doméstico previo proporcionaron una nueva oportunidad para actividades que no son de tratamiento, particularmente la revisión y la indexación de registros de casi 35 años. Los archivos de los clientes se examinaron cronológicamente y se les asignó una nueva etiqueta de acuerdo con el estándar consistente. Los contenidos de los archivos se identificaron y registraron en una planilla, cuyos campos describe el autor. A partir de estas entradas, los artículos se pueden categorizar luego por tipo de objeto para dar una representación del volumen histórico de la obra dentro de cada categoría. El uso de la nueva tecnología ha ayudado para modernizar la documentación y el proceso de comunicación. La revisión e indexación de los registros ahora proporciona la mejora del acceso y la utilidad del conocimiento y la documentación acumulada.

1. INTRODUCTION

The author's mentor Mae Danneman would say "There is nothing as permanent as the temporary." Starting out in private practice in 1986 was not a common endeavor in textile conservation. Today conservators in private practice make up a large proportion of members in AIC. In 1986 an IBM Selectric was still the mode of most efforts to move hand-written data to legible formats. Personal computers were being offered in the marketplace and they were relatively expensive compared to today's dollars. While setting up a workspace in one's domicile was not uncommon it was not the ideal environment. Like most startup endeavors there were no assurances of client loyalty, colleague acceptance, or many business models to follow.

2. BACKGROUND

The theme for the 2009 AIC Annual Meeting in Los Angeles, California, was Conservation 2.0 – New

HAROLD MAILAND

Directions. This topic addressed ways in which emerging technologies were affecting the field of conservation. The author asked his neighbor, Caroline, a State employee and self-confessed computer geek, "What does 2.0 mean?" She said "It is simply a new way of a computer working that builds on the past systems that worked and provides a new framework to make things prettier and easier. Hence, 2.0 is the second full version, no security patches, no fixes, no gapping holes, with all of the updates. Therefore, a whole new version is available to the user."

The Harold Mailand's business experience starts with a hand-written journal with the first entry dated 1974. Soon files appear with electric typewritten sheets. In 1986 shortly after going full-time into private practice as Textile Conservation Services, Mailand purchased a Macintosh Plus computer, a fax machine, and a dot-matrix printer. These first big expenses launched him into the "digital" world. While the floppy disk insertion was tedious and the dot matrix was noisy, it seemed that this was the right road in the documentation of work. Although no longer used, the first system still holds iconic status in his collection (fig. 1).

Figure 1. Author's Macintosh Plus in gallery setting.

This past winter Mailand took some time away from treatments and worked to put order to the many loose ends of documentation. The process was to organize client files, gather data, index the files, and create spreadsheets. This activity provided a chance to visually see and physically handle how fashions of documentation and treatments have evolved.

Before 1986 Mailand would do private practice work wherever he could. In 1986 he leased a dedicated space to work on a very poor condition tapestry. After the completion of this tapestry he moved the practice to the lower level of his rowhouse in Indianapolis. The business operated for 21 years in this space, expanding and constricting facilities to accommodate an untold number of objects over the years. It can be difficult to have people working in one's home, however Mailand considers working with some of the same people for 18 to 20 years to have been fortunate. These long-term co-workers have survived four presidential administrations and waves and fashions of what the public and private sector wants treated: tapestries, costumes, quilts, samplers, flags, and back to tapestries.

3. A NEW SPACE

While operating in this combined live/work space, Mailand had sought the "perfect" space for years: 2,500 square feet, skylights, 14-foot high walls, no interior walls or columns, and secure yet accessible. He would discover that sometimes the solution is not a dream fulfilled but a practical space hidden in plain sight. Both passion and deadlines can be partners for change.

In July of 2007, a tsunami of contract agreements necessitated quick action. Mailand located an oddly shaped space of about 900 square feet nearby, got his contractor in to look at it, pressed for numbers, and took them to the leasing agent. The owner did not want to do any of the work, and if he could, it would take forever. Mailand offered to have the work done himself and pay very little and on a short-term lease, to which the owner agreed. In the middle of October of 2007, the contractor started working on the space. The renovations included altering water and HVAC systems, resurfacing walls, adding 14-foot long storage shelves, designing a staff/guest service area, and hanging inspirational textiles. The emphasis was on mobility and change. Meanwhile, Mailand and one of his technicians prepared four tapestries for cleaning. They were in the new space, up and going, on the eve of Halloween (fig. 2).


Figure 2. New treatment space.


Figure 3. Tapestry treatment area.

4. TREATMENTS

Within one year, the new space allowed for multiple treatments to be undertaken simultaneously and at different speeds, and brought together four part-time technicians and two summer interns to work together on a 24-7 basis. Seven tapestries were wet cleaned and then stabilized using time honored methods of slit repair, underlayments and couching, and "Spannstitch" or self-couching stitches (fig. 3). Five shattered dress-weight silk costumes and a severely damaged flag were treated with underlayments, hand stitching, and an adhesive consolidate (Beva 371 spray-coated onto light-weight carrier fabrics) as per well-established protocols. A pro football jersey was also treated in the same manner as the silk costumes and flag. Eight embroideries damaged by Hurricane Katrina were wet cleaned and solar bleached, stabilized with hand stitching, and then mounted on heavy-weight polyester fabric.

A northern Indiana Miami wearing blanket constructed of a woolen trade cloth and embellished with silk ribbon was also an ideal candidate for the use of Beva 371. Organza fabrics were coated on one side and then pressed and heat-set into place. The wearing blanket was then housed in a special viewing case that was portable and could be adjusted to various points of view (fig. 4).

Figure 4. Northern Indiana Miami wearing blanket, after treatment.

The purchase of a Mac OSX, version 10.4.11 in 2008 provided Mailand the capacity to tie many tasks together, as well as experiment. One such example was to use the computer and Photoshop Elements 2.0 to simulate what a treatment would look like without actually doing the tedious task of stabilizing the object (figs. 5, 6).

Figure 5. A circa 1840 silk wall panel, before computer simulated treatment.

Figure 6. Silk wall panel in fig.5, after computer simulated treatment. Courtesy Chilluffo Photography.

5. MEANWHILE, A REVIEW

Once treatment had been transferred to the new space, the old lab allowed for the reviewing of work systems, writing lectures, pursuing research, documenting a private collection, and indexing records. This move provided a chance to get back to some long-deferred activities. Most of it was paper work: sorting and making new piles of paper, reading, self-empowerment through digital photography, and hiring someone to come in and do bookkeeping, indexing years of treatments, scanning color slides into digital images, filing, and re-filing. This attention to non-treatment activities seemed to be an ideal and not entirely possible when the business was focused on treating textiles, pleasing clients, and making a living. This year however, the goal of organized record-keeping was made a priority and an assistant hired to focus on this and to make it a seamless reality. All done so Mailand could find things on a whim.

The protocol was established and the following tasks were pursued. A review of the contents of each client file folder was undertaken for Textile Conservation Services (TCS). Each file folder was browsed for the following items: condition – giving an overview of the condition of the item; treatment proposal – proposing a treatment for the item, often providing alternate methods or levels of treatment; estimate – a contractual agreement with an estimate of the cost of the treatment; and billing statement – a statement of charges. Additional materials in the file were also noticed, including client-provided photographs, swatches of fabric, samples of items removed from the object being conserved, and filter cloths, although no notes were made of any of these items. Only photos, slides and negatives created by TCS were noted. These were left in the file with the rest of the client materials.

Figure 7. Detail of indexed files.

In order to keep track of the information found in the physical files, a spreadsheet was created. It contained the following columns: Year; File Number; Client Name; Client State; Object (terse description); Condition Report; Treatment Proposal; Estimate; Billing; From Ledger List; Physical Folder; Computer File; Qty; General; Object Type; Photo/Slide; Other Notes. The *Year* field is the four-digit year for the client. It was determined that the designated year would be when the client made contact and began the process of having an item conserved, irrespective of when the work was finished or paid for. *File Number* is the client number designation in a running number. It consists of the last two digits of the year and a three-digit, ordinal number indicating the order in which the work was received. The *Client Name* is the last name only of the client. *Client State* is the state of residence of the client. The *Object* field holds a brief description of the item, often including the number of items on the contract in the case of multiple like items. *Condition, Treatment, Estimate,* and *Billing* fields were simply marked with an X when the item was present. *From Ledger List* refers to clients who appeared on a hand-written ledger from the first years of TCS. *Physical Folder* refers to the fact that there was a file folder in the cabinet. This was used in conjunction with the field *Computer File*. There were several instances where there was a computer file with *no* physical file, although these discrepancies were rectified as the computer files were scanned and files were returned from workspaces to the cabinet. *Qty* refers to the number of items treated on the same contract. *General* refers to a general designation of the type of item treated and is used in conjunction with *Object Type*, a more specific and narrower classification. If *Photos/Slides* (or negatives) were found in the folder, an X was placed in this column. This allows the author to return to just those folders which contain images which may not be available anywhere else in the system. *Other Notes* is a general field where additional, miscellaneous notes can be stored. It may contain a reference to another file folder or client, or may indicate that a folder was started but no activity (or payment) took place.

First, a divider was placed for each year as the year was reviewed. All files for a particular year were physically removed from the cabinet. Each folder has a number, a name and occasionally an object noted on the label tab. Client names were matched with the correspondence within. Each found item was checked in a column on a spreadsheet. Objects and quantities, photos/slides/negatives and notes were recorded on the spreadsheet. The folders were re-stamped with a revised client number to reflect a change in the system of assigning numbers. Paper clips, when found, were removed and replaced by stapling. Additionally, materials from or used in conserving the object were generally stapled to the condition report to prevent their accidental loss. Folders were returned to the filing cabinet in a sequential numbering pattern (fig. 7).

Once the review of all the clients was completed, the spreadsheet was reviewed. Categories of items were determined, and each General object designation was assigned to one of the following categories:

- Attire – including all clothing, accessories and shoes
- Display – vitrines, mannequins, display cases, hanging display fixtures
- Education – workshops, lectures, seminars, study groups
- Embroidery – including fabric with surface decoration which did not fall into more specific category
- Flag – including banners and pennants
- Furnishing – upholstery, curtains, wall pieces, etc.
- Quilt – exclusively quilts and quilted items
- Rug – all rugs
- Tapestry – all items of tapestry-woven construction not included in other categories

The spreadsheet was then sorted by Object Type and totals were found for the number of each type. This information was transferred to a small chart on a second spreadsheet and used to create an exploded pie-chart, showing total numbers of each item (fig. 8).

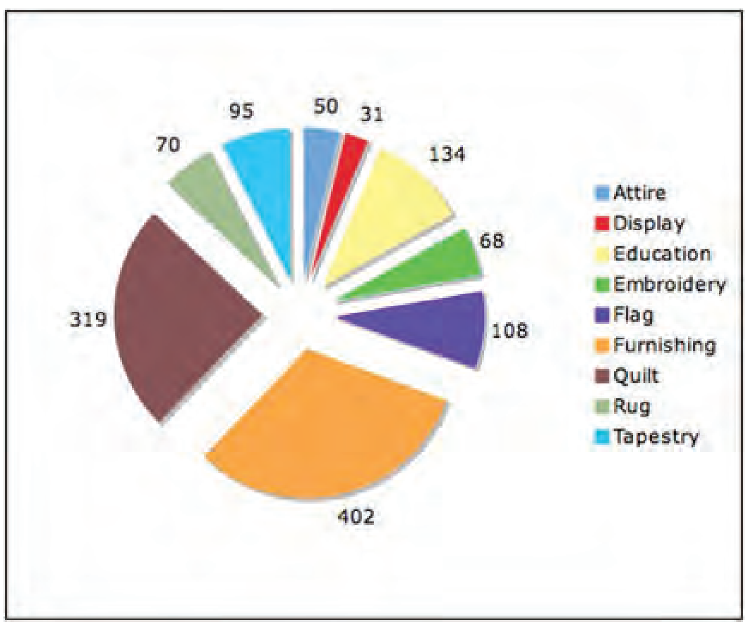


Figure 8. Breakdown of indexed files by type of object.

A review of the computer files matched physical folders and computer files. It was found that there are many more paper files than computer files. Discrepancies and missing files were corrected and noted.

6. CONCLUSIONS

To get to 2.0 implies that processes have not always been streamlined, easy, fast, seamless, et cetera. While textile conservation will still involve on some level the means of filling gapping holes, open seams, and time consuming techniques to stabilize degraded textiles, the documentation and communication avenues now appear to be more seamless. It is possible to start, or start "simply," using a digital camera and a laptop to generate documents about an object for the client or the curator. These systems have more immediate and visible resources for sharing the treatment process. However, to stay current in the field of conservation, computer technology – with the flexibility it provides – can go hand in hand with time–proven techniques.

In the case of the above-mentioned move, the space away from the main operating arena made it possible to successfully accomplish treatments of a wide variety in a timely manner. The space away from the work theatre allowed for the time-consuming but worthwhile process of indexing nearly 35 years of work and making it accessible to review for materials, protocol, and hours. Now there is the issue of scanning tens of thousands of slides and photographs into a digital format. Or not.

ACKNOWLEDGMENTS

The author would like to acknowledge Caroline Laudig, Garry Chilluffo, and Edward Marlow for their technical support; Mae Danneman and Janet Welliver for their encouragement; Jim Douglas, Ken Myers, Vikki B. Flack, Sarah Noggle, Kathy Lechuga, and Annie-Beth Ellington for their hand skills during this transition.

HAROLD F. MAILAND holds a master's degree in Textile Design and Education from Indiana University. His training in textile conservation includes internships at The Textile Museum, Smithsonian Institution, Museum of Fine Arts in Boston, and The Costume Institute/Metropolitan Museum of Art with grants from National Endowment for the Arts, National Museum Act and others. Mr. Mailand was Associate Textile Conservator for the Indianapolis Museum of Art, and in 1986 he founded Textile Conservation Services, a textile conservation facility in Indianapolis, Indiana. He is a Fellow in AIC. In 1999 he co-authored a 92-page text entitled, *Preserving Textiles: a guide for the nonspecialist*. In 2002, Mr. Mailand was selected as a Samuel H. Kress Conservation Publication Fellow to pursue research in the traditions of preserving textiles and costumes. Since 2002 he has also been the instructor for "Care of Textiles" at the Campbell Center for Historic Preservation Studies. Address: Textile Conservation Services, 928 North Alabama Street, Indianapolis, IN, 46202. hmail@textileconservation.com.

RENOVATING THE PRESERVATION RESEARCH & TESTING DIVISION LABORATORIES AT THE LIBRARY OF CONGRESS

FENELLA G. FRANCE

ABSTRACT—The Library of Congress Preservation Research and Testing Division (PRTD) is currently undergoing major laboratory renovations. The two main laboratories – Chemical and Physical Testing, and Optical Properties – are being upgraded, remodeled, and expanded in instrumentation to address the preservation needs of the Library collection. Close collaboration with the Facilities, Design and Construction Department as well as the Architect of the Capitol have been required to meet stringent safety and building requirements for research laboratories in a library building. These upgrades focus on chemistry and materials science with an emphasis on active pro-environmental practice. To integrate these requirements, specific factors were addressed in the laboratory renovation: laboratory design, developing new research policies and procedures, utilization of energy-efficient instrumentation through careful selection of equipment, and the establishment of procedures designed to protect the environment from avoidable harm. Current research protocols in PRTD emphasize the use of non-destructive analytical techniques and where sampling is required, the development of micro-analytical procedures to acquire the maximum required information with sampling on the micro and nano scale. The Library has a diverse collection of over 145 million items, and for the materials science studies of this range of composite materials, the PRTD now includes a scientific reference collection area.

RENOVACIÓN DE LOS LABORATORIOS DE LA DIVISIÓN DE INVESTIGACIÓN Y PRUEBAS PARA LA PRESERVACIÓN EN LA BIBLIOTECA DEL CONGRESO POR FENELLA G. FRANCE, RESUMEN—La División de Investigación y Pruebas para la Preservación (PRTD) de la Biblioteca del Congreso actualmente se encuentra sometida a grandes renovaciones del laboratorio. Los dos laboratorios principales – Pruebas químicas y físicas y Propiedades ópticas – se están mejorando, remodelando y expandiendo en instrumentación para abordar las necesidades de preservación de la colección de la Biblioteca. Se ha requerido una colaboración directa del Departamento de instalaciones, diseño y construcción así como también del arquitecto de Capitolio para cumplir con los requisitos más estrictos de seguridad y construcción para los laboratorios de investigación en un edificio de la biblioteca. Estas mejoras se centran en la ciencia química y de los materiales con un énfasis en la práctica active a favor del medio ambiente. Para integrar estos requisitos, se abordaron factores específicos en la renovación del laboratorio: diseño del laboratorio, desarrollo de nuevas políticas y procedimientos de investigación, utilización de instrumentación de energía eficiente a través de la cuidadosa selección de equipo, y el establecimiento de procedimientos designados para proteger el medio ambiente de daños evitables. Los protocolos de investigación actuales en la PRTD enfatizan el uso de técnicas analíticas no destructivas y cuando se requiere el muestreo, el desarrollo de procedimientos micro-analíticos para adquirir la información máxima requerida con el muestreo a micro y nano escala. La Biblioteca tiene una colección variada de más de 145 millones de artículos y para los estudios de ciencias de materiales de este rango de materiales compuestos, la PRTD ahora incluye un área de colección de referencia científica.

1. LIBRARY OF CONGRESS PRESERVATION RESEARCH

The Library of Congress was founded in 1800 and is the oldest federal cultural institution in the United States. With more than 145 million items in various languages, disciplines, and formats, it is the largest library in the world. The Preservation Directorate was founded in 1967 and it is within this division that the Library focuses on preservation awareness, education, research, and treatment of library materials. The mission of the Preservation Directorate is "to assure long-term uninterrupted access to the intellectual content of the Library's collections, either in original or reformatted form," and this mission provides the underlying basis for the requirement of the Library of Congress Preservation Research and Testing Division (PRTD) to mitigate risks to the Library's collections, while ensuring long-term access for researchers and the public.

The Preservation Research and Testing Division undertakes scientific and technical research to advance and support Library preservation. A range of instrumentation is employed to generate scientific data for the preservation of cultural heritage with a focus on non-destructive testing and micro-analytical scientific and forensic-type analyses of documents, objects, and library materials. This materials science research of library, archive, and museum materials relates to both substrates (paper, parchment, photographic materials, etc.) and the media used to record information (inks, pigments, colorants). As part of the service to the Library of Congress, collection research in the division is focused on specific lines of research that support materials and objects in the Library collections and collection issues. This includes a significant focus on quality control specifications to establish criteria and standards for supplies and techniques used in the conservation, housing, and storage of library collections. PRTD also works closely with other offices of the Library, in particular the Architect of the Capitol's Office, to assure that all collection materials are displayed, housed, and stored under appropriate environmental conditions, and that housing and architectural materials, paints, and coatings meet conservation standards. As part of its mandate for outreach, PRTD considers all research relative to the needs of the greater cultural heritage community – libraries, archives, and museums. As part of this outreach they are developing a Center for Library Analytical Scientific Samples (CLASS), environmental research that reflects the current focus on energy efficiency and the assessment of safe rates of change for materials, and outreach projects for cultural heritage institutions that do not have instrumentation required to address specific object issues.

2. CHANGES IN LIBRARY POLICIES AND PROCEDURES

Although planning began in 1957 for a third Library building, the Madison Building was officially opened in 1980 as the nation's official memorial to James Madison. PRTD has three research areas in the Madison Building on the ground floor and in the sub-basement:

- LM-SB27: Optical Laboratory
- LM-G52: Chemical and Physical Testing
- LM-G16: Preservation Reference Collection

In 2005 an initiative was undertaken to upgrade the 25-year-old laboratory spaces and instrumentation. This initiative allowed the Library to strengthen its scientific research effort through updated instrumentation that enabled the identification of problems that underlie deterioration of 21st century collections, allowing scientifically-based solutions essential to protecting continued access to cultural resources.

Given the recent awareness and concerns for the impact of activities on the environment, the Library has focused on increasing energy efficiency and reducing environmental impact. This development aligns with the convergence of chemistry departments and materials science research laboratories that have begun to emphasize active pro-environmental practice in a number of areas:

- Laboratory design
- Research policies
- Use of instruments
- Selection of equipment
- Procedures designed to protect the environment from avoidable harm

This approach, informally called “green chemistry” in “green labs,” focuses on implementing changes that address practices in the above areas. These practices include:

- Energy efficient design (whole building approach)
- Increased instrument sensitivity
- Micro-scale sampling
- Minimized solvent use to reduce environmental exposure and chemical wastes

In addition to the environmental benefits of this approach, other incentives include increased safety; increased resource efficiency in energy, materials, and water; reduced costs in energy, materials, and personnel; and smaller space requirements for instrumentation, storage of waste materials, and safety documentation.

3. GUIDELINES FOR ENERGY EFFICIENCY AND ENVIRONMENTAL DESIGN

Currently there are no internationally agreed-upon standards for the criteria one needs to meet to characterize a research laboratory as pro-environment, but guidelines for Leadership in Energy and Environmental Design (LEED) certification have been developed by the U.S. Green Building Council (USGBC). This program has established a “Green Building Rating System™” and its mission is to encourage and accelerate the global adoption of sustainable green building and development practices through the creation and implementation of universally understood and accepted tools and performance criteria. LEED promotes a whole-building approach to environmental sustainability by acknowledging the importance of pro-environmental performance in five critical areas of both environmental and human health: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality. The rating system is developed through an open, consensus-based volunteer committee process. To ensure the needs and requirements of all stakeholders are addressed, each committee comprises a diverse group of practitioners and experts representing a cross-section of the building and construction industry. The key elements of USGBC’s consensus process include a balanced and transparent committee structure, technical advisory groups that ensure scientific consistency and rigor, opportunities for stakeholder comment and review, member ballot of new rating systems, and a fair and open appeals process.

The Labs 21 Environmental Performance Criteria (EPC) is a rating system specifically designed for laboratory facilities. It builds on the LEED Green Building Rating System that was developed by the U.S. Green Building Council. One of the reasons that laboratories are focusing on the area of energy efficiency is due to the high demands for environmental control during testing procedures and specialized processes, and the high energy demands of the equipment in research laboratories. Given the importance and value of activities conducted in chemistry and more particularly cultural heritage research labs, they represent an area where energy efficiency improvements stand to yield abundant non-energy benefits if changes are effectively implemented. Generally, laboratories have a four to five times higher requirement for energy usage than office areas.

4. LIBRARY PRO-ENVIRONMENTAL IMPLEMENTATIONS

4.1 RESOURCE-EFFICIENT PRACTICES

In line with Library policies and procedures, PRTD began increasing environmental protections in 2005 by reducing the inventory of chemicals and eliminating stockpiles of chemicals common in research laboratories, and at the same time prioritizing the adoption of new, or adaptation of existing, experimental methods. These actions resulted in a 50% reduction from the previous decade in both the need for chemicals and the level of chemical waste disposal required. One of the areas mentioned above, addressing needed changes in research lab practice, was the investment in and installation of resource-efficient equipment and instruments that enhance research while incorporating environmental awareness. The incorporation of other instruments that eliminate solvents and eliminate or reduce sample size is one such recommended change, and accordingly, the Library installed a new laser ablator instrument that required no solvents for preparation of samples compared to a previous sample size of at least 100 ml per test. In addition, environmentally protective modern chemical instruments use less power and need less physical space, two benefits that were realized when, for example, the Library installed an Agilent gas chromatograph-mass spectrometer (GC-MS) that used 60% less power than the instrument it replaced, and a Thermo Electron ICP that occupied 50% less floor space than its predecessor.

New technology has allowed a much greater emphasis on the non-destructive and micro- and nano- techniques for preservation. This has the dual advantage of collecting required information while both reducing potential damage to already fragile historic cultural heritage materials and minimizing the impact on the environment. Advances in spectral imaging, spectroscopy, and microscopy further advance non-destructive analyses. Image analysis techniques enable the characterization of substrates, media, and materials through specific spectral responses in the visible and non-visible regions of the spectrum. The advanced imaging system employs innovative, conservation-safe integrated imaging and lighting capacities that utilize light emitting diodes (LEDs) with greatly reduced heat production and energy requirements. While scanning electron microscopes traditionally required customized rooms and machines to either gold- or carbon-coat samples, in 2007 the Library installed a new environmental scanning electron microscope that allows control of the environment within an easily accessible stage. This instrument can generate high resolution images within a range of vacuum settings, greatly reducing potential damage to micro samples, all while allowing them to be examined by other methods later, as opposed to the previously destructive nature of sample preparation methods. Newer techniques complement older research tools, for example advances in Fourier transform infrared spectroscopy (FTIR) enhances micro-analytical and non-destructive analytical instrumentation in the laboratory. Advances in complementary spectroscopic techniques include Raman and three-dimensional fluorescent spectrometry. The combination of a range of complementary techniques reduces the traditional need for sampling of objects in order to acquire the component analysis required for treatment of the items. When sampling is deemed absolutely necessary for specific critical information, it is then reduced to micro- and nano-levels.

4.2 COMPLETION OF LABORATORY ONE: SB27

The first laboratory under reconstruction was SB27. Design and modifications to the area required extensive interaction with the Office of the Architect of the Capitol (AOC) and the Facilities, Design and Construction (FDC) Division. One concern with multi-divisional projects is scheduling, since a number of factors can impact estimated timeframes. Often the length of time for contracts for materials, furniture, and installations can be extended due to delays in quotations being received. In order to schedule and coordinate the installation of consecutive services, PRTD staff worked closely with FDC as well as other contractors. Collaboration with AOC in the specification of materials was essential to ensure the quotations met the requirements for a conservation laboratory in terms of allowed materials, off-gassing, and paint and surface finishes such as powder coatings. Flexibility in planning was necessary so that modifications to accommodate intrinsic building features could be implemented midway through reconstruction (fig. 1).

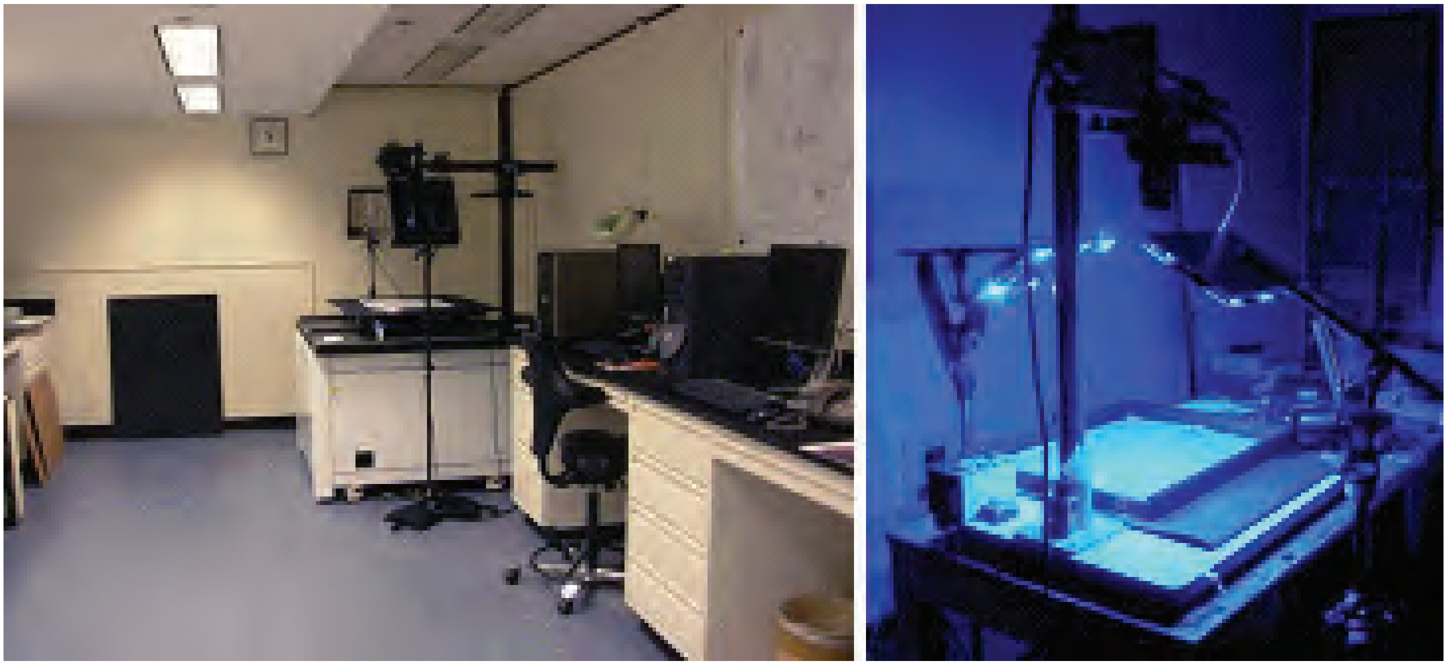


Figure 1. SB27 Hyperspectral Imaging Room.

4.2.1 EQUIPMENT AND INSTRUMENTATION ISSUES

One of the greatly overlooked aspects when implementing laboratory upgrades is the provision for storage of highly sensitive and often costly scientific equipment for an extended period of time. In addition to its requirements in terms of space, this instrumentation often requires physical stabilization to minimize damage to highly sensitive sensors, security against theft, and a stable environment to prevent damage due to changes in temperature, pressure and relative humidity. Further areas of concern include the de-installation and re-installation processes, how these processes impact insurance coverage and maintenance contracts, what such contracts cover, and whether they need to be continued over the period of de-installation.

4.2.2 ERGONOMIC ISSUES

Another issue that was addressed in the reconstruction was that of ergonomics. Many areas were lit only with overhead office-type lighting that was energy inefficient and not optimal for preservation science activities. Changes in lighting were implemented to address particular needs, such as reduced lighting in the imaging lab, and task lighting at specific work areas to facilitate fine detail viewing. In addition specific counter heights, knee-hole spaces and chairs were investigated, resulting in the selection of a two-way reversible chair that could act as a conventional chair and also be used in reverse to lean over a bench when doing repetitive work and minimize back problems.

4.2.3 INSTALLING NEW IMAGING EQUIPMENT

One of the major modifications of the facilities was redesigning an area originally intended as a wet chemistry laboratory into an optical imaging room. This required adapting the existing room to meet the requirements of the imaging system. Given the changed use of this space, the redesign included working with vertical and horizontal limitations for a 2 m copy-stand, X-Y table, space allocations for the integrated camera and lighting equipment, and the computers required to control, acquire, and process captured images and data. In order to insure that the needs of fragile collection items could be accommodated, there was particular concern for the stability of lighting and camera equipment, appropriate computing requirements, and assessment of environmental conditions in the space through the monitoring of relative humidity, temperature, and light.

As noted previously, one of the challenges was the installation of controlled lighting for imaging. This required coordinating a new electrical circuit switch that did not disrupt existing lighting controls in the sub-basement area, and integration with existing lab arrangement. In addition, since specific lighting comprised both visible and non-visible radiation, it was necessary to provide safety equipment, particularly ultraviolet-blocking safety glasses. The hyperspectral imaging system utilized a 30 Megapixel high resolution monochrome camera, integrated LED illumination panels, and low energy defined spectral bands. Some of the specialized requirements for imaging of paper, textiles, and other objects included:

- An X-Y table on Z control copy-stand to minimize handling of artifact
- Low light levels
- Controlled environment
- Raking lights for topography
- Range of spectrum lighting to include ultra-violet, visible and infra-red
- Extended support for large items

4.3 ENVIRONMENTALLY CONTROLLED ROOM

As part of the G52 Chemical and Physical laboratory upgrade, a new more energy-efficient double room was designed to replace the existing conditioned room which had not been operating effectively for at least two years. The new room was comprised of two controlled internal spaces – one general area conditioned to TAPPI paper testing requirements, and another more tightly controlled space entered from within the external controlled space - thus reducing the impact of controlling an environment when buffered directly against unconditioned building conditions. After a number of locations were assessed for the installation of the new room, it was discovered that there was a limited number of feasible alternatives due to chilled water access in the building and the condition that all upgrades had to be commensurate with the existing building structure. In addition, a number of safety regulation issues for sprinklers and chemicals were discussed in detail with the Library safety office. The benefits of the revised conditioned room were numerous. Having two internally controlled spaces allowed energy savings for the smaller internal area with a greater capacity for RH and temperature control and modification over a wider range of values due to a separate glycol control system. The internal area also acted as a storage area for fragile organic reference materials and long-term natural aging studies. A special feature for external glove access to the internal area allowed research materials to be accessed without having to open the internal door, thereby maintaining non-fluctuating conditions. In addition to providing energy savings, this feature was more efficient by eliminating the need to wait for conditions to restabilize during activities requiring constant environmental conditions, such as tracking changes in moisture absorption. At this stage additional upgrade work on G52 is still ongoing (fig. 2).

4.4 COMPLEMENTARY RESEARCH TECHNIQUES

Emphasizing non-invasive and non-destructive techniques to protect collection objects studied has greatly

Figure 2. G52 Laboratory Re-Construction.

reduced the energy, material, storage, and waste removal requirements in the research laboratories. The complimentary use of a range of instrumentation and non-destructive techniques has been employed to reduce the impact on the environment while increasing the protection to the original cultural heritage artifact: Hyper-spectral

Imaging, 3D Fluorescence, ESEM, X-Ray Florescence, and FTIR and Raman spectroscopy. Linking analyses for enhanced research capacity has advanced the area of non-destructive testing at the Library and allowed more standardized procedures and protocols to be developed that optimize time and instrumental efficiency within the laboratory.

5. PRESERVATION REFERENCE COLLECTION OF SCIENTIFIC SAMPLES

The Library of Congress has a large and diverse collection of over 145 million items ranging from balloon cloths to modern media which would challenge the capacity of any laboratory by its volume, variety, and complexity. The essential materials science studies of this range of composite materials has led to the final planned space of approximately 9000 square feet that allows for an extensive range of research capabilities, specialized conditioned room, and the housing of a materials reference collection. The collection will include a wide range of reference materials:

- New, naturally aged, and accelerated aged samples
- Physical samples including reference papers, books (the Barrow collection), pigments, leather, stone, fibers, leather book bindings, and cloth samples
- Digital files associated with collection objects and reference samples from a range of techniques and instrumentation including hyperspectral images, FTIR, Raman, XRF, SEM images and spectra, and more.

The organization of and access to these preservation reference materials will be through an open source software architecture and platform utilizing a customized Resource Description Framework (RDF). This will allow international access to data with data interoperability using standardized file formats. The reference collection is also part of the pro-environment move, since by allowing advanced research of material properties, a better understanding can be gained about rate changes and the tolerances of materials in regards to the needs for specific environmental controls, and the commensurate costs associated with this control.

6. CONCLUSIONS

In order to meet the requirements and specialized demands of a working research laboratory within a library building that comprises office and collection storage areas, the integration of the PRTD research laboratory upgrade with the existing building structure required close coordination with building construction personnel and architects. Safety requirements for access, equipment, personnel, chemicals, fire and other potential hazards had to be met. Specifications of materials for laboratory equipment and furniture were necessary to ensure the controlled environment required for the protection of collection items while under research. To further this protection of cultural heritage while minimizing environmental impact, the utilization of non-destructive and micro- and nano- sampling was aided by the introduction of efficient low-energy equipment. Future advances toward truly sustainable preservation of cultural heritage within the current global economy, escalating energy cost, and changing climate can by achieved through international research collaborations, but will require the continued integration and sharing of complementary research techniques, the development of standardized work processes and data collection methods, and the establishment of advanced materials science for preservation that addresses current economic, climatic, and environmental needs.

FURTHER READING

Christens-Barry, W., K. Boydston, F. G. France, K. Knox, R. L. Easton, and M. B. Toth. 2000. Camera system for multispectral imaging of documents. Proceedings. Digital Imaging Sensors and Applications, 21st Annual IS&T/SPIE Symposium on Electronic Imaging, San Jose, CA.724908-1 - 724908-10.

France, F. G. 2009. Best practice and standards in environmental preservation for cultural heritage institutions: goals, knowledge, gaps. In Advances in paper conservation research. British Library conference, 23–24 March 2009, London. London: British Library. 16-26. http://www.bl.uk/aboutus/stratpolprog/ccare/events/France.pdf (accessed 9/19/2009).

France, F. G., E. F. Hansen, and M. B. Toth. 2009. Creating a composite cultural heritage artifact – the digital object. Preprints. Digital Humanities 09 Conference, University of Maryland. College Park: Maryland Institute for Technology in the Humanities (MITH).113-115.

Green Chemistry. U. S. Environmental Protection Agency. http://epa.gov/gcc/index.html (accessed 9/19/2009).

Labs. Sustainability at Harvard. Harvard University. http://www.greencampus.harvard.edu/labs/index.php (accessed 9/19/2009).

Lawrence Berkeley National Laboratory. A design guide for energy-efficient research laboratories. http://ateam.lbl.gov/Design-Guide/ (accessed 9/19/2009).

Library of Congress. 2009. Lab renovation: increasing energy efficiency and reducing environmental impact. http://www.loc.gov/preserv/rt/projects/lab_renovation.html (accessed 9/19/2009).

Mills, E., G. Bell, D. Sartor, A. Chen, D. Avery, M. Siminovitch, S. Greenberg, G. Marton, A. de Almeida, and L. E. Lock. 1996. Energy efficiency in California laboratory-type facilities. Lawrence Berkeley National Laboratory Report LBNL-39061. http://www-library.lbl.gov/docs/LBNL/390/61/PDF/LBNL-39061.pdf (accessed 9/19/2009).

U. S. Department of Energy Environmental Energy Technologies Division, http://eetd.lbl.gov/ (accessed 9/19/2009).

U. S. Environmental Protection Agency. Laboratories for the 21st Century. http://ateam.lbl.gov/Design-Guide/DGHtm/labs21low.energydesign.htm (accessed 9/19/2009).

U. S. Green Building Council. Leadership in Energy and Environmental Design (LEED). http://www.usgbc.org (accessed 9/19/2009).

FENELLA G. FRANCE is currently a research chemist in the Preservation Research and Testing Division at the Library of Congress researching non-destructive imaging techniques, and anoxic environments. She received her Ph.D from Otago University, New Zealand. After lecturing at Otago, she was the research scientist for the Star-Spangled Banner project at National Museum of American History. An international specialist on environmental deterioration, she focuses on links between mechanical properties and chemical changes from environmental damage. Dr. France has worked on projects including the World Trade Centre Artifacts, Pre-Columbian textiles, the Ellis Island Immigration Museum, and work on lighting standards for the preservation of cultural heritage. Address: Library of Congress, 101 Independence Ave, SE, Washington DC, 20540; frfr@loc.gov.

NEW LAB SPACE, NEW DE YOUNG

SARAH GATES & BETH SZUHAY

ABSTRACT—Following earthquake damage to its previous structure, the de Young Museum in San Francisco, California, opened a new building in 2005, which includes a purpose-built textile conservation lab. In designing the new facilities, the textile conservation staff researched existing labs, compiling written, visual, technical, and experiential information. By first enumerating the basic functions required of the space, the conservators were able to focus specifically on the layout, square footage, and equipment needed to accomplish these functions. The size of the workspace was dictated by three factors: the administration's desire for professional facilities, a trustee's generosity, and the space needs for treating monumental tapestries and carpets. The interior space was then worked out through scaled templates on a floor plan. The design of a temporary lab for the five-year construction interim was useful practice for the planning of the permanent facilities. The conservators faced challenges in communication, both in their comprehension of complex architectural plans and in successfully conveying their concerns to the architects though intermediaries. The resulting discrepancies in what was desired and requested and what was actually built have required a range of responses, including re-purposing furniture, retrofitting vents and furniture, replacement of ineffective fixtures and unsuitable materials, and resignation to spatial, structural, or financial limitations.

NUEVO ESPACIO DE LABORATORIO, NUEVO DE YOUNG POR SARAH GATES Y BETH SZUHAY, RESUMEN—Luego del daño del terremoto a su estructura previa, el Museo de Young en San Francisco, California, abrió un nuevo edificio en 2005, que incluye un laboratorio de conservación de artículos textiles específicamente diseñado. Al diseñar las nuevas instalaciones, el personal de conservación textil investigó los laboratorios existentes, compilando información escrita, visual, técnica y de experimentación. Al enumerar primero las funciones básicas requeridas por el espacio, los conservadores pudieron centrarse específicamente en el diseño, pies cuadrados y equipos necesarios para cumplir estas funciones. El tamaño del espacio de trabajo fue determinado por tres factores: el deseo de administración para las instalaciones profesionales, la generosidad de un miembro del consejo de administración y las necesidades de espacio para tratar los tapices y las alfombras monumentales. El espacio interior luego se trabajó a través de plantillas a escala en un plano de planta. El diseño de un laboratorio temporal para el ínterin de construcción de cinco años fue práctica útil para la planificación de las instalaciones permanentes. Los conservadores enfrentaron desafíos en comunicación, tanto en su comprensión de los complejos planos arquitectónicos como en la transferencia exitosa de sus inquietudes a los arquitectos a través de los intermediarios. Las discrepancias resultantes entre lo que se deseaba y se solicitó y lo que realmente se construyó ha requerido un rango de respuestas, incluyendo muebles remodelados, ventilaciones y muebles refaccionados, reemplazo de mobiliarios poco efectivos y materiales poco adecuados, y la resignación a limitaciones espaciales, estructurales o financieras.

1. INTRODUCTION

The new de Young Museum in San Francisco, California, opened October 5th, 2005. Included in the new building is a textile conservation lab of almost 3000 square feet, with separate dry, wet, and dye rooms. The growing permanent collection is comprised of 13,000 textiles including costumes, monumental European tapestries, and carpets. This paper will review the questions asked and decisions made about the lab space in regards to the needs of the collection. The authors will also discuss the positives and negatives of the resulting space after more than ten years of research, negotiation, and compromises.

2. BACKGROUND

The H.M. de Young Memorial Museum first opened its doors in Golden Gate Park in 1895. It is one of two museums administered by the Corporation of the Fine Arts Museums of San Francisco, the other being The Palace of the Legion of Honor, located in Lincoln Park overlooking the Golden Gate Bridge. In 1989, the museum building, then an amalgamation of six different ill-designed structures built between 1915 and 1955, suffered irreparable structural damage due to the Loma Prieta earthquake. Two city bond measures asking for funding to rebuild the museum failed and the administration was forced to turn to private sources. It was then that the administration, board of trustees, and capital campaign donors realized that this was a chance to build what they described as a "state of the art" facility using architects and builders of their own choice. In 2000, the building was closed for demolition. Five years later the new building, re-christened simply the de Young Museum, opened on the same site.

3. THE OLD LAB

The textile lab in the old building had been created in the early 1970's by modifying an existing half basement next to the main storage rooms. The dry lab was separated from the wet cleaning room, with the objects conservation lab in between. It was far from ideal; for example, an old bathroom multitasked as a washer/dryer/dye room, tea breaks were taken in the corner of the main workspace or in the hallway, and the small wet cleaning room had a drain in the highest point of the floor.

4. RESEARCHING EXISTING LABS

The task of gathering information on textile conservation workspaces began in 1996, four years before the demolition of the old museum. Since the only other dedicated museum textile conservation space on the West Coast was located at the Los Angeles County Museum of Art, it was necessary to go east, and even abroad, in order to gain a body of knowledge to help with making informed decisions.

The visits made to other textile workspaces took many forms. Besides individual appointments and courier trips, an East Coast tour organized by UKIC proved very useful. Conservation workspaces as well as storage, galleries, and public study centers were all included in the study. Experiencing how these spaces were being used as well as how they were situated in conjunction with each other was very important. The visits were documented with still images, videotape, and handwritten notes. Other information was gathered via e-mail. It was invaluable when taking on such an enormous task that colleagues were willing to share information.

All of the methods used to gather data were enormously useful in shaping the ideas for the new de Young space. The videos and photos were especially helpful when talking to the people responsible for the re-design, both those in and outside the museum field. One of the most important documents throughout the process was a copy of the official building plans for the Conservation Center at Colonial Williamsburg by the firm Juster, Pope and Frazier, courtesy of former director F. Carey Howlett. Having an actual professional building plan in-hand proved very useful when negotiating with the architects and builders. Many details, for example the size of drain required in a wet cleaning area, did not have to be reinvented nor did we, the textile conservators, have to prove that something such as a 15-foot ceiling was an important structural element for textile conservation spaces, as it could be sited in the Colonial Williamsburg document.

It is important to note that although the stunning exterior and overall "look" of the museum was designed by Herzog & de Meuron of Basel, Switzerland, the details of the interior spaces were designed by a local architectural firm, Fong & Chan. Fong & Chan circulated a survey at the beginning of the project to determine how the space would function, and used this for their design, incorporating the overall "look" determined by Herzog &

de Meuron. The battle between form (architects) and function (conservators) was mediated by a project management associate, hired specifically for this purpose. Not having direct access to the architects would prove frustrating and in some cases necessitate costly retrofitting. In the beginning however, it was more about determining the ideal work situation.

5. QUESTIONS TO ANSWER

The main question the textile conservators needed to answer during the re-design of the lab was "what does the space need to do?" The answer to this was as follows:

- To accommodate the treatment of the growing permanent collection of 13,000 textiles of which the most demanding in regards to space includes monumental tapestries, carpets, and costume
- To accommodate the preparation for rotating exhibitions. The new textile gallery and its foyer would be almost 4700 square feet and the study gallery another 600 square feet.
- To provide staging area for exhibitions including the construction of any custom mounts
- To house two to three staff conservators as well as five volunteers and a variable number of interns. This would require offices, closets, a separate kitchen for breaks, and a restroom.
- To be adjacent to one or more of the following: textile galleries, art path, storage, photography, other conservation labs, textile curators, proposed "Textile Study Center"

Further questions were derived from these answers, such as "what would the needed conservation treatments entail as far as layout, square footage, and equipment?" In answer to this, the first requirement was space for the following lab functions and equipment:

- Aqueous and non-aqueous cleaning with extraction system and floor drain
- Non-aqueous treatments with large hoist and minimum 15-foot ceiling space
- Dye area with stove top, extraction system, deep sink, and space for dye machine
- Washer, dryer, and overhead drying racks
- Water purification system with capacity to wet clean tapestries
- Fume hood, sinks to wash hands, microscope, closed cupboards, as well as open shelving for supplies and small equipment
- Storage for archival materials such as grey corrugated board, Ethafoam, rolled fabrics, tissue
- "Sewing center" to include sewing machines, iron, and serger

Other considerations included large doorways for ease of access, and large hallways to allow for rolled textiles up to 28 ft. to enter the workspace.

To answer the question of "how much space?" it was necessary to look at the equipment currently in the lab, the future equipment desired, and the square footage of our largest textiles. Detailed surveys describing space requirements, as mentioned earlier, were completed by Museums staff at the request of local architects Fong & Chan. The surveys required images and dimensions of all equipment. It was these answers to the surveys that helped us more than once: to design both our Interim Lab and the new lab as well as to aid us in the two physical moves that were required - out of the old de Young to the interim space, and out of the interim space to the new de Young. Using these surveys, the dimensions of equipment that was hoped to be obtained in the future (such as a wash table), plus the dimensions of the largest tapestry in the collection (15 x 27 ft.), produced a fairly accurate idea of what size of workspace was needed at a temporary site as well as our home site.

6. THE INTERIM LAB

During the demolition and rebuilding process, temporary quarters were carved out from a South San Francisco warehouse owned by the City's Airport Commission, where the San Francisco architectural firm STUDIOS Architecture designed custom-made labs, art storage, and office space. Having an Interim Lab, as it came to be called, and two physical moves, was both fortunate and unfortunate. Having to design a temporary lab from empty warehouse square footage was a great way to gain experience for designing the final one. Having to physically move not once, but twice, could be considered by many to be a nightmare.

While at the Interim Lab, there were two priorities: continue with exhibitions at the Legion and plan the new museum. In addition to the lab details, other topics under consideration were the spatial interactions between a study center, library, and gallery with the lab, storage, and staff. Curators, conservators, and museum administrators were all involved in this dialogue.

7. TRANSLATING INFORMATION TO A PLAN

Once specific space requirements were verified, a plan view of the space could be drawn up and explored. The general size of the lab, almost 3000 square feet, was based on information from the original Fong & Chan surveys and was supported by a generous museum benefactor who had an interest specifically in textiles. To secure so ample a space, it was indeed beneficial for the textile lab to have had a friend in high places. Along with the news of the square footage allotment came the information that all of the conservation labs - textile, objects, and paintings - would be together along one large hallway or "art path" as well as being next to the textile library and study gallery. Adjacent to these areas would be the dedicated textile gallery space that in turn connected to other public galleries.

With the parameters for the new lab outlined, as well as the general idea of what would be surrounding the new lab, the conservators began work on shaping the rooms and putting the existing and hoped-for equipment into place. A low-tech system of cutting colored paper to shape and scale of each piece of equipment or supply item and fitting the pieces into the space allotted was used to determine the layout. Two colors of paper were used: one color for existing equipment and another for what was hoped-for. Even the footprint of old circular fluorescent magnifying work lights was drawn out on paper. It was important to know that all the equipment was on wheels and could be cleared to make the maximum floor space available when it was needed. Although the method used was time-consuming, it had proven very effective in designing the Interim Lab. The result was a "dry" room with a hoist housed in a nineteen foot ceiling "pop-up"; a "wet" room with slanted floor for cleaning treatments; a dye room to house the deionized water system, fume hood, washer/dryer and drying racks, and stove top; two offices; and a storage room for supplies. There was an additional office space to be shared by the single staff person for the Textile Arts Council, a museum auxiliary group, and by volunteers who helped in the lab two days per week.

8. COMMUNICATION

As each of the building phases were completed, the textile conservators received an architectural drawing showing the percentage completed, for example "50% plan," "75% plan," and "90% plan." Reading these required an advanced degree in architecture, or at least a lot of time and patience. Some of the confusion was caused by the facts that the updated plans did not always include all of the details from previous plans and that changes were not highlighted, requiring the conservators to pour over every inch of the plan and cross-reference previous plans. The pressure was on, because if the conservators did not find any incorrect changes and speak out through the appropriate channels of communication, this silence was interpreted by the builders as indicating that the textile conservators approved the revised plans.

It is important at this point to explain the lines of communication and how much access and/or influence conservators had with the architects and builders. There were two project management associates answering to a project director. One of the associates was the link between conservators and the design team and builders, hired to interact with conservators, and who answered to the project director. At no time did the conservators have direct access to the builders or architects except for the initial planning stages, as in the Fong & Chan survey described earlier, for the Interim Lab and the new de Young. While the administration had the foresight to provide

someone as an intermediary who knew the language of building, this person did not understand the language of conservation, and therefore compromised in areas that required steadfastness from a conservator's point of view. It took more than two years after settling into the new lab for some major issues to be rectified. If communication had been better, or more direct, several of these would probably have been avoided or worked out earlier.

9. MOVING IN TO THE NEW LAB

The collection began to move into the new museum in February of 2005. In May 2005, the conservators were able to move into their labs. The new textile lab is comprised of two large rooms (dry lab and wet lab), a small equipment storage room, a dye lab/wash room, and two offices. The lab has a pass-through leading to the library and curator's offices, which serves as an office for the volunteers and curatorial assistant.

The conservators had provided a list of specified equipment and materials that were used by the operations manager to acquire bids and make the purchases. Fittings of the completed lab include chemical-resistant epoxy resin countertops and custom design and construction shelving. Ventilation is provided by E-Z Arm fume extraction trunks and a Fisher Hamilton fume hood. Johnsonite rubber tile flooring was installed in the dry lab and hallways, while a Dex-O-Tex Cheminex floor was used for the wet lab. De-ionized water for wet cleaning large textiles is provided by a Siemens Reverse osmosis system with polisher, capable of producing 10 gallons per minute. Overhead lighting is provided by fluorescent tubes, UV shielded and matched to daylight.

The ceiling is 24 x 24 in. acoustic tile. To improve cleanliness, the textile conservators chose to have the ceiling dropped to 15', below the ductwork. The conservators for objects and paintings chose to have open ceilings in their labs, but have since re-thought this as noise from the HVAC system has been found to be a problem.

Only a few new pieces of equipment were gained upon move-in, which included (1) chain link fencing along the walls of the supply/storage room that makes art as well as supplies easier to hang, (2) two overhead pulley-system drying racks for drying sheets and toweling in the dye room, and (3) two types of wheeled dollies to transport dressed mannequins (figs. 1,2).

Figure 1. Back portion of the dry lab, leading to the wet lab, showing the hoist, pop-up, and tapestry frames.

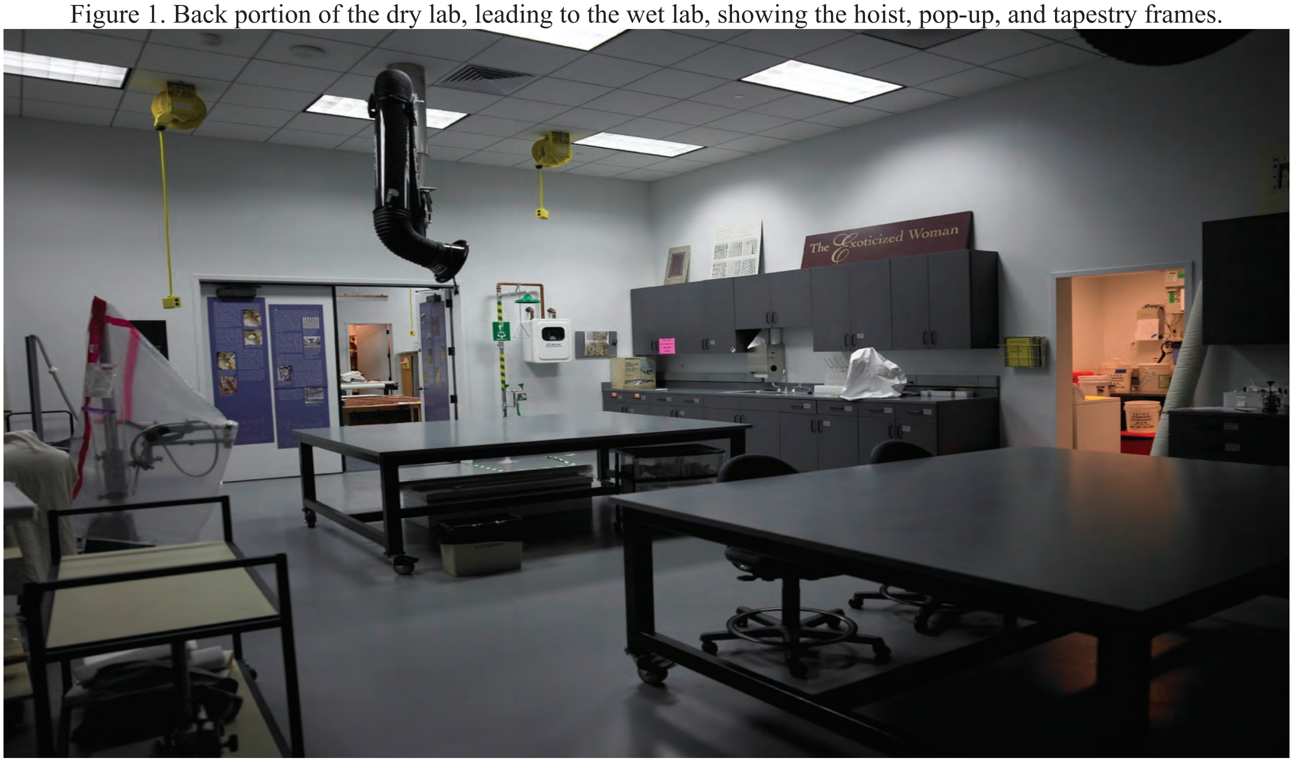


Figure 2. Wet lab looking toward the dry lab with the dye lab to the right.
The slanted floor drains to the right of the viewer.

10. HINDSIGHT IS 20/20

Generally, the new lab space is very useful and a pleasure to work in. Still, there were some problems that needed to be solved. The majority of the problems can be attributed not to errors in planning by conservation staff, but to the lack of communication between conservators and architects, hindered by the intermediary. Whether requested details were eliminated because of costs or lack of understanding of their importance is unknown. Today, three and one-half years after move-in, three-quarters of the problems have been successfully solved. The remaining quarter could be solved eventually, but not without a great deal of money.

10.1 SIMPLE SOLUTIONS

Some of the problems were easy to solve. For example, stylish gooseneck faucets had been installed to fit the look of the lab, but the curve was so shallow that the water splashed behind the faucet and collected along the base of the backsplash. These were replaced with gooseneck faucets with wider arcs that directed the water into the sink. Also, the shelves chosen by the architect had a lip, presumably as an earthquake safety measure, that prevented pulling the large tubs of fabric scraps easily from the shelves. The shelves were merely turned upside down.

10.2 COMPROMISES, COMPROMISES

Some of the problems were just accepted as inconveniences. For example, the conservators had requested the toe kick be eliminated on the cabinetry with adjustable shelving intended to store trestles and vacuums, allowing the items to easily slide in rather than having to be lifted over a sill. Although the toe kick was not installed, the bottom shelf was installed permanently, rather than being adjustable. Spending the money to alter the cabinets was not a priority for the administration, so the trestles could not be stored in the closed cabinets due to their height, and the vacuums have to be lifted in and out of the cabinet when used. Also, the architect supplied new worktables to match the interior of the lab that proved too tall for the conservators who worked there and too heavy to move easily. After making the case that the old worktables were necessary to tapestry conservation, the conservators were allowed to keep them. One of the new worktables was given to another department, while the other two were kept as exam tables.

The omission of a photo drape was another nuisance that required compromise. However, instead of installing a drape at one end of the wet room as had been planned, a portable photo backdrop was made by an outside contractor. During treatment, photos continue to be taken in-situ at the worktables.

10.3 BEGGING FOR A FIX

Some problems required a lot more negotiating, as well as proving that the people who have to use the equipment care more about utility than style. For example, a vent was omitted during building for the washer and dryer set. Instead of retrofitting a vent, the administration supplied a beautiful front loading, water saving, no-vent ASKO washer and dryer. However, the load capacity and the lack of control of the amount of water being used made the units impractical. Eventually, a vent was retrofitted and a larger capacity Kenmore washer and dryer set was installed. Another problem was that when it came time to install a Baeder rack for storing rolls of fabric, it was discovered that the wall was not strong enough to support it. Though this had been discussed during the planning stages, at some point during the building process the reinforced walls were omitted.

Eventually, an outside contractor was hired to modify the rack to be supported by the floor and it was installed. In order to cut costs, a sulfur-containing rubber tile was installed as the flooring for the labs and adjacent hallway. After much negotiating, the flooring in the lab was replaced, but the hallway has the original flooring material.

10.4 CAN'T GET NO SATISFACTION

There are other things that could not be fully corrected. For example, the conservators had requested a pop-up ceiling for the hoist that would be tall and wide enough to accommodate the largest tapestries in the collection and deep enough to provide a sight line that would allow for the entire object to be photographed. However, the pop-up was built smaller than requested due to the constraints of the building, which also negate retrofitting. An extension was built for the hoist to provide for textiles which are wider than the pop-up, but when using the hoist for taller textiles, the top section cannot be seen.

At some point in the building process, a small, Millipore reverse osmosis water treatment system was installed, presumably as an alternative to turning on the larger system used for wet-cleaning. This smaller system proved difficult and expensive to maintain and was eventually shut off. For small amounts of de-ionized water, gallon jugs are filled when the big unit is turned on.

The negatives that cannot be changed without a great deal of funding include: (1) a stove top that has a safety shut-off which prevents large dyebaths from reaching a sustained temperature and (2) a freezer/environmental room which does not drop low enough in temperature for successful use in pest management.

11. CONCLUSION

The journey that began over ten years ago still continues. While much as been achieved, the wish-list for new equipment still contains (1) a large wash table, and (2) a dye machine for producing color matching samples.

Conservators were told in the early stages of planning to "pursue the space and the staff and equipment would come later". The space was achieved by first clearly defining what was ideal through researching other labs, knowing what was most important and worthy of fighting for, and being able to be creative in solving the left-over problems. Staffing is something conservators have little control over. The Museums' administration does seem to understand that an increase in nearly seven times the gallery space requires additional trained conservators. So far, the response to this increased need has been limited primarily to temporary contract work for the installation and de-installation of major exhibitions.

Despite the staffing and equipment challenges, the lab is a wonderful space to work in. In the end, the resulting space is due to the administration's desire for a state of the art facility to match the state of the art museum, the determination of the conservators to meet the needs of the collection, and the generous support of a few donors who understand the importance of conservation.

ACKOWLEDGEMENTS

The Textile Conservation staff of the de Young gratefully acknowledge George and Marie Hecksher and Carolyn and H. McCoy-Jones; F. Carey Howlett, Joanne Hackett, and Yadin Larochette; the Conservation and Administrative staff at the FAM; Barbara Arthur, Donald Ellison, Kathy Murphy, Barbara Nitzberg, Jean Scardina, and Trish Daly. Special thanks to Kevin Riley and Robert Haycock, both of whom have been instrumental in turning negatives to positives.

SOURCES OF EQUIPMENT AND MATERIALS

Floors
Dry lab:
Johnsonite Triumph Rubber Multi-functional and Sports Floor Tile, special weathered finish
Johnsonite
16910 Munn Road
Chagrin Falls, Ohio 44023
440-543-8916 or 800-899-8916
Fax 440-543-8920 or 440-543-5774
http://www.johnsonite.com

Wet lab:
Cheminert "K" epoxy resin with Aero-Flor coating and Dex-O-Tex Cheminert SC Membrane
Dex-O-Tex
3000 E. Harcourt St.
Rancho Dominguez, CA 90211
310-886-9100 or 800-833-9683
Fax 310-886-9119
http://www.dex-o-tex.com

Hall:
Johnsonite Roundel Series Rubber Floor Tile, special weathered finish (contains sulfur)
Address: As for dry lab flooring

Solvent exhaust trunks
E-Z Arm
Airflow Systems Inc.
11221 Pagemill Road
Dallas, Texas 75243-8314
214-503-8008
Fax 214-503-9596
http://www.airflowsystems.com

NEW LAB SPACE, NEW DE YOUNG

Fume Hood
Thermo Fisher Scientific (previously Fisher Hamilton, L.L.C.)
1316 18th Street
Two Rivers, WI 54241
920-793-1121
Fax 920-794-6478
http://www.hamiltonlab.com

De-ionized water system
Reverse osmosis de-ionization system with polisher, design and maintenance
Siemens Water Technologies Corp.
181 Thorn Hill Rd.
Warrendale, Pa. 15086
866-926-8420 or 724-772-1402
http://www.water.siemens.com/en

SARAH GATES has been affiliated with the FAMSF since 1980 and was named head of the Textile Conservation Department in 1992. She received a BA from Mills College in 1981, interned in the Organics Divisions of the British Museum in 1985 and received a 3-year Diploma in The Conservation of Textile from the University of London, Textile Conservation Centre, Hampton Court, in 1987. Address: Textile Conservation Lab, De Young Museum, 50 Tea Garden Drive, San Francisco, CA 94044; sgates@famsf.org.

BETH SZUHAY has been with the Fine Arts Museums as a textile conservator since 2001. She holds an MS from the Winterthur/University of Delaware Program in Art Conservation, and a BA in International Studies from Miami University in Oxford, Ohio. She is a member of the American Institute of Conservation (AIC), and the Western Association for Art Conservation, and serves on the board for the North American Textile Conservation Conference (NATCC). Address: as for Gates; bszuhay@famsf.org.

TRADING PLACES: THE NEW GABRIELLA & LEO BERANEK TEXTILE & FASHION ARTS CONSERVATION LABORATORY, MUSEUM OF FINE ARTS, BOSTON

MEREDITH MONTAGUE

ABSTRACT—In June 2005, the textile conservation staff of the Museum of Fine Arts, Boston moved into renovated laboratory facilities in spaces previously utilized by the Museum's Main Library. The move, which included relocation of textile storage, curatorial offices and study room, was part of a master plan that would empty the entire east wing of the Museum in preparation for demolition and construction of a new wing for American art. Planning for the new facilities took place intermittently over a five year period concurrent with a full schedule of exhibition programming. Having occupied the space for three years, an informative critique of the lab will be detailed. With the perspective of time and a working knowledge of the facility; the design, planning, and implementation of the laboratory will be presented.

LUGARES DE INTERCAMBIO: EL NUEVO LABORATORIO DE CONSERVACIÓN DE ARTÍCULOS TEXTILES Y ARTE EN MODA DE GABRIELLA Y LEO BERANEK, MUSEO DE BELLAS ARTES, BOSTON, POR MEREDITH MONTAGUE: RESUMEN— En junio de 2005, el personal de conservación textil del Museo de Bellas Artes de Boston, se mudó a las instalaciones renovadas del laboratorio, en espacios previamente utilizados por la Biblioteca Principal del Museo. La mudanza, que incluyó la reubicación del almacenamiento de artículos textiles, las oficinas de los curadores y la sala de estudio, fue parte de un plan maestro que vaciaría toda el ala este del Museo, para prepararla para su demolición y construcción de una nueva ala para arte americano. La planificación para las nuevas instalaciones tuvo lugar, en forma intermitente, durante un período de cinco años, conjuntamente con un cronograma completo de programación de exhibiciones. Al haber ocupado el espacio durante tres años, se detallará una crítica informativa del laboratorio. Con la perspectiva de tiempo y el conocimiento de las obras de las instalaciones, se presentarán el diseño, la planificación y la implementación del laboratorio.

1. INTRODUCTION

In 2000, the Museum of Fine Arts unveiled a major building plan to construct a new wing of American art on the east side of the Museum. All existing operations in the east wing would be displaced, including the Textile and Fashion Arts offices, collection storage and the textile conservation lab. Planning began in earnest to relocate these operations. The final decision rehoused the lab and collection storage in spaces formerly occupied by the Main Library, which was moved to an offsite location. Curatorial offices and study room were moved into an adjacent gallery, a plan that preserved historic adjacencies that had served the collection well.

The year before the unveiling, all six of the Museum's conservation labs were consolidated under one Chair, Arthur Beale, who subsequently initiated extensive planning exercises for upgrades to all the conservation labs. Working with an architect, each lab documented equipment, electrical requirements, current supply storage and work space allocations, as well as those changes that could make the greatest impact on the efficiency, productivity, and quality of our work. The Chair also successfully raised funds for the renovations through a generous grant from the Fairchild Foundation. Because the textile lab was the first to move into renovated facilities, the planning exercises played a critical role informing the design of the new facility. Progress and direction of the plans to relocate textile and fashion arts operations took many turns over the next several years; however, construction began in January of 2005, and the new facilities were complete in June of that year. These facilities were presented to the Textile Specialty Group at the American Institute for Conservation annual meeting in Los Angeles in 2009.

TRADING PLACES: THE NEW GABRIELLA & LEO BERANEK TEXTILE & FASHION ARTS CONSERVATION LABORATORY, MUSEUM OF FINE ARTS, BOSTON

2. THE TEXILE LAB SPACE

The former library spaces were located on the second and third floors of the south side of the Museum, facing Huntington Avenue. A mezzanine level, added in the 1950's to provide more space for book stacks, was renovated for the textile conservation lab, with collection storage on the floor above and below the mezzanine.

The space presented several challenges for the occupants, including low ceilings, seven enormous south-facing windows and open window wells to the collection storage floor below. The physical connection between the lab and collection storage necessitated careful choices of building materials introduced into the space (fig. 1).

Figure 1. Seven windows, measuring 13 feet x 6 feet dominate the space. Creation of the mezzanine in the 1950's created open window wells to the floor below. Windows are shown here with Mechoshade Ecoveil® roller shades.

The museum's scientific labs tested all materials for harmful volatiles before they could be considered for construction. The mezzanine level ceiling height of 9'2" was initially a concern, but was later ameliorated with a purpose-built high ceiling workspace built in an adjacent laboratory.

Both ultraviolet (UV) light and visible light from the windows were addressed with a combination of UV film applied to the glass and window shades. Madico UV film filtered 99% of UV light and reduced visible light by 10%. The window shades blocked 95% of the remaining visible light while still allowing visibility through the window. A Mechoshade fabric called Ecoveil® was used for the window shades; it had been recently introduced as an alternative to their polyvinyl chloride coated fiberglass line. Ecoveil®, which utilizes an olefin fiber content, was marketed as a sustainable and more ecologically sound product, and indeed proved safer for our use in the storage/lab area. The use of these shades was also helpful in diffusing solar gain that resulted from the large expanse of glass. Because of the open window wells and subsequent desire to reduce harmful off gassing of new construction materials, the Ecoveil™ fabric as well as materials used for cabinetry, counters, and flooring were all submitted to Oddy testing. Materials which did not cause any tarnishing of metal coupons were chosen for use in the lab renovation.

At 2200 square feet, the new lab was twice the size of the old lab; however a need for efficiency and practicality drove the design process (fig. 2). For example, even though there was a desire to have a separate room for mount-making activities, the floor plan was kept open in order to allow for flexibility of workspaces to suit the needs of different projects. The one exception to the open floor plan was a 4 x 18 foot built-in storage median that separated the larger dry conservation work areas from the wet lab. Supply storage and work stations for specific tasks were located around the perimeter of the space, and include a dedicated photo area that utilized existing wall divisions, a computer work station, a fume hood, electric cook top, large stainless steel sink, and storage cabinets mounted above and below a large expanse of chemical resistant countertop. Tables and equipment are on wheels to allow reconfiguration for different project needs.

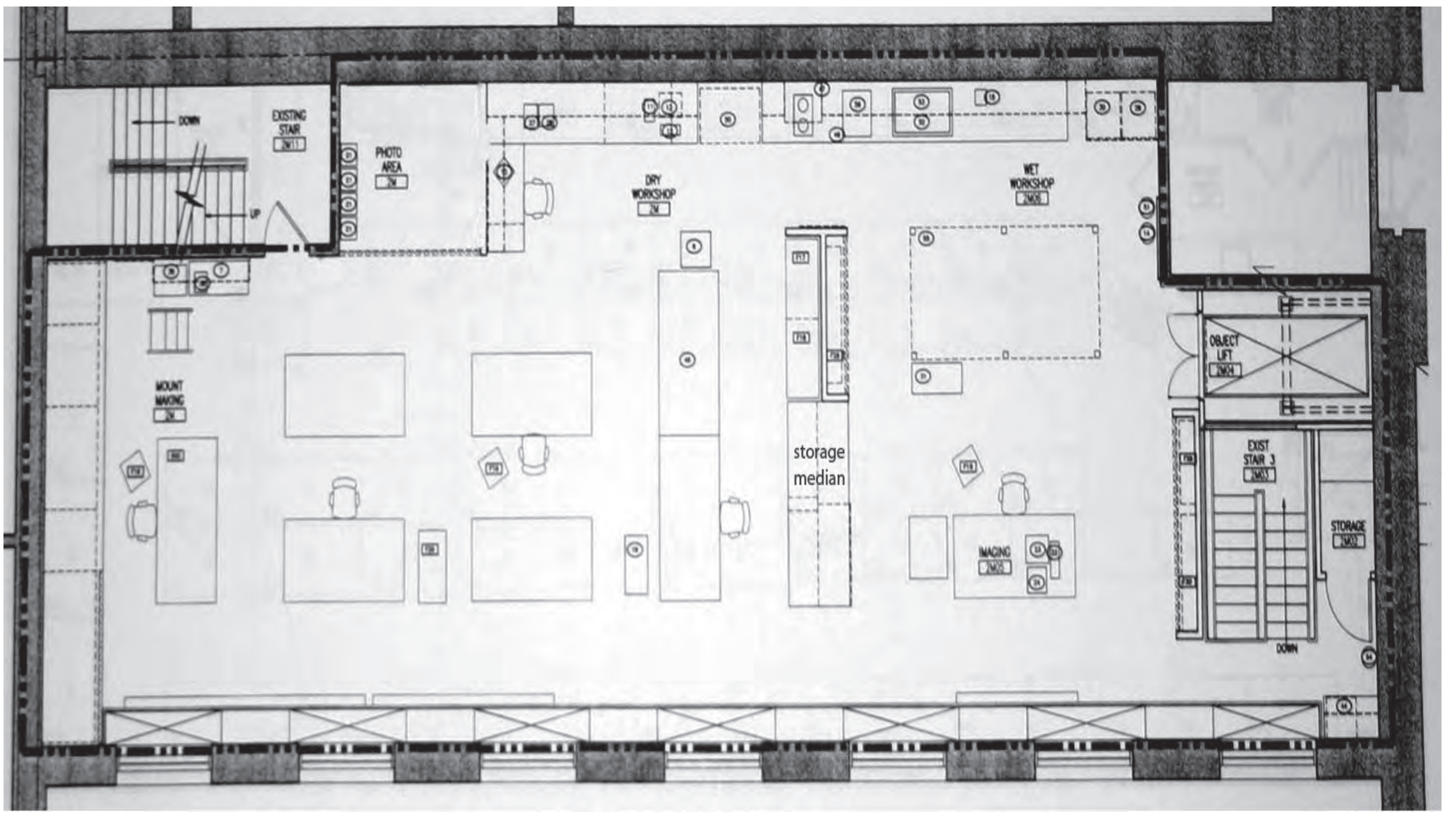


Figure 2. Textile and Fashion Arts conservation laboratory floor plan.

2.1 DRY CONSERVATION SPACE

Over the course of six years, tables in the old lab were replaced with two new table designs. Several custom tables were built by a local cabinetmaker with removable blocks along one edge; openings in the table surface allow for sewing projects where full support the object is preferred. These tables, built with maple legs and framing for a Formica® top, are also fitted with two sizes of suction disks for localized cleaning treatments. The second table type is commercially available through the Phoenix Benchline company and comes with a metal base, Formica® top and silicone rubber edge band. These tables have a half shelf below, and can be adjusted hydraulically to heights within an eight-inch range. A ten-foot Nederman fume extraction hose was designed for use in the dry conservation area, as well as a fume hood, which also serves as chemical storage (fig. 3).

Figure 3. Dry conservation area with ceiling mounted Nederman exhaust trunk, and two types of tables.

2.2 WET CONSERVATION SPACE

The wet lab houses the wash tank and deionized water system, eye wash and shower, washer and dryer units, sink, and cook-top and counter for conservation dyeing functions. The 6' x 12' wash tank is constructed with welded polypropylene, supported by a powder coated steel framework. Municipal water is purified with two cartridges of mixed bed resin, a carbon cartridge to remove organics and chlorine, and a five micron particulate filter; and fed through short lengths of polypropylene pipes and hoses. Water quality is monitored with an in-line conductivity meter. A Meile electric residential cook top and hood are used for conservation dyeing projects. Large capacity residential Kenmore Elite washer and dryer units have multiple settings, including a sanitizing cycle, as well as a manual override. Water pipes that feed this equipment have on/off shutoff valves and drip pans fitted with moisture sensors that will shut water supply off in case of leaks (fig. 4).

2.3 EXAMINATION AREA

Abutting the wet lab, an examination area is well placed away from the higher activity zone of the dry conservation lab. A Leica stereo microscope and Olympus polarizing light microscope are fitted with a digital video camera with software by Microfire and tied in to a computer work station for recording and storing photo macrographs and micrographs in the collection database. This computer, printer, and large flat screen monitor sized for working with images, are also used to process digital documentation photography.

Figure 4. Wet lab.

2.4 PHOTOGRAPHY AREA

This dedicated photography space is perhaps the single greatest improvement the new lab has brought to our work, improving the quality and efficiency of the documentation with consistent lighting set-ups and convenient locations for camera equipment. A small room at 9 x 7 feet, it is fitted with a curtain for creating a light tight space for photography and examination with UV light. Lighting tracks in the ceiling are fitted with a variety of gallery lighting options, making the photography area useful for color matching of custom dyed conservation support fabrics under gallery lighting conditions. A variety of support devices are available for setting up an object for photography, including large padded rigid boards for flat textiles, an adjustable tabletop for shooting 3-dimensional works, and a hanging rail. For larger 3 dimensional works such as dressed costume that need wider lighting placement, a gray roller shade was designed to cover an open area of rolled storage and double as a backdrop.

2.5 HIGH CEILING WORK SPACE

Coming several years later when the new paper conservation lab moved to an adjacent space, a shared high ceiling space was designed with 26 foot high ceilings, 24 feet long by 6 feet wide, with an additional 2 ½ feet in width at the floor level for working. An electronic hoist is installed at the ceiling, supporting a 23’ wood beam for hanging large textiles. The electronic hoist, installed by VerTex, is composed of 3” circular pipe at the ceiling combined with a Somfy rotating motor that allows the cable attached to the support beam to spool as it is raised. This application is used primarily to operate window and door awnings in commercial settings. When the space is not being used for textiles, the paper lab uses it for mobile storage units (fig. 5).

Figure 5. High Ceiling work space has electronic hoist for examination and treatment of large textiles (hoist lowered at right). Lighting is provided by adjustable light fixtures on vertical tracks.

2.6 SUPPLY STORAGE

Custom storage for conservation supplies has also greatly improved the efficiency of the lab. At the back of the space an entire wall was subdivided into six sections, which are closed off with a combination of sliding doors and roller shades. The roller shades cover an area of oversized shelves designed for storage of large rolls of batting, Ethafoam, and Volara, and home to large plastic bins of smaller supplies. Behind sliding doors, custom storage was designed for short term housing of flat textiles and hanging costumes with additional sections for vertical oversized cardboard storage, shelves and vertical dividers for paper and board supplies, and shelves for volunteer projects and exhibition mounts. Storage incorporated into the median between wet and dry conservation areas includes a wood drawer unit brought from the old lab, shelves, and a tack board. Behind the tack board, accessed at the end of the unit, there are vertical sections used to store card and mat board, and acid free tubes. A space for storage of rolled paper, Tyvek and Gortex products was incorporated into the median, using closet brackets and poles. This space is closed off using roller shades, which allow access to the entire space, create a clean uncluttered look when closed, and reduce the clearance needed for doors (fig. 6).

Brackets were attached to the existing railing along the window well at the south wall of the lab for storage of pinning bars and rollers that make up the tapestry repair beam and measure up to 16 feet in length. This simple bracket system removes the hassle of having the large rollers stored in the general workspace, while allowing for easy and immediate access when needed.

Figure 6. Storage median that divides wet and dry conservation areas has storage for paper products using closet pole and bracket hardware, tack board, shelves, and vertical divided storage for cardboard materials accessed from the end of the unit.

2.7 LIGHTING

Focal Point's Luna fluorescent light fixtures provide both diffused and reflected light to the work areas. Incandescent light fixtures were added to the lighting plan to improve the color rendering index of the overall lighting. The incandescent fixtures are infinitely adjustable, and can be focused on work surfaces for color matching of repair fabrics under gallery lighting conditions. Multiple switches allow lights to be manipulated for specific needs, for example, for viewing only with incandescent light, or by turning on selective fixtures, raking light conditions can be created for enhanced visibility of surface characteristics.

2.8 ELECTRICAL SERVICE

A variety of electrical and data outlets were incorporated into the design, including standard wall outlets, electrical strip molding above countertops, and flush mounted floor outlets for laptops and other equipment in the dry conservation and examination areas. The floor mounts are located in many areas throughout the space and accommodate both standard electrical equipment and network data cables. A separate power outlet was needed for the operation of the suction disk; this was placed in an area adjacent to the fume extraction systems for necessary extraction of organic solvents during treatment. In addition, the Phoenix Benchline tables are mounted with electrical outlet strips for use with additional task lighting and equipment.

2.9 FLOORING & COUNTERS

The flooring is a Nora product consisting of 40" tiles composed of natural and synthetic rubber. A very durable material, but the light colors do show scuff marks. The flooring material is permanently stained by oily materials, which has been an issue with floor mats and the wheels of a variety of carts and tables that contain oily residues. Epoxyn countertops are chemical resistant resin that does not stain even next to the dye workstation, and are easily cleaned; however it should be noted that the white color marks easily.

2.10 OBJECT MOVEMENT

An object lift measuring 4' x 11' operates between three levels to transport objects between storage, lab, and galleries. An existing book lift was expanded to its maximum size to create the object lift. It is not licensed for passenger use due to the lack of space required by safety codes in the shaft below the lowest service point. Subsequent renovation of the Paper Conservation Lab in an adjacent space included a passenger elevator that can at least accommodate handicapped individuals on level 1 and 2.

MATERIAL	MANUFACTURER	PRODUCT
Window film	Madico	CLS-200-XSR (UV Plus)
Window shades	Mechoshade Systems Inc.	Ecoveil®
Supply storage shades	Mechoshade	Equinox™ 0100 Series
Flooring	Nora®	Norament® 925 Grano
Ceiling Tiles (storage)	Ecophon®	Ecophon® Hygiene™ Advance A
Countertop	Epoxyn	Phenolic resin, Chemtop 2
Exhaust Trunk	Nederman	10' Nederman Original
Fume Hood	Kewaunee®	Supreme Air Dynamic Barrier H50
Cooktop	Meile	KM400 Electric Cook top
Washer and Dryer	Kenmore®	Elite HE 3t Steam™
Wash tank	Harley Tool and Machine	Custom
Cabinetry	Panolam Industries®	Nevamar® high pressure laminate
Work Tables/ Tapestry beam	Powder House Woodworkers	Custom
Work Tables	Phoenix Benchline	Ergonomic Series 400 Bench

Table 1. Vendors and products used in the lab.

3. CONCLUSION

After three years and with few small exceptions, the Leo and Gabriella Beranek Textile & Fashion Arts Conservation Lab continues to provide a logical, pleasant and efficient work environment for the Textile Conservation staff of the Museum of Fine Arts Boston.

As with all renovation projects, many lessons were learned. Perhaps the single most important step in the process and one of the most difficult, is the review of architectural drawings. Understanding each detailed drawing and the coordination of systems between drawings is critical. Once the drawings are approved, it becomes expensive to make changes even when an architect's design or specification is non-functional. Second, doing research on equipment is essential. Seeing the equipment in operation and speaking with people who have experience with the equipment will help to get the functionality that is needed. This seems intuitive, however, logistically, it is difficult to do what is needed for every piece of equipment.

Currently at over 30,000 objects, and a staff of three conservators and one collection care specialist, the Textile and Fashion Arts collection will be well served in future years with the newly renovated textile conservation facilities.

MEREDITH MONTAGUE is Head of Textiles and Fashion Arts Conservation at the Museum of Fine Arts, Boston. She received her MA with Certificate of Advanced Study in Conservation from Buffalo State College in 1991. Author's address: Museum of Fine Arts, 465 Huntington Avenue, Boston, MA 02115, 617-369-3539.

OUT OF THE BOX: NEW COSTUME & TEXTILE STORAGE AT THE PHILADELPHIA MUSEUM OF ART

SARA REITER, ANDREW LINS, LINDA GOTTFRIED & KEVIN O'BRIEN

ABSTRACT—In 2008 the 30,000 piece Costume and Textile Collection of the Philadelphia Museum of Art moved from an overcrowded thirty year old storeroom to a new facility in the Hamilton Center for Costume and Textiles in the recently opened Ruth and Raymond Perelman Building. The new storage space occupies just over 6,000 square feet and utilizes 12' high compacting powder coated steel storage cases. Working together, the staff conservators from PMA, Borroughs engineers, and project manager Kevin O'Brien of O'Brien Business Systems, developed a textile specific storage system that protects the collection from water, light and dust and provides greater visibility and access to the collection at a significant cost savings from traditional closed storage cabinets. The principle innovations of the system are: an angled roofline and water shield that protect the collection in the event of a sprinkler discharge; an interlocking closing system that inhibits light and dust penetration; and interior components designed specifically for textiles. Coordination and teamwork were crucial to the development of this unique facility. The Philadelphia Museum of Art hopes that this project will serve as a model to help other institutions achieve safe, cost effective storage for their collections.

INNOVACIÓN: NUEVO ALMACENAMIENTO DE TRAJES Y ARTÍCULOS TEXTILES EN EL MUSEO DE ARTE DE FILADELFIA, POR SARA REITER, ANDREW LINS, LINDA GOTTFRIED Y KEVIN O'BRIEN: RESUMEN—En 2008, las 30.000 piezas de la Colección de Trajes y Artículos Textiles del Museo de Arte de Filadelfia, se mudó de un depósito superpoblado de treinta años de antigüedad a instalaciones nuevas en el Centro Hamilton para Trajes y Artículos Textiles, en el recientemente inaugurado Edificio Ruth y Raymond Perelman. El nuevo espacio para almacenamiento ocupa un poco más de 6.000 pies cuadrados y utiliza cajas de almacenamiento de acero, revestidas con polvo comprimible de 12' de altura. Al trabajar en forma conjunta, los conservadores del personal del Museo de Arte de Filadelfia (PMA, por sus siglas en inglés), los ingenieros de Borroughs y el gerente de proyecto Kevin O'Brien, de O'Brien Business Systems, desarrollaron un sistema de almacenamiento específico para artículos textiles, que protege a las colecciones del agua, la luz y el polvo, y brinda una mayor visibilidad y acceso a la colección, con considerables ahorros en el costo, en comparación con los gabinetes cerrados para almacenamiento tradicionales. Las principales innovaciones del sistema son: la línea del techo en ángulo y blindaje contra el agua, que protegen a la colección en caso de una descarga del aspersor, un sistema de cierre de interbloqueo que no permite que penetren la luz ni el polvo y componentes internos diseñados específicamente para artículos textiles. La coordinación y el trabajo en equipo fueron cruciales para el desarrollo de estas instalaciones únicas. El Museo de Arte de Filadelfia espera que este proyecto sirva como modelo para ayudar a otras instituciones a lograr un almacenamiento seguro y rentable para sus colecciones.

1. INTRODUCTION

In December 2008, the Costume and Textiles Department of the Philadelphia Museum of Art (PMA) completed the move of over 30,000 objects to a new 6,010 square foot storage facility in the Ruth and Raymond G. Perelman Building. Designed specifically for the storage of costume and textiles, the facility is equipped with custom storage furniture that meets the special requirements of the collection. This project was presented at the Textile Specialty Group in Los Angeles in 2009. The project involved over eight years of planning and implementation, and its success was due to the high level of cooperation and coordination between conservators, curators, architects, manufacturers and installers.

2. HISTORY

PMA's Costume and Textiles Collection is one of the oldest, largest, and finest in the United States, comprising over 30,000 textiles, costume and accessories ranging from Chinese Han Dynasty (206 BC–221 AD) fragments to contemporary fashion and fiber art. In the mid-1970s, the Museum constructed what was then considered a state-of-the-art 4,200 square-foot storage area with wooden laminate drawers topped by hanging racks constructed from commercial piping. By the early 1990s the collection had severely outgrown the existing storage space; overcrowded drawers and aisles filled with rolling racks of hanging costume provided less than desirable conditions for safe museum storage (fig. 1).

Figure 1. Costume and Textile Storage at the PMA c. 2001.

In late 1999 the Museum acquired the Ruth and Raymond G. Perelman Building. Located just north and across the street from the main building, this Art Deco building was constructed in 1927 to house an insurance company. Between 1999 and 2002, a study was conducted to determine the optimum use of space in both Museum buildings. Curators, conservators, administration, trustees, support staff and museum visitors were solicited for input. The final proposal that was adopted for the Perelman Building allocated space for a new Costume and Textiles Study Center with significantly improved storage, as well as executive offices, administrative support, curatorial offices, the Library, a Prints, Drawings and Photographs study center with storage, and exhibition spaces.

3. THE PLANNING PROCESS

Planning for the new storage facility took place on several levels and addressed: the needs of the collection in terms of space and proper storage mounts; the way in which the curators hoped to use and work in the new facility; concerns about environment and collection safety; and the storage furniture itself. These issues were addressed simultaneously at the beginning of the project. Numerous meetings with architects, engineers, curators, installers and manufacturers were supplemented by site visits to fourteen other institutions. To assist with the planning, the Museum contracted with O'Brien Business Systems, specialists in designing and installing storage and retrieval systems. The company works directly with many different storage furniture manufacturers and most importantly has experience designing and installing museum storage systems. O'Briens' previous work on storage spaces in the Museum had demonstrated its understanding of the special concerns and requirements for museum construction projects.

3.1 AN IDEAL STORAGE FACILITY

The first step of the planning process was to determine what constituted an ideal costume and textile storage. The costume and textile curatorial and conservation staff each developed a list of features they felt were important. After much discussion six major elements were agreed upon as essential:

- The space must be large enough to accommodate the entire collection properly stored
- There should be enough room for 15-20% growth
- Objects should be easily visible without handling
- Objects should be easily and safely retrievable
- Components - trays, hanging rods, drawers and shelves- should accommodate objects of variable size, shape and weight
- Objects must be protected from dust, light and accidental sprinkler discharge

3.2 INITIAL SURVEY

During the initial meeting with the architects the question was posed "How much room do you need?" Curators and conservators agreed that three to four times the existing 4,600 square footage was necessary. This was significantly more than the one and a half times the architects had assumed. To justify the higher number, Textile Conservator Sara Reiter completed a rough survey in approximately three days with a representative of the Museum's in-house architectural planning team, Deborah Lippincott, taking notes. Each hanging rack was examined and an estimate made by eye to determined how many linear feet would be needed to eliminate the compressed overcrowded conditions. Every drawer was examined and a projection made of how many more drawers would be needed if the same configuration were retained. The cubic feet necessary for all of the objects stacked in boxes and resting on flat surfaces was calculated. The results of this first report suggested that a minimum of two and a half to three times the existing cubic feet of storage space would be needed to rehouse the collection properly without room for additional growth. This first report helped the architects and administration to determine the space needs of the collection. It was followed by a more thorough survey aimed at quantifying the types of storage needed and establishing timelines and cost estimates for the rehousing and move.

1.3 STORAGE STANDARDS

A critical step in this process was the selection of a standard storage unit size. As with any large construction project, it was important to minimize costs. Dictating a standard size with as few variations as possible was key to keeping the cost of the project as low as possible. Based on observations made during the first survey, a standard tray 60" wide by 30" deep, slightly larger then the existing drawers, was selected. The 30" depth would accommodate the vast majority of the hanging costume and a 60" width would be adequate for most flat costume, textiles and accessories. Four basic components were chosen: light weight trays for flat objects and accessories; bottomless drawers with bars for storing rolled textiles; rods for hanging costume; and shelves for heavier objects. The majority of the collection would be placed in trays to increase visibility. The size of additional units to accommodate larger objects and the amount and size of shelves needed for boxed storage would be based on the results of the next survey.

3.4 THE SURVEY

Throughout the fall of 2001 a protocol was developed for a survey to examine the entire collection. The goals were to determine storage space needs, as well as the time, staff, and materials needed to implement the project.

It was imperative that the entire collection be examined in a timely manner. The survey, therefore, was very specific and limited in scope. The survey form (fig. 2) included only the following information for each object:

- The accession #
- The current location
- A brief description (for example, "blue dress")
- The need for rehousing and the time required to complete it
- A recommended storage method (i.e. tray, rolled, hanger, etc.)
- The dimensions of the object as rehoused (i.e., storage dimensions for a 60" x 45" length of printed cotton
- rolled on a 2" tube would be 48" x 2 1/4" x 2 1/4")
- An assessment of conservation treatment needs

In May of 2002 the Museum was awarded an IMLS grant for the survey project. The grant provided matching funds for a full time conservator and a full time data entry technician. Together with a team of fourteen volunteers and the Costume and Textiles and Textile Conservation staff, all 30,000 collection objects were surveyed in one year.

The information was handwritten on paper forms and entered into the Museum's database, The Museum System. The information in the database was retrieved through a report and downloaded to an Excel spread sheet. The survey confirmed that 2 ½ - 3 times the existing cubic space would be necessary to properly rehouse the existing collation with no additional room for growth.

3.5 SPACE ALLOCATION

Early in the construction planning, it became clear that costume and textile storage would be located on the second floor of a proposed addition to the Perelman Building, since the floor loads in the original building were not adequate to support the weight of high density storage. The first floor of the addition would be dedicated to exhibition space. The basic size of the addition was limited by a street to the east, a major sewer line to the north and the protected historic facade of the building to the south and west. The maximum usable floor space would be less than 6,500 square feet. The original plan for the second story specified a 12' ceiling which would allow 8' high storage cabinets. The ceiling height had been designed to give the museum the option of adding a third story for office space. This plan provided only 1 1/2 times the square footage of the existing storage, significantly less then the estimated needs. Given the space requirements of other departments that would be occupying the Perelman building, additional square footage was not an option.

Location ___________

IMLS Survey - Costume and Textile

Acc# ____________________ ☐ Costume ☐ Textile ________________________

Condition: ☐ Stable ☐ Needs rehousing ☐ Needs first aid

☐ 30 min - rolled
☐ 30 min - boxed
☐ 90 min - custom mount
☐ 60 min - custom mount
☐ 30 min - custom mount
☐ 60 min - custom box

☐ 30 min - padded hanger - 20th c.
☐ 60 min - padded hanger - 18th/19th c.
☐ 30 min - padded hanger - childs
☐ 30 min - padded hanger - skirt/pant

☐ **Drawer** ☐ Flat L:________ W:________ H:________
☐ **Tray**
☐ **Either** ☐ Folded L:________ W:________ H:________

☐ Rolled L:________ D:________ Tube size: ☐ 1 1/2" ☐ 2" ☐ 3" ☐ 4"

☐ **Box** ☐ 30" x 18" x 6" ☐ 30" x 22" x 4" ☐ 30" x 24" x 6" ☐ 40" x 18" x 6" ☐ 60" x 18" x 6"
☐ 60" x 36" x 5" ☐ shoe 12" x 8" x 5" ☐ boot 14" x 7" x 12 1/2"

☐ whole ☐ 1/2 ☐ 1/3 ☐ 1/4 ☐ 1/6 ☐ 1/8

☐ **Custom Box** L:________ W:________ H:________

☐ **Shelf (fixed)** L:________ W:________ H:________

☐ custom mount

☐ **Rolled** L:________ D:________ Tube size: ☐ 1 1/2" ☐ 2" ☐ 3" ☐ 4"

☐ **Rack hanging** L:________ W:________ D:________
☐ S-hooks ☐ Velcro

☐ **Needs special handling during move**

Figure 2. Survey form, Costume and Textile Collection 2002-3.

Site visits to other institutions provided insight into ways to use storage furniture to optimize the limited floor space. Compacting storage, which can provide up to 35% more usable cubic footage than free standing, stationary storage units was the obvious choice, though even this would not completely fulfill the space needs. The National Museum of the American Indian Cultural Resource Center in Suitland, Maryland and the Haags Gemeentemuseum, in The Hague, Netherlands have compacting storage units 12' (4 meters) high. Both institutions have large textile collections. The Haags Gemeentemuseum collection includes hanging costume and accessories similar to those in the PMA collection. They have found compacting storage to be a safe and effective for most objects including hanging costume that is structurally stable. After reviewing the information provided by the collection surveys, the administration, architects, conservators and curators agreed that the best use of the space was to forgo the potential of a third story and raise the ceiling height of the second floor to 18' to accommodate compacting storage units with a 12' usable interior height.

4. STORAGE FURNITURE

Several factors were instrumental in the selection of the manufacturer for the storage furniture. In addition to Costume and Textiles storage, the Museum was also purchasing new furniture for the Prints, Drawings and Photograph Department and the Library. Purchasing all of the storage units from a single vendor would help to lower costs, provided the supplier could meet the very different needs of the three departments. Following competitive bidding from three firms, Borroughs Systems was chosen to provide the storage furniture, based on a combination of price, experience with library shelving and willingness to work with us to develop new designs.

4.1 CABINET DESIGN

The engineers at Borroughs were given the basic size and materials requirements; powder coated steel compacting units 60" wide x 30" deep with 12' usable interior height. In addition the units were required to be watertight with respect to sprinkler discharge, have safe and easily replaceable gasketing, and safe closures; all materials used in construction and/or installation must meet museum standards and be tested for chemical inertness and reviewed by the PMA Conservation Department.

The initial design presented to the Museum was for 6'standard museum storage cabinets stacked on compacting carriages. Metal trays in this system could support up to 300 lbs. A 60" x 30" tray of properly stored textiles, costumes or accessories weighs significantly less. Several prototype trays of the heaviest objects in the collection were created. These included: rolled carpet fragments, metal accessories such as swords and knives; beaded bags and small rolled textiles where the weight of the archival tube would significantly add to the overall weight. The heaviest group of objects that would be placed on a 30" x 60" tray weighed 78 lbs. Borroughs re-evaluated their proposal based on the reduced weight load and developed a system using their stock shelving system. This basic shelving design has keyhole every 1.5" making the units completely adjustable within the entire 12' height. Light weight steel panels would be mounted on the shelving to create cabinets. The use of stock shelving and lighter weight panels significantly reduced the cost of the entire project. Components were developed to be strong but light weight. Trays with corrugated polypropylene bottoms were designed to hold up to 150 lbs., yet could be handled by a single person when empty. Due to the decreased weight, the trays could be fitted with Teflon glides rather than rollers, another cost savings.

4.1.1 WATER SHIELDS

Fire protection for the art storages areas at the Perelman Building included both a gaseous suppression system and a traditional wet pipe sprinkler system. The later was mandated by local fire regulations. Due to the quantity of combustible materials that would be stored in the facility, the fire department required that space be left between each unit at night so the sprinkler system would be more effective. However, this would leave the collection susceptible to irreparable damage should the sprinkler system discharge accidentally. The most obvious solution, placing doors on the cabinets, proved to be cost prohibitive. An innovative water shield design was developed by Andrew Lins, working with the Borroughs Corporation and O'Brien Business Systems, to provide a safe effective alternative. Each 60" x 30" x 12' cabinet was provided with a solid back. The cabinets were placed back to back on the compacting carriages with a 1" gap between them. The open fronts meet with a specially designed flange at the roofline. When all the cabinets are cranked closed it creates smaller units with less fire load within each unit. In the event of a sprinkler discharge, the water flows between the backs of the cabinets cooling the cases and containing the fire within a single row of cabinets (fig. 3).

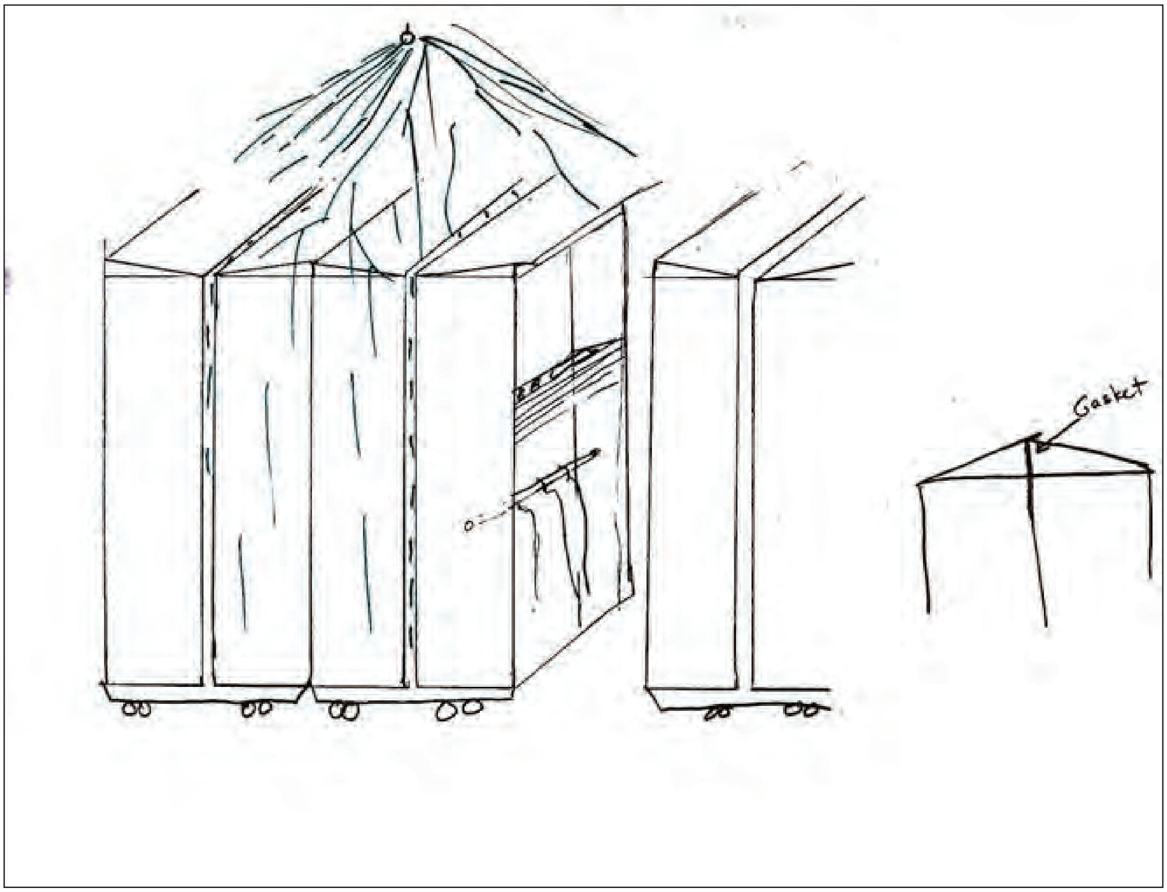


Figure 3. Early sketch showing the concept for the water shield.

4.1.2 GASKETS AND SIDE CLOSURES

Limiting the use of rubber or imitation rubber gaskets was a priority in the design of the storage system. Various types of gasketing materials have been used on compacting units in the past to insure a tight seal between the cabinets and prevent infiltration of light, dust and water. During site visits to other museum it became apparent that this was a significant point of failure. There are very few gaskets that have low enough off-gassing to meet museum standards. Many gasket materials degrade, corrode, or harden over time, causing the gaskets to lose effectiveness and requiring costly and time-consuming replacement. Gaskets were found to be a necessary part of the water shield and extend across the width at the top of the units. To avoid their use along the vertical closures, the engineers at Borroughs developed a simple but ingenious design. The edges of the end panels are bent at opposing 45° angles to interlock when the units are closed, creating an effective dust and light barrier (fig. 4). Not only was the design simple and effective, it could be produced at no additional cost while creating a sturdy closure that will not require high maintenance over time.

Figure 4. View down the aisle, new Costume and Textile Storage. Note angled closure on end panel.

4.2 FINAL DESIGN

The final design of the compacting storage incorporated four sizes of cabinets all 12' high.

- The basic cabinet with a usable interior space 63" wide, 30"deep
- Double-wide/double-deep units with interior usable dimensions 103" wide, 60" deep
- Deep cabinets 63" wide, 40" deep
- Narrow cabinets 63" wide x 20" deep

The basic cabinets are arranged in rows of 5, with adjacent rows mounted back to back on twenty-seven 61" wide carriages, 27' long There are three 30"-wide carriages and one stationary 30" wide unit for objects too fragile to withstand the movement of compacting storage. These 230 units house the majority of the museums collection using 441 hanging rods, 1462 trays and 93 bottomless drawers. Three carriages each contain a row of 40"deep cabinets, which are back-to-back with rows of 20"deep cabinets. The 40" cabinets house hanging costume with full skirts, such as those from the mid to late 19th century. The 20" deep cabinets are fitted out exclusively with shelving, primarily for the 1,200 hats in the collection. Over-sized and unique-sized objects are housed in 9 double-deep/double-wide units arranged on three carriages. These cabinets are accessible from either side and hold 121 trays, and 96 bottomless rolled textile drawers. Shelves within the double-wide double-deep units hold 60 x 18" archival boxes (figs. 5-7).

Figure 5. View of basic cabinets.

Figure 6. Double-wide, double-deep storage cabinets prior to receiving objects.

Figure 7. Shelf storage for hats.

Figure 8. Bracket system to hold long rolled textiles.

In addition to the compacting units an adjustable wall mounted bracket system was designed by Borroughs to house textiles rolled on tubes up to 12' long. It can be easily modified to accommodate even longer objects if necessary (fig. 8). Standard shelving units were installed along the south and east walls. The majority of the shelving is 63"wide by 20" deep to accommodate the standard 60 x 18" boxes that are used for non-hanging costume. The storage area is not rectangular. Where possible, deeper units were installed to make optimum use of the space.

5. PROTOTYPES AND TESTING

The engineering and construction managers at Borroughs took the designs back to the factory in Kalamazoo, where small scale models of the proposed cabinets and water shields were constructed to test for leakage. Numerous gasketing materials were examined and tested by the Conservation Department staff before finding the best alternative. Full scale models of the basic cabinet and components were also made and shipped to Philadelphia (fig. 9). Mock-ups of storage mounts, hangers and boxes were used to help refine the design and make final modifications prior to manufacture. A final, full size scale model of the cabinet and water shield were constructed and representatives from the PMA (Andrew Lins) and O'Brien Systems (Kevin O'Brien) traveled to Kalamazoo to participate in the final testing. A video of the water shield test is included on this CD.s

To assure that the powder coating of the steel was properly applied, a small percentage of each coating batch were tested, using a modified materials testing procedure, as they arrived at the Philadelphia Museum of Art. Silver, copper and lead coupons were placed in contact with, and suspended above, the powder coated surface. Beakers of deionized water were placed nearby to provide humidity (above 90% RH) and all were covered by a glass dome with Volara gasket. The coupons were left for 14 days and examined for signs of corrosion (fig. 10).

Figure 9. The full size mock-up being inspected.

Figure 10. Testing the finished cabinets.

6. INSTALLATION

Installation took place in two phases over a six month period. The first phase, laying of the rail for the carriages, took place during the rough construction of the space. The first layer of concrete floor was poured, the rails set and protected by the O'Brien Systems and the final top layer of concrete was applied by the construction crew. The second phase, assembly of the storage units, began after the finish carpentry of the room was complete and took a dedicated crew of three men three months to complete. The experienced crew understood that what they were assembling would be an art storage space and realized the importance of making sure that the space remained clean and that all joins and edges had to be smooth and well finished to prevent damage to the collection. First the carriages were assembled and placed in the proper order. Then skeletons of the cabinets were built on top of the carriages (fig. 11). The backs, roofs, water shields and end panels were secured prior to installation of the components.

The installation of the trays, drawers, shelves and rods, was the most labor and time intensive part of the project. Every object in the collection was assigned a location and detailed elevations of each cabinet were developed based on the information gathered during the survey phase of the project (fig.12). The type of component, and it's location to within 1 1/2" were predetermined to take advantage of the limited cubic footage and assure that the collection was safely stored in the minimum amount of space. Exact placement was crucial to assure that the objects would fit into the planned location and the move would proceed in a timely and orderly manner

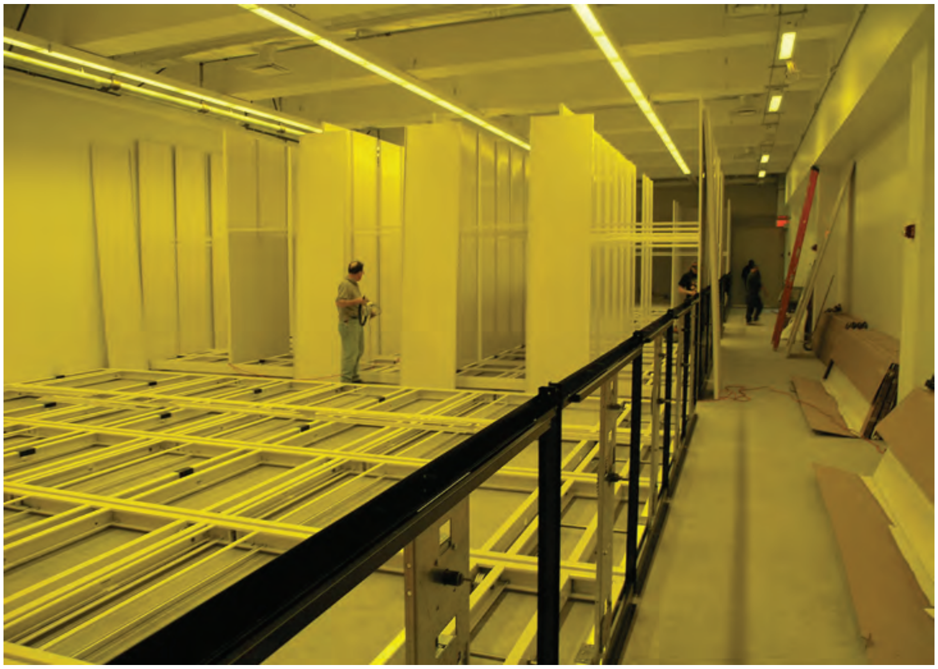


Figure 11. Shelving skeletons prior to installation of sides and backs.

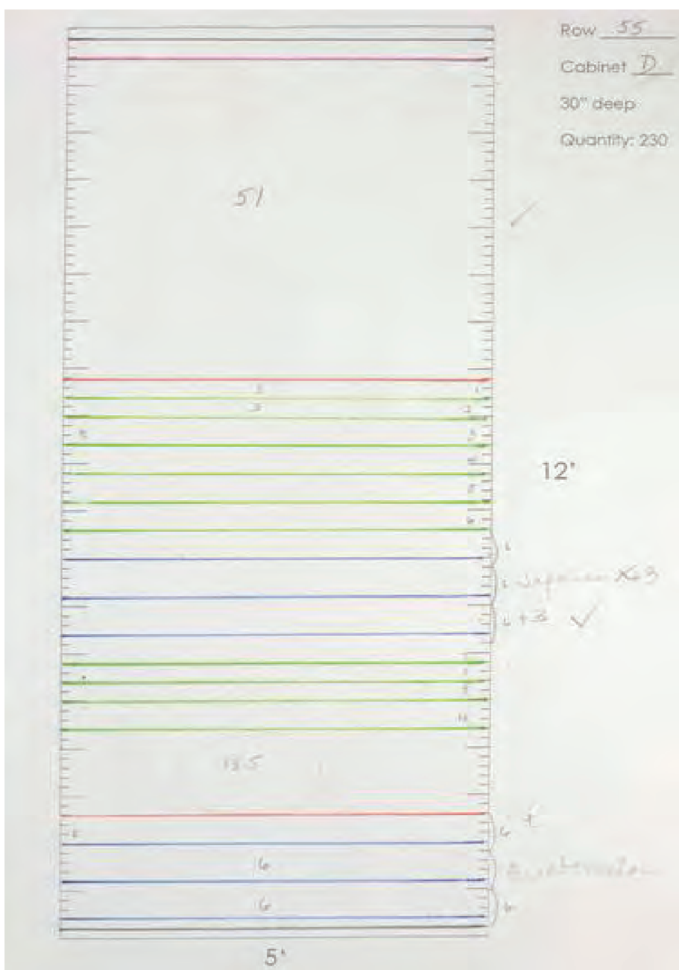


Figure 12. Layouts for component installation.

7. CONCLUSION

The new Costume and Textiles storage area meets nearly every criterion set forth at the beginning of the project. The 38' x 160' space has 18' ceilings, and is divided into two separate rooms for fire safety purposes. With just over 6,000 square feet, it less then 1 1/2 times the square footage of the previous storage area, yet we were able to achieve greater then 2 1/2 times the old storage volume through the use of 12' high compacting units and carefully designed interior components. The newly rehoused collection fits well within the provided space. In one area, space for growth, the goals were not achieved. Less then 5% of the space is available for new accessions. However, by arranging components it was possible to maximize empty space in areas, such as contemporary hanging costume, where the curators expect to have the greatest growth. Retrieval is safe and relatively easy with the use of appropriate equipment such as ladders and personnel electric lifts. The well designed water shields and angled end panels proved excellent protection from dust, light and water. And, as each row of cabinets is rolled open, impressive views of the collection are revealed (figs. 5, 7).

Coordination and teamwork were crucial to the development of this amazing facility, as was the willingness of everyone to explore new ideas and adapt existing materials and techniques to the special needs of costumes and textiles storage in the museum environment. The experience, skill and consistency of the installation crew were critical elements in the successful completion of the project. The Philadelphia Museum of Art staff is proud of what has been accomplished and hopes that it will serve as a model to help other institutions achieve safe, cost effective storage for their collections.

SARA REITER is the Conservator of Costume and Textiles at the Philadelphia Museum of Art. She received her MS in Art Conservation from the University of Delaware/Winterthur.
Address: Philadelphia Museum of Art, Conservation Department, PO Box 7646, Philadelphia, PA 19101-7646.
E-mail: sreiter@philamuseum.org.

ANDREW LINS is the Neubauer Family Chair of Conservation at the Philadelphia Museum of Art. He received his MA and diploma in conservation from NYU Institute of Fine Arts and an MS in Corrosion Engineering from London Polytechnic. Philadelphia Museum of Art, Conservation Department, PO Box 7646, Philadelphia, PA 19101-7646. E-mail: alins@philamuseum.org.

LINDA GOTTFRIED, Borroughs Director of Museum Products has worked continuously and exclusively in the Museum storage field for over fifteen years, completing over 1,000 installations. Borroughs capabilities extend from prototyping and design to state of the art manufacturing, earning ISO 14001 and 9002 designation. Address: Borroughs Corporation, 3002 N. Burdick Street, Kalamazoo, MI 49004-3483. E-mail: lindag@borroughs.com.

KEVIN O'BRIEN is the President of O'Brien Business Systems. He received a BS in Finance from Villanova University. The firm was founded in 1979 with a specific focus on providing storage and retrieval solutions including: Macroprogramming, Comparative Test Fits Microprogramming, and, Implementation. Address: 739 E. Elm Street Conshohocken, Pa. 19428 U.S.A. E-mail: kevino@obriensys.com.

THE DEPARTMENT OF TEXTILE CONSERVATION AT THE METROPOLITAN MUSEUM OF ART

FLORICA ZAHARIA

ABSTRACT - The Textile Conservation Department at the Metropolitan Museum of Art is responsible for the preservation, conservation, display, and technical studies of the Museum's diverse collection of more than 36,000 textiles. In 1995, concurrent with the installation of the Antonio Ratti Textile Center, a major redesign of the Department of Textile Conservation's facilities was completed. Subsequent adjustments and upgrades have maintained the excellent condition of the space and its equipment. The facilities include a core lab with adjacent office space and library/conference room, and specific labs for wet-cleaning, solvents and dyes, chemical analyses, reference materials, and fiber analyses, each of which is described.

The Department's broad expertise allows its staff of eighteen professional conservators to develop and employ various treatment and display methods and to establish the best methods of the care and handling of textiles. Ongoing collection surveys, research, technical analysis, and experimentation serve to enhance the collection-related database and to develop improved techniques for the future. The Department has been responsible for numerous major treatment projects and exhibition installations. The Department strives to continually improve its facilities, instrumentation, staff, and expertise in line with increasing demands and physical restrictions.

EL DEPARTAMENTO DE CONSERVACIÓN TEXTIL, EN EL MUSEO METROPOLITANO DE ARTE, POR FLORICA ZAHARIA: RESUMEN – El Departamento de Conservación Textil del Museo Metropolitano de Arte es responsable de la preservación, la conservación, la exhibición y los estudios técnicos de la diversa colección de más de 36.000 textiles del Museo. En 1995, conjuntamente con la instalación del Centro Textil Antonio Ratti, se completó un importante rediseño de las instalaciones del Departamento de Conservación Textil. Los posteriores ajustes y actualizaciones han mantenido la condición excelente del espacio y de su equipo. Las instalaciones incluyen un laboratorio central con un espacio adyacente para oficinas y una biblioteca/sala de conferencias, y laboratorios específicos para limpieza en húmedo, solventes y tinturas, análisis químicos, materiales de referencia y análisis de fibras, cada uno de los cuales se describe.

La amplia experiencia del Departamento permite a su personal, compuesto por dieciocho conservadores profesionales, desarrollar y emplear diversos tratamientos y métodos de exhibición, y establecer los mejores métodos de cuidado y manipulación de los textiles. Las continuas evaluaciones, investigaciones y análisis técnicos de la colección y la experimentación, sirven para mejorar la base de datos relacionada con la colección y para desarrollar técnicas mejoradas para el futuro. El Departamento ha sido responsable de diversos proyectos de tratamiento importantes y de instalaciones para exhibición. El Departamento lucha para mejorar continuamente sus instalaciones, instrumentos, personal y conocimiento práctico de acuerdo con las crecientes demandas y restricciones físicas.

1. INTRODUCTION

The Textile Conservation Department at the Metropolitan Museum of Art responds to the need for preservation, conservation, display, and technical studies of the Museum's core collection of more than 36,000 textiles (belonging to thirteen curatorial departments). Eighteen professionals, permanent staff members with excellent diverse qualifications, as well as fellows, interns and volunteers – make up the Department, which is located in a 9,400-square foot lab specially designed with state-of-the-art facilities to accommodate the great variety of projects it is assigned.

The Department has a long history of well-established professional standards, achieved by working with one of the most comprehensive textile collections in the world and founded on the staff's practical experience and knowledge based on continuous research. The Department is fortunate to have a background of more than thirty-five years of conservation treatments and preservation methods which are continually being evaluated and built upon.

This paper presented to Textile Specialty Group at the American Institute for Conservation Annual Meeting in Los Angeles in 2009 will describe the Department's lab facilities and physical organization, its history, and its present and future challenges related to existing conditions and upcoming needs. The Department's work specifics and major accomplishments are briefly discussed.

2. BACKGROUND

The work performed by the Department of Textile Conservation, the specific directions, and the professional strengths, as well as the design and organization of the laboratory facilities, are directly related to the collection entrusted to it. The Metropolitan Museum of Art's diverse textile collection covers worldwide textile history from the Prehistoric period to the present day. The entire collection is in a good state of preservation. Several factors contribute to this, including the staff's qualifications and expertise, the state-of-the-art facilities for conservation, lab work and storage, the careful consideration given to textile display and acquisitions, and the constant attention to preservation factors.

Given the exceptional quality and condition of this collection, conservators focus on searching for the best methods of its preservation, conservation treatment, and display. Equal importance is given to analytical work and research, to dissemination of results through publications, to participation in field and education programs, and to enriching the collection-related database.

Figure 1. South view of the Main Treatment Lab of the Department of Textile Conservation at The Metropolitan Museum of Art, 2008. Image © The Metropolitan Museum of Art.

THE DEPARTMENT OF TEXTILE CONSERVATION
AT THE METROPOLITAN MUSEUM OF ART

The work is performed in the Department of Textile Conservation's facilities (fig. 1), opened in 1995. Fourteen years after its construction, additional adjustments and upgrades have maintained the excellent condition of the lab space and its equipment. The collection is stored in the Antonio Ratti Textile Center (RTC), a study/storage facility under curatorial management and with its own staff. The RTC is located near the Department of Textile Conservation. Textile conservators work with curatorial and RTC staff to assure the finest standards for the storage and preservation of the Museum's textile collection.

3. THE HISTORY OF THE DEPARTMENT OF TEXTILE CONSERVATION

The Department of Textile Conservation became an independent entity in 1973, when a preservation/conservation program was implemented under the leadership of Nobuko Kajitani, Conservator-in-Charge until her retirement in 2003. Prior to 1973, textile conservation was integrated within the Objects Conservation Department. Originally, only one room, of approximately 800 square feet, formed the Textile Conservation lab (fig. 2). It included space for conservation treatments, areas designated for wet-cleaning, and room for the storage of selected textiles. A library and object files were housed there as well. As the number of staff increased, other small rooms scattered through the Museum's ground and first floors were used for conservation treatment, analytical

Figure 2. Treatment Lab of the Department of Textile Conservation at
The Metropolitan Museum of Art, 1991. Image © The Metropolitan Museum of Art.

work, and art storage. One small room was dedicated to the dyeing process of conservation materials.
In 1995, after six years of construction work, new facilities for the Department of Textile Conservation were completed. In redesigning the facilities, the goal was to bring the whole staff and all lab activities together in one space, an area adaptable to the great variety of projects entrusted to the Department by the Museum. Within these same facilities, separate individual laboratories were planned to accommodate specific textile treatments, analytical work, and conservation materials preparation. The facilities were designed by architect Kevin Roche, John Dinkeloo and Associates, and John Altieri Consulting Engineers. The staff and conservators of the Department were directly involved in planning the facilities and in choosing or designing new equipment. The new facilities opened in the fall, 1995.

At the same time, the Department of Textile Conservation was assigned to assess the Museum's entire textile collection's needs for long term preservation. The conservators participated in planning and designing the RTC's state-of-the-art study/storage facilities. The assignment provided an exceptional opportunity for conservators to review the condition of all pieces in the collection. As part of the process, the storage format and materials for each textile were re-evaluated. The textiles were transferred from storage at individual curatorial departments into a common temporary storage/preparation space. Each textile was placed into its new storage format and specifically relocated in the new RTC storage facility (fig. 3).

Figure 3. Antonio Ratti Textile Storage at The Metropolitan Museum of Art, 2007.
Image © The Metropolitan Museum of Art.

During the past six years, the number of Department conservators increased from eleven to eighteen. The total number of fellows, interns, and volunteers has also increased. This was in response to an augmented interest in the textile collection and consequently to a greater work load. These changes have had a direct effect on the way the existing lab's space and equipment is used. Additionally, the rapid transformation of technology continues to impact the conservators' work and the lab's organization of space. As a result, improvement of the facilities and the upgrading of existing analytical equipment, as well as the purchase of new equipment proved necessary. These changes were recently completed. Working within the existing space, this time the goal was to enlarge the main conservation treatment area through the reorganization and redistribution of existing furniture and equipment, to improve the quality and number of analytical equipment stations throughout the lab, to expand the existing computer network, and to create new offices while better organizing the existing ones.

4. THE PHYSICAL ORGANIZATION OF THE DEPARTMENT OF TEXTILE CONSERVATION

The lab space is organized to respond to the needs of various work specifics performed in the Department. The core of the lab is an open space that accommodates a range of conservation treatment projects and related analytical work (fig. 1). A section of this space is permanently dedicated to capital projects, which are mostly tapestries and carpets. Two custom-built restoration tension table/frames, each with two rollers and extra overhead lighting, are used in this area. The rest of the main lab accommodates movable tables that can be used to create working surfaces of various dimensions as needed for specific objects. The height of the tables is thirty four inches. The maximum size of the tables is 96x 96 inches. Other tables are half or quarter sizes of this maximum dimension. This allows for easy extension of the working surface when necessary. Tables are built with locking mechanism and enclosed storage space underneath. Three stations holding analytical equipment are distributed throughout this main lab (Phipps and Hwang 2009). The specific quality of equipment, the custom-built supports that hold it, and their location allow the conservators to work with a range of textile sizes, to minimize handling, and to store and process the captured data in the Museum's network. At the west side of this main lab are desks with computer networks for staff members, alternating with built-in storage cabinets and drawer units. Above these, fitted storage cabinets contain conservation materials (fig. 4). At the opposite side, built-in niches hold the collection-related database which includes images and files for each object (fig. 5). Behind these units are offices for conservators and a temporary art storage room (fig. 5). At both ends, easily accessible walk-in cabinets hold basic conservation materials for daily use.

At the north end of the main lab are the Department's library and main conference room. Access to this area is wide open, although folding doors that can close the space are available. Situated at the northeast corner of the facility are the locker and conference/lunch rooms. Staff access to these spaces is through two doors: one leading directly from the outside lab corridor and another from the lab's main entrance. For art, the entrance to the lab is through a main door situated at the southeast corner of the main lab, and a second door located at the southeast end of the facility.

Figure 4. West view of the Main Treatment Lab of Textile Conservation, Metropolitan Museum of Art, 2008. Photo by F. Zaharia, © The Metropolitan Museum of Art.

Figure 5. East view of the Main Treatment Lab of Textile Conservation, Metropolitan Museum of Art, 2009. Photo by F. Zaharia. Image © The Metropolitan Museum of Art.

Located at the south end of the central area and isolated from it, are the specific labs for wet-cleaning, working with solvents and dyes, chemical analyses, reference materials, and fiber analyses. At the west side, a large door leads to a wide corridor, assuring large objects easy access to the solvent and wet labs. The solvent lab is equipped with a vacuum suction table, a fume hood chamber, and three fume hood elephant noses to assure proper air flow in that area.

Adjacent to the solvent lab, a spacious area is occupied by the wet lab designed to accommodate the wet-cleaning of textiles with a maximum size of 28 x 20 feet. A slanted tiled floor incorporates an extensive drainage system. A custom-designed Mixed Bed De-ionized water system provides water of optimum purity, temperature, and flow for the wet-cleaning of textiles. A sink with a 60 x 20 inch fitted screen is available for washing small textiles. For the washing of pieces larger than those corresponding to the dimensions of the existing washing table, 95 x 59 inches, a pool related to the textile's size can be created for each process (fig. 6).

Figure 6. Wet Lab of the Department of Textile Conservation, Metropolitan Museum of Art, 2005.
Photo by Textile Conservation, The Metropolitan Museum of Art, © The Metropolitan Museum of Art.

The deconstruction of the pool after washing leaves the space free to be used for other projects, including viewing, incoming examination, and anoxic treatment. A direct access to the wet lab from the outside corridor is also provided. When necessary, both accesses to the wet lab can be closed. Continuing from the main lab's area, at its east side a door provides access to the fiber testing lab, the reference materials lab, and the chemistry and dye labs. The fiber testing lab is equipped with four microscopes that assure a range of conditions for analyzing fibers and capturing the relevant data (fig. 7) (Phipps and Hwang 2009).

Figure 7. Testing Lab of the Department of Textile Conservation, Metropolitan Museum of Art, 2009.
Photo by F. Zaharia, © The Metropolitan Museum of Art.

Figure 8. Dye Lab, Chemical Lab, and the Reference Materials Room of the
Department of Textile Conservation, Metropolitan Museum of Art, 2009.
Photo by F. Zaharia, © The Metropolitan Museum of Art.

The Department of Textile Conservation owns a large collection of reference materials for dyes, fibers, and textile structure. Because of its fundamental role in conservation work, this reference material is systematically organized and continually expanded.

The chemical lab serves for analytical study of organic materials such as dyes or glues, and other conservation treatment or preservation-related investigations (fig. 8). The lab is equipped with an indispensable High-Performance Liquid Chromatography (HPLC) instrument and with a fume hood chamber. An Associate Research Scientist, a member of the Department of Scientific Research's staff, performs specific analytic work in the Textile Conservation's chemical lab. Other analyses, especially of inorganic materials, are performed by or in collaboration with the Department of Scientific Research.

The dye lab serves for the dyeing of yarn and fabric needed for the conservators' works in progress. An Ahiba IR machine is used for dyeing yarn and fabric samples with Ciba-Geigy synthetic dyes. The lab is also used for dyeing reference samples and for varied experimentation with natural dyes (fig. 8).

5. THE DEPARTMENT OF TEXTILE CONSERVATION'S WORK SPECIFICS

The high professional standards of the Department of Textile Conservation are based on the consistency and the long history of the Department's professional practices. Therefore, any necessary changes in performance are made only after careful consideration for consistency throughout the entire collection.

The Department especially excels in the extensive practice of textile preservation and conservation treatment of the various categories of textiles: tapestries, carpets, woven textiles, and embroideries of European, Islamic, Asian, and American art. It preserves these textiles and prepares them for display using various methods of mounting, including a range of pressure mounting (Kajitani and Phipps 2006, Sato and Zaharia 2007) and stitch mounting. Furthermore, the Department excels at establishing the best methods of care and handling of textiles through individual and team effort, and in developing a systematic study and scientific investigation of the textiles' technical characteristics and the criteria for conservation documentation data. It also builds and constantly refines--as research advances--a collection-related comprehensive database, which was initially used to generate The Museum System (TMS).

At this time, ongoing collection surveys aim to establish the state of the collection and to prioritize future treatment, preservation, and investigation needs. The Department's conservators are continuously experimenting and researching textile materials and technology, key components for decision making related to the collection's preservation. Data resulting from conservation work constitute an important part of the extensive database created by the Department.

During the past thirty five years, a large percentage of the collection has been undergoing conservation treatment. Major projects include the conservation of the collections' highlights, among which are: the *Christ is Born as Man's Redeemer* Tapestry (Cloisters collection), the *Courtiers in a Rose Garden* Tapestry series (Medieval Art collection), the *Gathering of Manna* Tapestry (ESDA collection), and the *Unicorn* Tapestry series (Cloisters collection), the *Emperor's Carpet* (Islamic Art collection), and the *Yuan Dynasty Mandala* Tapestry (Asian Art collection).

Throughout the Museum's extensive exhibition programs, the conservators are responsible for the preparation and handling of textiles during the installation/de-installation of major exhibitions. These included *Flowers Underfoot*, *Tapestry in the Renaissance*, *Tapestry in the Baroque, Byzantium Faith and Power (1261-1557),* and *China Down to the Golden Age, 200-750 AD.* At present, work in preparation for the reopening of the Museum's Islamic galleries, completion of the conservation of the tapestry *Christ is Born as Man's Redeemer*, as well as planning for a celebratory tapestry conservation symposium are the Department's major projects.

6. CHALLENGES AND DIRECTIONS FOR THE DEPARTMENT

Perhaps the greatest challenge in designing and creating a textile conservation laboratory is to plan the space and its long term use to allow for future upgrading and adjustments in response to evolving conditions. The constant need for transforming a lab's facilities is a result of a steadily growing interest in textiles, an increase in the size of the collection, advances in technology, an increase in the number of conservators required and the quality and quantity of equipment, tools, and materials used in the lab. In addition, the rising interest in investigative work and the enlarging database impose the need for an extensive reference material collection, for the most advanced analytical instruments, and for storage to accommodate the resulting data.

At this moment, among the Department's challenges in relation to the existing facilities, are the need to accommodate a great number of long-term and short-term conservation projects, to create the best working space for the increased number of staff, students and fellows, to efficiently organize the storage of conservation materials and the reference materials collection, to provide designated areas for work with non-object materials, and to store the electronic formats of the database.

In the future, the Department's priorities will continue to be determined by the Museum's mission to preserve, conserve, and study the textile collection, and to share it with the public through exhibitions, publications, and electronic media. To respond to these tasks, significant challenges will continue to be the limited space; the development of the best textile preservation and conservation methods in relation to new technology and conservation materials and their integration within existing ones; the upgrading and inclusion of new technology; and management of a steadily growing collection-related database.

ACKNOWLEDGMENTS

I thank Kathrin Colburn, Midori Sato, Ruth Rosenthal, and Caroline Borderies of the Department of Textile Conservation, and Giovanna Fiorino-Iannace and Melinda Watt of the Antonio Ratti Textile Center. The Textile Conservation facility has been made possible by the Fondazione Antonio Ratti and David H. Koch Charitable Foundation.

REFERENCES

Kajitani, N. and E. Phipps. 2007. A Contact Pressure Mounting System. Paper presented at Harpers Ferry Regional Textile Group meeting, Washington D.C.

Phipps, E. and M. S. Hwang. 2009. Thirty years of microscope imaging technologies for examination and documentation of textiles in the Textile Conservation Department, Metropolitan Museum of Art. *Textile Specialty Group Postprints.* American Institute for Conservation of Historic & Artistic Works. 37th Annual Meeting, Los Angeles. Washington, D.C.

Sato, M. and F. Zaharia. 2007. Pressure Mounting Textiles. Paper presented at ICOM-CC Interim Meeting, Upholstery, Krakow, Poland.

FURTHER READING

Metropolitan Museum of Art. [1995] 1999. *Textiles in The Metropolitan Museum of Art*. Reprinted from *The Metropolitan Museum of Art Bulletin* 53(3) (Winter 1995/96). New York: Metropolitan Museum of Art.

SOURCES OF MATERIALS

Analytical equipment
Mike Specht
Spectra Services
6359 Dean Parkway
Ontario, NY 14519
Tel: 800-955-7732 ext 12
mspecht@spectraservices.com
www.spectraservices.com

Ahiba IR Dye Machine
Datacolor International
5 Princess Road
Lawrenceville, NJ 08648
Tel: 609-924-2189
Fax: 609-895-7447

DI Water System
Siemens Water Technologies
20 Murray Hill Parkway, Suite 140
East Rutherford, NJ 07073
Tel: 201-531-9332
Fax: 201-531-9450

Office construction (2007)
Bauerschmidt & Sons
119-20 Merrick Blvd.
Jamaica, New York 11434
Tel: 718-528-3500
Fax: 718-276-9021

THE DEPARTMENT OF TEXTILE CONSERVATION
AT THE METROPOLITAN MUSEUM OF ART

Restoration tension table/frame
Bob Harley
24 McDermott Pl.
Bergenfield, NJ 07621
bobharley2000@yahoo.com

FLORICA ZAHARIA is the conservator-in-charge of the Department of Textile Conservation at The Metropolitan Museum of Art, New York. She earned a Ph.D. in Visual Arts from the National University of Art *Nicolae Grigorescu* in Bucharest. Her subject was "Aesthetical and Technological Considerations related to the traditional textiles made of wool, hemp, and linen, in some ethnographical areas of Transylvania." Her latest major publication is the *Traditional textiles from transylvania –technology and aesthetic* (2008. Suceava: Accent Print). The material in this book is based on more than fifteen years of research on the technology of traditional textile material from the villages of Transylvania and the surrounding areas in Romania. Address: Textile Conservation Department, The Metropolitan Museum of Art, 1000 Fifth Avenue, New York, New York 10028-0198; florica.zaharia@metmuseum.org.

THIRTY YEARS OF MICROSCOPE IMAGING TECHNOLOGIES IN THE TEXTILE CONSERVATION DEPARTMENT, METROPOLITAN MUSEUM OF ART

ELENA PHIPPS & MIN SUN HWANG

ABSTRACT—Macro- and micro-scale images taken from 0.5 to 1000x are critical for the documentation, study and conservation of textiles. Since 1978 when the Textile Conservation Department at the Metropolitan Museum of Art purchased its first video camera for the lab's stereo-zoom microscope, the constant search for the appropriate tools for examination, capture and storage of images has been a continuous endeavor. Applications range from identification of materials, documentation of weave structures and other technical characteristics, characterization of surface soils, fabric composition features and treatment activity. These all require not only different levels of magnification but also different sets of equipment to accommodate various working heights, viewing methods and capture devices. The paper focuses on the evolution and development of systems for examining textiles that incorporated film, video and digital imaging technologies in the context of the department's efforts to create and improve methods for the examination, documentation and preservation of the Museum's textile collection.

TREINTA AÑOS DE TECNOLOGÍA DE ADQUISICIÓN DE IMÁGENES DE MICROSCOPIO PARA EL EXAMEN Y DOCUMENTACIÓN DE LOS ARTÍCULOS TEXTILES EN EL DEPARTAMENTO DE CONSERVACIÓN DE ARTÍCULOS TEXTILES, MUSEO DE ARTES METROPOLITANO POR ELENA PHIPPS Y MIN SUN HWANG, RESUMEN—Imágenes a macro- y micro-escala tomadas de 0,5 a 1000x son críticas para la documentación, estudio y conservación de los artículos textiles Desde 1978 cuando el Departamento de Conservación de Textiles del Museo de Artes Metropolitano compró su primera video cámara para el microscopio estéreo del laboratorio, la constante búsqueda de las herramientas apropiadas para el examen, captura y almacenamiento de las imágenes ha sido un esfuerzo continuo. Las aplicaciones abarcan desde la identificación de materiales, documentación de estructuras de tejido y otras características técnicas, caracterización de manchas de superficies, características de composición de telas y actividad de tratamiento. Todo esto requiere no sólo diferentes niveles de aumento sino también diferentes juegos de equipos para acomodar las variadas alturas de trabajo, métodos de visualización y dispositivos de captura. El artículo se centra en la evolución y desarrollo de los sistemas para examinar textiles que incorporan películas, video y tecnologías de adquisición de imágenes digital en el contexto de los esfuerzos del departamento por crear y mejorar los métodos para el examen, documentación y preservación de la colección de los artículos textiles del Museo.

1. INTRODUCTION

The Textile Conservation Department at the Metropolitan Museum of Art (Met) is responsible for the care, preservation and technical documentation of approximately 36,000 textiles in the collection. Conservation work and technical documentation has been ongoing since the department was established in 1973, under the direction of Nobuko Kajitani, who was committed to incorporating the technical understanding of textile materials and weave structures as a core component of the work of the textile conservator. Her commitment to utilizing new technologies for micro-imaging systems established the long-term involvement of the department in the evolutionary process (fig. 1).

Over the years, the department has incorporated a number of types of microscopes and imaging equipment to achieve these goals. This paper given at the American Institute for Conservation Annual Meeting in Los Angeles in 2009, presents an historical overview on the use of technologies for examining textiles that have been employed at the Met over the past thirty years, discusses their efficacy, and proposes criteria for ongoing development of systems for the future. The development of many of these systems pre-date the use of computers and came long before digital technologies were even on the horizon.

Figure 1. Still video camera mounted to Bausch and Lomb stereo zoom microscope. Photo 1993.

2. PHOTOGRAPHY

Photo documentation of textiles is an important aspect of a conservator's work; it is used as a tool for examination of textile surfaces, weave structures, yarn construction, fiber identification and conservation treatment. At the Metropolitan Museum, professional photographic staff has traditionally conducted the photography of textiles. Record photographs were systematically taken of all works of art as part of the accessioning process and were stored as negatives in the Photo Studio. Although there are large exceptions to any institutional program on this scale, we have been fortunate to be able to work with a huge archive of black and white record shots and some color images. When prints were required by conservation, they were ordered and processed through the Photo Studio.

Over the course of 20 years, through the meticulous execution of systematic weekly orders of 15 prints at a time by a dedicated volunteer Elizabeth Riley, the Textile Conservation Department amassed a collection of over 14,000 black and white prints representing almost one half of textiles in the collection. This photo archive was scanned in 1995 to form the backbone of the collection management imaging database designed for the Antonio Ratti Textile Center, the Museum's state of the art textile study/storage facility (Phipps 1998). (In the 1990s our photo department migrated to digital format.)

In the lab, these prints were photocopied, as needed, and formed the basic image used for conservation documentation of condition, restoration, technical features, weave orientation, etc. At the same time, for conservation purposes, conservators have always taken their own photographs, which became part of the permanent object record.

Detail photography took place using a 35 mm film camera and a variety of macro lens and ring devices that enabled close-up views of varying degrees of magnification through the lens. These were used to document the textile's condition as well as technical and structural features not clearly captured in the main record shot. Initially these images were taken with black and white photographic film—following the archival standards of the day, however, with the relative stabilizing of color image processing in the 1970s slides, the film of choice became color slides shot with 160 ASA Ecktachrome. The slides from this period, kept in polyethylene sleeves, for the most part, remain archivally viable. While this photography produced reliable results, the need to look at closer detail, and especially at textile surfaces, weave structures and fibers at magnifications higher than that achievable with a camera alone required a different set of specialized equipment.

3. MICROSCOPY

3.1 HISTORY

Examining textiles from 2x to 70x can be achieved with relatively low cost, using simple loupes or magnifiers, which rest on the surface of the textile and binocular microscopes with 10x to 70x magnification. The relatively long focal distance of the binocular scope enabled the use of the equipment not only for examination of textiles, but also for performing conservation treatment, such as removal of soils with micro-vacuuming tools. These activities took place over the course of hours if not days. The examination of the textiles worked well with the microscopes: the challenge was how to capture images from them.

In the late 1960s and early 1970s a Polaroid camera back was mounted to a large format bellow. The equipment, a bit intimidating in its size, was near obsolete by the mid 70's but was kept around for occasional use. Eventually, the Polaroid camera was replaced with a regular 35mm camera, with a series of tubes that enabled the camera back to be mounted onto the microscope. Though difficult and infrequently used, this equipment when used correctly enabled photography through the microscope with excellent results.

Beginning in the late 1970s, the department purchased a still-video camera, which was mounted to the binocular microscope (Kajitani and Phipps, 1992). Examination of microscopic images became possible on the video monitor. This alone was a great achievement, particularly in relieving eyestrain for the staff, caused by long sessions of microscopic work. The system was easy to use, and became part of the daily work in the lab.

Printing the video image became possible with the acquisition of a still-video printer, which could also be used to label the print. The prints had a relatively high degree of permanence and were sharp enough to be used for publication. In the days before digital scanning was the norm, to prepare the image for publication, a 35mm photo of the video print had to be taken, in other words, requiring a second generation image, in order to be able to achieve the fine grain resolution required for publication quality images. The capture and storage of the image was done using a storage device that encoded the image onto a small magnetic video diskette. The diskette was readable only in the same type of still-video device, and not easily transferrable. This stand-alone system was used by the lab for almost twenty years. For reference, this equipment was purchased years before the department purchased its first computer.

The 3-chip video camera could also be mounted on a compound transmitted and polarized light microscope, which was used for fiber analysis, with magnification from 40x -1000x. Initially, a 35 mm camera mount was used to capture images onto film, as was traditionally used in most labs. This required mathematical calculations for appropriate photo settings until the acquisition of an automated shutter system that enabled the automatic light calculation for image capture. Processing the film took time, as it was sent out of the building, so that one was not sure if the image was captured correctly until a minimum of five days to one week later, when the film would come back from the photo lab, requiring that samples be preserved.

Fiber identification using the compound microscope required taking samples from the artwork. In some cases, this was not possible, whether due to the condition of the object, its mounted format, or other physical or ethical reasons. Yet, we very much wanted to examine textiles and make fiber identifications *in situ* and at high magnification.

3.2 HIGH RESOLUTION DIGITAL MICROSCOPES

In 1995 the department was fortunate to be able to obtain an instrument that would enable this process. The Keyence High Resolution Digital Microscope VH 6300 combined fiber optic technology and high magnification in a portable unit that allowed viewing and capturing of images from a hand-held scope. The tiny monochrome screen was acceptable at the time; since the miracle of examining the surface of a textile at 1000x without taking samples had previously been unheard of. However, the high cost of the hand-held equipment at over $35,000 fifteen years ago was intimidating for the staff and combined with the lack of clarity of image on the monitor made it not an ideal piece of equipment for a working lab. Newer versions of this scope are greatly improved and now function through computer software on a laptop.

The building of the Antonio Ratti Center Study Storage, and concurrently the new Textile Conservation lab completed in December 1995, provided an opportunity to expand and improve the microscope/imaging systems. Drawing on the experience gained over the previous fifteen years with the various video imaging technologies mentioned above, improvements were sought for image production and capture. Additionally the design of the new lab afforded new opportunities to develop features for improving the functionality and manner in which the equipment could be incorporated into the new work space.

Microscope equipment setups are problematic particularly for the examination of large, fragile textiles. The physical location of the scope, its stand—whether on the floor or on a table surface, its relation to the textile and the person viewing it, as well as the need for space for all the camera and peripheral equipment, impacts the ability of the conservator to perform examinations from a practical perspective. The mounting of a still-video camera and the viewing monitor enabled staff to stand at a distance, away from the scope, and allowed for multiple persons to view concurrently. This was a great feature for teaching and training. However, focusing the image, adjusting light and positioning the object still required hands on the equipment, meaning that the viewer needed to standing close enough to the knobs and buttons to be able to refine the viewing. Remote access became possible when the video system was finally connected to a computer, utilizing a frame-grabber card to convert the analog video image to a digital format.

The technical improvements came in a number of steps. First, we were able to reduce the footprint of the equipment and eliminate the microscope body by utilizing a high powered Navitar lens for the camera. This lens was then custom fitted with motorized zoom that ranges from 30x to 360x and focusing mechanism that could be controlled by the computer. Automatic light level adjustments were synced with the motorized zoom, and all of these features could be adjusted through the Vision Gauge imaging and measurement computer software program. A second major improvement came when the equipment was positioned on a bridge that was specially designed to span the width of the eight-foot work table. The bridge was fitted with a greaseless motorized belt system that allowed for movement in an x and y direction (fig. 2).

Figure 2. Wide span bridge over worktable. HD camera fitted with Navitar lens on motorized arm. The large flat screen monitor (left) shows the HD analog image and the computer screen (right) shows the processed digital image. Photo 2009.

3.3 DIGITIZATION

Digital cameras had become part of the photography scene for a number of years, but were resisted in the department. This was due to the preference for the still video camera's ability to provide smooth, continuous viewing of the textiles during movement. For example, the following of a single thread or design feature, while maintaining focus, over a length of fabric was easy in a video environment. In contrast, all the digital cameras that were examined exhibited slow re-constitution of image upon movement, and immediate loss of focus at every shift of position. In spite of these drawbacks, at some point, the need for higher resolution images outweighed the aversion to the shakiness and stop-action functionality of the digital camera.

Video images captured and transformed to digital files had a maximum of a 780 kilobyte file, while digital images could be much larger. As digital technology blossomed, from cameras that would capture initially small 1 or 2 MB files to the present standard 10-16 MB file and even greater, our expectations for clear resolution for record print and publications have grown. As a result, the video systems were gradually replaced with digital capture devices. However, in spite of its limitations, the still video setup, as a daily working system continues to have some appeal, particularly to view long continuous motion and to that end, a new technology has been incorporated: a High Definition video camera fitted with the Navitar lens for zooming. The Panasonic high definition camera body is mounted to the Navitar lens and is capable of both 1080i (1920 x 1080) and 720p (1280 x 720) resolutions. The camera processes 14-bit analog to digital signal. Because this results in higher magnification than needed for our work, we use a 0.5x adapter to cut the magnification levels in half. Working distance in focus is approx. 3 3/8” (8.5cm). The images are viewed on a large flat screen HD video monitor, used for teaching and viewing on large scale. These HD analog images are captured at a resolution higher than our previous 6MB still-video system and may be acceptable for publication, though they are not the optimum format.

Experience with this technology built up expectations for increasing the number of applications and refined set of requirements for all of our microscopic equipment. The goal became one where examination of textiles could lead to the identification of fibers *in situ* and to eliminate the need for removing physical samples, except where absolutely necessary.

3.4 Z-STACKING FEATURE

Because of that goal, when the opportunity arose for acquisition of new equipment, we returned to the use of a physical microscope, fitted for digital image capture (fig. 3). The Mitutoyo compound microscope using reflected light with a Spot digital camera enabled examination of textiles from 20x to 200x magnification, and to some degree, captures images with sufficient clarity and definition to be able to identify fibers without removing samples (fig. 4). The Mitutoyo compound microscope uses two light sources: internal light for dark field and external light for bright field use. It has motorized focus control for three speeds. The eye pieces are 10x and the objectives mounted in the turret are 2x, 5x, 10x, 20x but others are possible. The exposure and the brightness of the light can be adjusted through the camera software. Image capture for this microscope can be done using one of two software programs: *Spot Advanced* for viewing and capturing images (see SPOT camera specs for file size) and *Image Pro* for the extended focus or Z-stacking feature. The spot camera presents the live image in 1024 x 1024 resolution, with a file size from 12 to 48MB. This requires high magnification and extreme sharpness of image focus, particularly as these images are viewed with reflected and not transmitted light. Because of the narrow depth of field at high levels of magnification, however, the results were not completely acceptable.

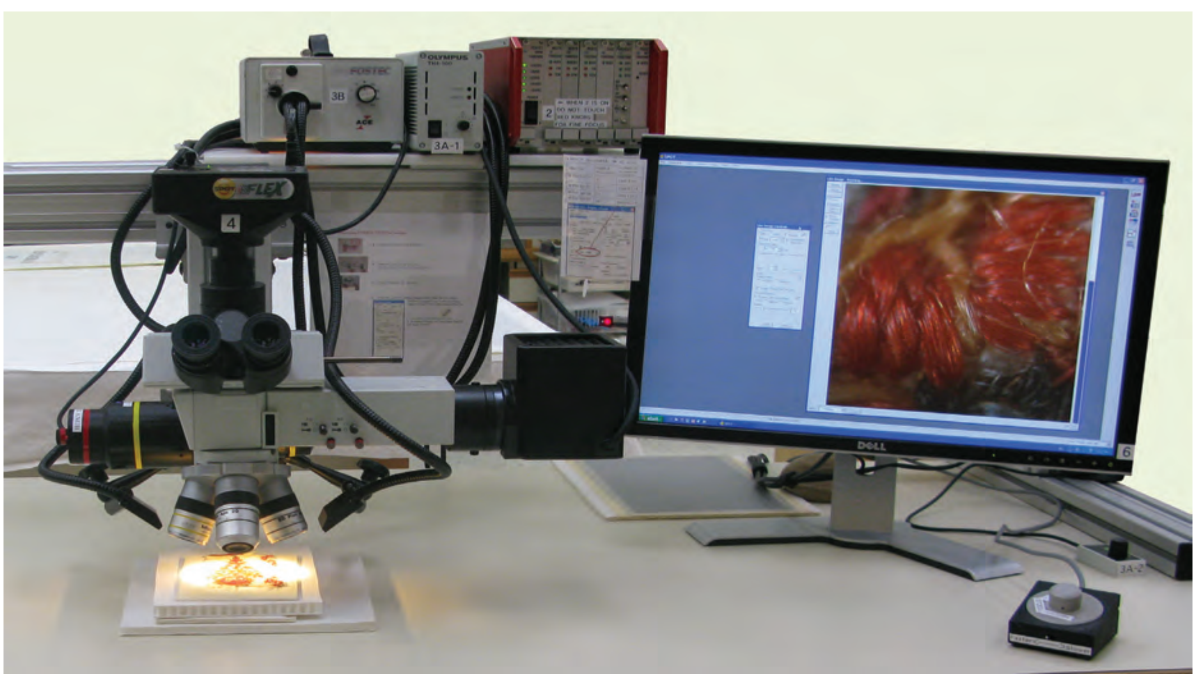


Figure 3. Mitutoyo compound microscope with spot camera, control unit, and fiber optic light. Photo 2009.

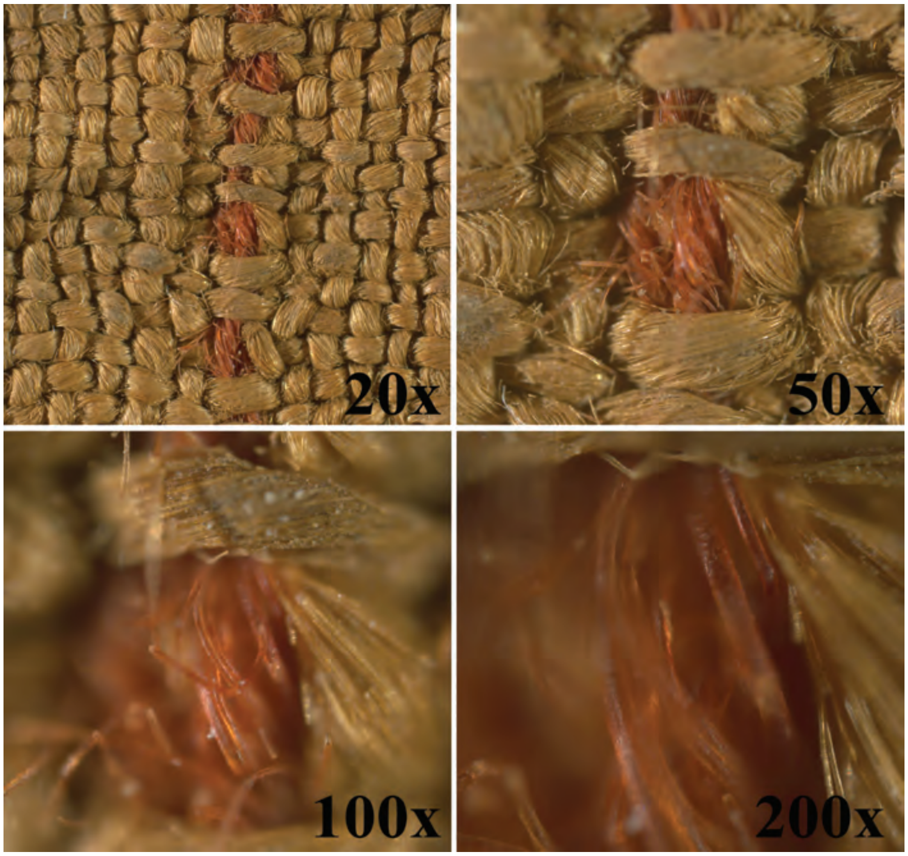


Figure 4. Egyptian linen and wool textile viewed under Mitutoyo microscope: magnification 20x – 200x. Photo by E. Phipps.

Figure 5. Extended focus or Z-stacking process begins by determining the highest (top left) and lowest (bottom left) point of focus. The image (right) shows the result of Z-stacked composite image incorporating 8 layers (100x). Photo by E. Phipps.

Improvement came with the addition of a combination of computer software programming and a mechanical motor for focusing. Through the synchronized feature of extended focus sometimes referred to as Z-stacking, greater improvement in the depth of field of the images became possible (fig. 5). The extended focus feature is achieved through a sequential capture of digital images each taken at a specified set focus points for a specified range and at specified intervals. The software allows us to set the parameters for a number of levels or slices while moving from bottom to top of the image focus range. The software program combines the individual images to create one master image, which represents a view that is fully in focus. While problematic at times due to artifacts that may be introduced in the process, this feature enables fiber analysis to be conducted from the surface of a textile-- something that had been extremely difficult, if not impossible prior to this time.

This Z-stacking feature is possible on a number of different microscopes which we now have in the lab, including the Olympus BX51 transmitted and reflected light polarizing compound trinocular microscope with 40-600x magnification (fig. 6). The possible use of reflected light as well as transmitted light expands the viewing parameter, in longitudinal or cross section, at high magnification, enabling a different perspective using different light sources. A digital Spot camera attached to the microscope functions via computer software and enables the viewing of the image on the screen while files—captured up to 48MB in size-- can be saved directly in the computer. The microscope is custom fitted with motorized focus, and using the same software program used in the Mitutoyo, "z-stacked" images can be captured that overcome the problem of small depth of field that is particularly an issue with these highest levels of magnification.

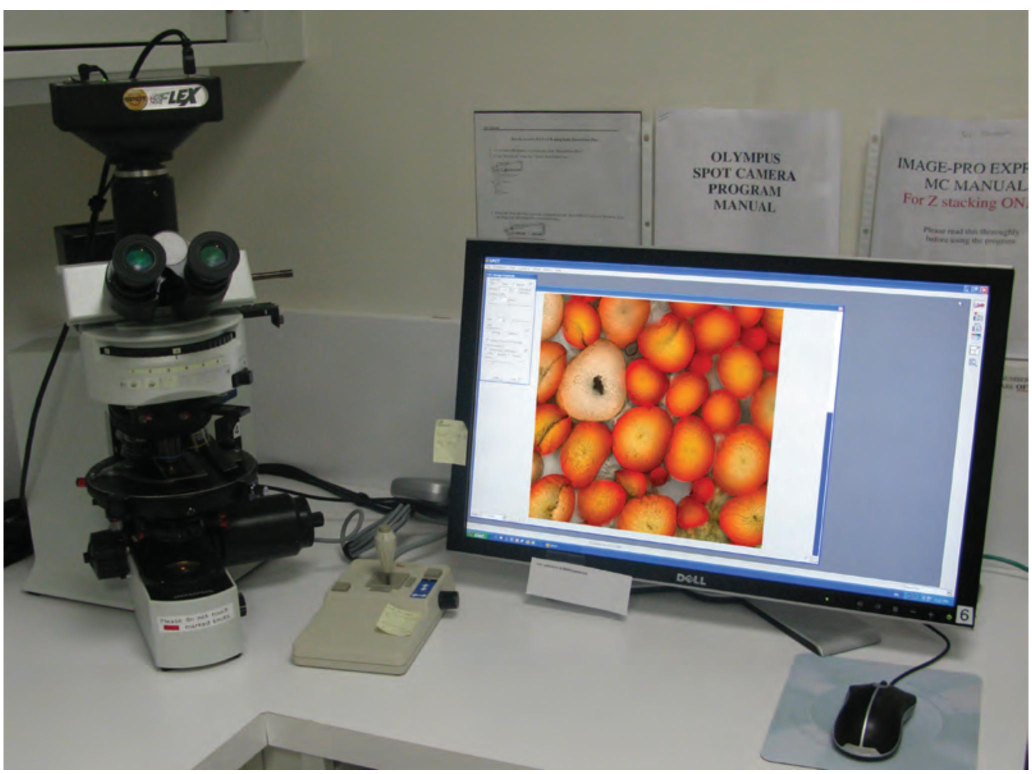


Figure 6. Olympus BX51 compound microscope with spot camera, motorized zoom and focus control unit.
The fiber seen on the computer screen is yak hair, cross-section 400x. Photo by M. S. Hwang.

The Zeiss Discovery V12 stereo microscope also has the Z-stacking feature. It has external fiber optic light source and uses a Zeiss Axio Cam camera that captures an image creating a 3.8MB to 34.5 MB file using Zeiss Axiovision software.

While the three three-lens turret, with lens from 0.68x to 160x, on this stereoscope is manually changed, unlike the other microscopes which must be calibrated each time for each lens, the Zeiss software automatically recognizes which lens is in place. The magnification level, synced with an automatic zoom feature, is also recorded along with the depth of field and other meta data stored with the image file.

The full automation of the Zeiss equipment has one more important feature: it allows for web-based remote access. This access does not only, for example, allow remote technical assistance by the manufacturer's representatives, but also opens up the possibility for sharing and using equipment via the web among professionals. With this, it is possible to do everything remotely, including zooming, Z-stacking and image-capturing. The only exceptions would be turning on the equipment and positioning the sample which would be possible with a motorized stage. Although this is not in place, it could be the next step. The collaborative research potential for use via the web is an exciting development for the near future.

4.0 CONCLUSIONS

Computer and imaging technologies are part of a rapidly changing field that is critical to conservation. These systems are transforming working methods and broadening the scope and depth of conservation work. At the same time, they require long-term investments on behalf of the institution in staff time and money; require constant maintenance and incremental upgrading and migration of stored files to new formats and storage media. In general, conservators need to find the balance between developing working systems that can aid in the day to day conservation of works of art, while at the same time utilizing the potential of these systems for education, documentation and preservation efforts.

There is no doubt that micro-imaging is an important feature of conservation work: that has become the norm. Now that many conservators are using this or related equipment, it is important to know how the information can be saved, used and shared within the institutions with our internal colleagues and as well as across institutions both nationally and abroad, to create networks of shared technical conservation data/images that will make long term and lasting contributions to the study and preservation of textiles.

ACKNOWLEDGEMENTS

Microscope/imaging specialist Mike Specht has been a key player in the technical design and development of the majority of these custom-made systems and has worked with the department as a consultant for over 25 years. Photos courtesy of The Metropolitan Museum of Art were taken by E. Phipps (1) and Min Sun Hwang (2-6), Textile Conservation Department, MMA.

REFERENCES

Kajitani, N. and E. Phipps. 1992. Video Imaging Technology for Textile Research. Features section, *Hali* Issue 66 (December), 87.

Phipps, E. 1998. The Design, Planning and Implementation of the Antonio Ratti Textile Center, Textile Study and Storage Facility at the Metropolitan Museum of Art. In *Textile Specialty Group PostPrints*, American Institute for Conservation, 87.

THIRTY YEARS OF MICROSCOPE IMAGING TECHNOLOGIES IN THE TEXTILE CONSERVATION DEPARTMENT, METROPOLITAN MUSEUM OF ART

SOURCES OF MATERIALS AND EQUIPTMENT

MICROSCOPES

Keyence Corporation of America
50 Tice Blvd.,
Woodcliff Lake, NJ 07677
Tel: 1-201-930-0100
Fax: 1-201-930-0099
E-mail: keyence@keyence.com
Web site: http://www.keyence.com

Mitutoyo USA Headquarter
965 Corporate Blvd
Aurora, IL 60502
Tel: 1-888-648-8869
Fax: 630-820-2614
Email: info@mitutoyo.com

Navitar Inc.
200 Commerce Drive
Rochester NY 14623
Tel: 585-359-4000
Fax: 585-359-4999
info@navitar.com

Carl Zeiss INC.
Service Administration
One Zeiss Drive
Thornwood, NY 10594
Phone: +1 800 233 2343
Fax: +1 914 681 7446
http://www.zeiss.com/micro

Spectra Services, Inc.
ATTN: Mike Specht
6359 Dean Parkway
Ontario, NY 14519
Tel: 1-800-955-7732 X 12
http://www.Spectraservices.com

CAMERAS

Diagnostic Instruments, INC. [Spot Camera]
6540 Burroughs
Sterling Heights MI 48314-2133
Tel: 586-731-6000
Fax: 586-731-6469
email: info@diaginc.com
http://www.diaginc.com

Panasonic System Solutions Company [HD Camera]
Three Panasonic Way 2H-2,
Secaucus, New Jersey 07094
Tel: 1-800-528-6747
http://www.panasonic.com/business/

IMAGE SOFTWARE

Image Pro
Media Cybernetics, Inc.
4340 East-West Hwy, Suite 400
Bethesda, MD
20814-4411 USA
Tel: + 1 301-495-3305
Fax: + 1 301-495-5964
techsupport@mediacy.com
http://support.mediacy.com

Visionx INC. (Vision gauge image measurement software)
274 Lakeshore
Pointe-Claire, Quebec
CANADA H9S 4K9
Tel: 514-694-9290
Fax: 514-694-9488
http://www.visionxinc.com

ELENA PHIPPS is Senior Museum Conservator, The Metropolitan Museum of Art, where she has worked since 1977. She has her PhD in Pre-Columbian art from the Department of Art History and Archaeology, Columbia University (1989), and was responsible for the design and implementation of the Antonio Ratti Textile Center (1990-1995), as co-manager of the design and building phase. In 2004 she was co-curator of an exhibition and co-author of the catalogue *The Colonial Andes: Tapestries and Silverwork 1430-1830*, at the MMA. She is interested in the material and techniques of textiles in the context of cultural and art history. The documentation of these features has been a primary interest throughout her work at the MMA, where she has been instrumental in the design of the microscopic-imaging systems used in the lab. Address: Metropolitan Museum of Art, 1000 Fifth Ave. New York, NY 10028. Elena@ephipps.org

THIRTY YEARS OF MICROSCOPE IMAGING TECHNOLOGIES IN THE TEXTILE CONSERVATION DEPARTMENT, METROPOLITAN MUSEUM OF ART

MIN SUN HWANG is Assistant Conservator, Textile Conservation Department, The Metropolitan Museum of Art. Her specialty is East Asian textiles and costumes, including China, Japan, and Korea. She received her M.A. in 2002 from the Department of Museum Studies (Costume and Textiles) at the Fashion Institute of Technology in New York. She made two presentations at the Textile Society of America (TSA) conferences – "Traditional hemp fiber and cloth making in Andong, Korea" in 2006 and "A Comparative Study of Andonpoh and Musam Korean Hemps: Developments of two distinctive hemp yarn productions in Korea" in 2008. She contributed an article on the same subject to the 2007 UCLA publication, *Bast and Leaf Fiber Weaving: Cultural Preservation in the Asia-Pacific Regions.* Mailing address as above, email: min-sun.Hwang@metmuseum.org.

UPDATE: DETERGENCY & THE AQUEOUS CLEANING OF ANTIQUE TEXTILES

MARY W. BALLARD

ABSTRACT—The European Union has curtailed the use of nonylphenol ethoxylates. In the United States, octylphenol ethoxylates have also been questioned for their safety to humans and for their waste products. Yet the search for substitutions has led to cleaning agents designed for metal, glass, and nonabsorbent plastics in specialized industrial settings: dairies and breweries. How did we get so far afield? How effective are these products? The current study will review the current legislation and examine the efficacy of potential choices, nonionic and anionic within the context of museum textile and clothing collections.

ACTUALIZACIÓN: DETERGENCIA Y EL LAVADO ACUOSO DE ARTÍCULOS TEXTILES ANTIGUOS POR MARY W. BALLARD, RESUMEN—La Unión Europea ha restringido el uso de etoxilatos de nonilfenol. En los Estados Unidos, los etoxilatos de octilfenol también han sido cuestionados por su seguridad para los seres humanos y por sus productos de desperdicio. Aún así la búsqueda de substituciones ha conducido a agentes de limpieza designados para metal, vidrio y plásticos no absorbentes en entornos industriales especializados: centrales lecheras y fábricas de cerveza. ¿Cómo llegamos a lugares tan distantes? ¿Cuál es la efectividad de estos productos? El estudio actual revisará la legislación actual y examinará la eficacia de las elecciones potenciales, no iónicas y aniónicas dentro del con contexto de textiles de museo y colecciones de ropas.

1. INTRODUCTION

In earlier times, centuries passed without substantial changes to the type of fibers available, the type of finish available, or the type of surfactant available for textiles and costumes within a culture. Today, the post-1950 additions to the fiber and fabric content are now arriving in textile collections; they incorporate substantially new synthetic fibers and new finishes. Textile conservation generally works 50 to 100 years behind the American apparel and furnishings market, as clothing and fabric gradually become treated as heirlooms and accessioned into museum collections. With these new synthetic fabrics and finishes, it is especially useful to revisit surfactant selection. This paper will address the soil removal mechanism, fiber type, and fiber finishes as well as a discussion of detergency and surfactants, with particular attention to nonionic alkyl phenol ethoxylates. It was given as an oral presentation to the Textile Specialty Group, at the 37th Annual AIC Meeting.

2. SOILS & SOIL REMOVAL METHODS

Detergent manufacturers divide soil into six major groups: particulate soil, water soluble soil, oily or greasy soil, liquid food stains, protein or starch based stains, and odors (table 1) (Broze, 1994).

Soil Group		Examples
Particulate soil		Dirt, Dust
Water Soluble soil		Table salt, table sugar
Oily (liquid) soil	Oily Soil	Non-polar hydrocarbons—motor oil
	Greasy Soil	Fatty foods with polar components-vegetable or animal greases
Fruit, beverage stains		Coffee, tea, cola
Protein or starch		"macaroni & cheese"
Odors		Esters, diamines, body oils (squalene, sebum)

Table 1. Soil groups and examples (after Broze, 1994).

Oily soils and particulates have been thoroughly characterized in order to evaluate home laundry detergents and commercial soil release agents (Kissa, 1987a, Kissa 1987b). Yet such oily soiling common to home laundry is uncommon in museums. Antique textiles--tapestries, carpets, flags, or costumes--are more likely to be acquired by a museum in a "clean" state although prior soap residues in the form of salt or fatty acids may be mistaken for mold when they tend to outgas from silk or wool, suggesting a preferential deposition or adsorption on these substrates (Heald et al., 1994). Sometimes museum records and circumstantial evidence can help to determine past wet cleaning treatments (Kajitani, 1987).

Heirloom textiles and antique textiles are more likely to have soils associated with their location in an exhibition hall or due to their fundamental nature. Water soluble soils and oily or greasy soils—kitchen or garage soils—are much less common. Costumes might have old stains or odors, archaeological textiles might have stains as well as particulates. Museums with antique textile collections are most often located in urban settings. Soils deposited on antique textiles after acquisition (and while on exhibition) are associated with street dust (Francis, 2002). In the United States, an early major study of street soil showed a variation on the quantity and quality of soils in different cities (table 2). The soils have fairly uniform inorganic components, perhaps due to a similarity of city building materials and street pavements; the non-combustible ash content is over half the material. The most variable part of urban soil is the solvent soluble component--the oiliness of the soil which was as low as 4.9% in Detroit and as high as 12.8% in St. Louis.

The majority of city soil particles are surprisingly small; this is particularly important for museums since the smaller particles can travel farther with lighter breezes. A series of studies of soil deposited in museums have focused on modeling the velocity and deposition rate of airborne particles (Nazaroff et al., 1990a). Here the soil inside museums is divided into elemental carbon (soot) and soil dust into grades with a 2.0 micron diameter cut-off point. New ventilation and filter systems can reduce the level of indoor soils to 15-20% (fine) or even less than 5% (coarse), although one museum has more measured elemental carbon inside than out (Nazaroff et al., 1990a:71). In a related article, the authors correlate the velocity and turbulence of mechanical ventilation

Component	**Pittsburgh**	**Detroit**	**Cleveland**	**Buffalo**	**St. Louis**	**Boston**
Water-soluble	15.4	13.5	15.9	11.4	14.9	15.4
Ether-soluble	10.8	4.9	7.1	6.5	12.8	7.7
Moisture	--	1.7	3.0	-	-	2.1
Total Carbon	**26.4**	**24.7**	**24.0**	**26.9**	**25.6**	**28.9**
Ash	**53.8**	**57.8**	**56.3**	**52.0**	**51.2**	**50.5**
$Si0_2$ (total)	25.6	25.5	26.4	24.0	21.4	21.4
R_20_3 (total)	11.6	9.9	11 .1	9.5	9.4	11.1
CaO (total)	6.2	8.4	7.7	6.9	7.4	6.4
MgO (total)	1.7	2.0	1.7	2.0	1.6	1.7
CaO (water-soluble)	0.3	0.4	0.7	0.3	0.4	0.7
MgO (water-soluble)	0.1	0.2	0.2	0.2	0.2	0.2
N	-	1.6	-	-	-	2.1
pH (10% slurry)	7.0	7.3	6.7	7.2	7.0	7.3
Carbon black ("')	0.8	0.6	0.55	0.5	0.5	0.6

Table 2. Analyses of natural dirt form various U.S. cities (after Sanders & Lambert,1950).

registers, temperature and circulation currents near windows or doors to the level of soil disposition (Nazaroff et al., 1991). An early analysis by the Hoover Company found that 45% of "natural soils" picked up by vacuum cleaners were sand and clay. Vacuum cleaners picked up the particles in the size range of 0.3 to 35 microns, but the soil left on the fibers of carpets is smaller: 0.2 to 4 microns (Martin and Fulton, 1958).

3. DETERGENCY

If the commercial categories of soil are grouped by their typical removal method, there are three major options: mechanical removal, specialty reagent removal, and detergency (table 3). Technically, detergency is defined as "the removal of unwanted substances from a solid surface brought into contact with a liquid" (Kissa, 1987a: 2). There is agitation or mechanical action during detergency cleaning, of course, and detergency can be aided by specialty chemicals. Certainly, commercial detergents accommodate water conditions and climatic variation by adding various auxiliaries. However, detergency as an aqueous soil removal method mainly involves removing a solid substance either by a reduction in soil adhesion or by liquefaction and solubilization. Liquid soils are 'rolled up' by detergency (table 3) (Cox, 1994).

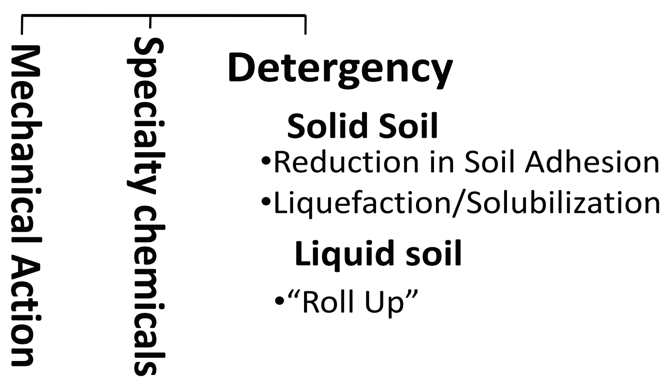


Table 3. Soil removal mechanisms (after Cox, 1994).

Surface active agents, a term condensed to *surfact*ants, are used to remove soils. They are the diplomats of the chemical community, getting disparate factions working together—getting oil and water to mix. These surfactants wet surfaces, suspend soils in water, and absorb onto surfaces. They function as biocides, they enable soil removal. Surfactants are identified by their two part composition: one part of their chemical structure is hydrophilic, one part of their structure is hydrophobic; they are chemically bilingual. Other chemical structures also affect surface tension. The surface tension rises with the concentration of electrolytes. Solvents, like ethanol, can help to wet out a surface when they are mixed with water. However, surfactants will lower the surface tension at an extraordinarily low concentration, and at the same time suspend soils, again because of their chemical bilingualism.

The surface active agent has a "head" that is the water-soluble component-- a carboxylate, sulfate, sulfonate, quaternary ammonium, ethylene oxide chain (EO), etc.—and a non-aqueous "tail" that is a straight or branched hydrocarbon. For Synperonic N, the hydrocarbon is a 9-carbon chain attached to a phenol ring; for Triton X-100, an octyl (8-carbon) group is attached to the phenol. For Orvus WA Paste, the lauryl (12-carbon chain) is hydrophobic. Here, lauryl suggests a vegetable origin for the carbon chain; its synonym, dodecyl, indicates a petroleum origin, so the surfactant can be abbreviated SLS or SDS.

Another term for the hydrophobic tail is 'lipophilic,' having an affinity for oils. The relative strength of head versus the tail is characterized as the hydrophilic lipophilic balance or HLB number. For the last half century the HLB values have been provided by surfactant manufacturers for nonionic surfactants: the HLB value is the percentage weight of the hydrophilic group, divided by 5. A large water soluble component will increase the number; a large hydrophobic or lipophilic group will reduce it. Wetting agents have an HLB of 6-9; oil in water emulsifying agents 8-18, solubilizing agents, 10-18. Triton X-100 has a HLB of 13.5, and Synperonic N, a HLB of about 13.4. As measured by the HLB values of its two halves, Orvus WA Paste would have an equivalent HLB value of 40 (Merianos, 2001; Jönsson, et al., 1998).

Ionic surfactants have a charge—anionic or cationic depending on the type of "head." Orvus WA Paste, a SDS, is one of the most researched anionic surfactants (Preston, 1948). As with all surfactants, a very small quantity has a pronounced effect on water and on a fabric/solid surface. At the critical micelle concentration (CMC) it begins to function as a detergent. Values of CMC are specific for specific surfactants and the values are widely reported (Mukerjee and Mysels, 1971; Jakobi and Löhr, 1987; Kaler, 1994; Merianos, 2001). The CMC for ionics is generally two orders of magnitude greater than for nonionics (Jönsson, et al., 1998). Ionics work best in a range at or slight above the CMC (Boring and Ewer, 1991 & 1993). Both ionics and nonionics have temperature parameters: ionics have a Krafft point temperature and concentration below and beyond where they change phase structure; nonionics have a phase change above a certain temperature where they cease to act as surfactants. Blends of surfactants can affect the cloud point and additives like electrolytes will alter the Krafft point (Kaler, 1994; Patterson and Grindstaff, 1977). Greatly increased concentrations, though, do not increase efficacy, and can gum up the solution, taking it out of phase (Jönsson, et al., 1998).

With different types of soils, the functioning mechanism of soil removal by surfactants changes, regardless of the type of surfactant. For solid soil particles, surfactants remove particles by reducing the adhesion between the fiber surface and the soil and by reducing the size of the contact between the fiber surface and the soil (Kissa, 1981). Anionic surfactants remove and suspend solid, particulate soil very well (Cox, 1994). Another kind of solid soil is the organic solid—solid at room temperature but semi-solid or liquid in lukewarm water. Surfactants can slice off layers of this type of soil, peeling layers off. Nonionic ethoxylates are very useful for dishwashing and cleaning glassware for this reason (Cox, 1994). Once peeled off, surfactants can form stable "micro-emulsions" that keep the oil solubilized in water. Again, this works most successfully with a little surfactant, a lot of water, and a little oil (Kaler, 1994).

In addition to solid soils, there are entirely liquid soils which surfactants can remove by changing the interfacial tensions—increasing the tension between the oil and the fabric while reducing the tension between the water and the fabric. Surfactants can make the fiber much more hydrophilic, but even as adept chemical ambassadors, surfactants have their limits.

4. FIBERS

Fibers vary in several fundamental ways (table 4). Hydrophobic, synthetic fibers do not become hydrophilic in water with the addition of anionic surfactants and liquid oily soil does not "roll up" from a hydrophobic fiber in the presence of anionics. In table 5, the results of an experiment to remove a fatty soil, a triglyceride, are compared. Cellulosics are well cleaned by ionics or nonionics; on Teflon, this soil is only removed by a nonionic surfactant. Oily soil on nylon is poorly removed by ionics; and oily soil on polyester is virtually unaffected by anionic surface active agents.

Classification System	**Example**
Chemical Formation	Natural, Regenerated, or Synthetic
Polar or non-polar	Attract head or tail of surfactant
Porous or non-porous	Staple fiber or spun fiber
Critical surface tension	Affect of water droplet on fiber surface
Electrical charge in water	Natural fibers have a negative charge

Table 4. Fiber classifications.

Fiber (without finish)	**Soap**	**Anionic**	**Nonionic**	**Cationic**
	Sodium palmitate	Sodium lauryl sulfate	Nonylphenyl-ethoxylate	Cetyltrimethyl-ammonium bromide
Cellulose	--	92%	94%	93%
Polyester	78%	3%	99%	7%
Nylon	--	28%	99%	82%
Teflon	--	22%	96%	22%

Table 5. Percentage of oily soil removal* from various surfaces by different surfactants (after Patterson and Grindstaff, 1977).
*glyceryl tristearate tagged ester removed from 0.01M surfactants in 15 minutes at 60°C.

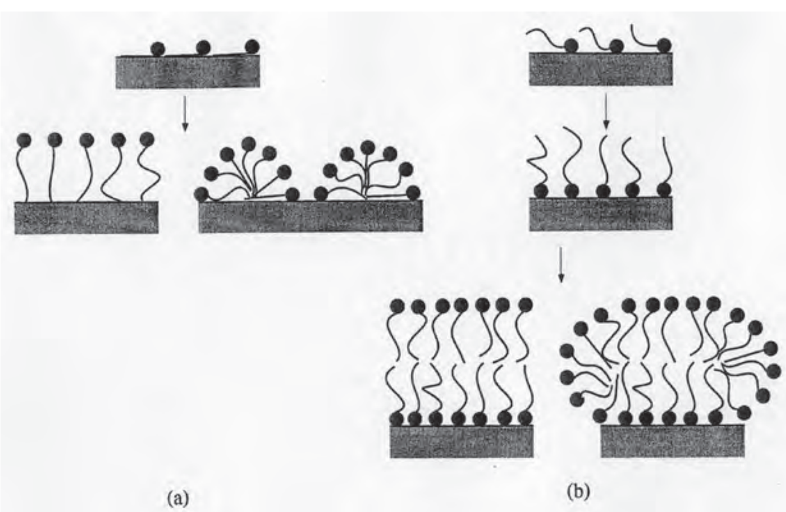


Figure 1. On a non-polar fiber surface (a) the hydrophobic hydrocarbon will align in contact while on a polar fiber surface (b), the hydrophilic head of the surfactant will be the point of contact (Jönsson et al., 1998).

A fiber and its properties will profoundly affect the efficacy of a surfactant. Nonionics are absorbed on cotton, but only slightly on wool. SLS absorbs onto wool and silk significantly, but not on cotton (Weatherburn and

Bayley, 1952; Rhee and Ballard, 1994). The polarity of the fiber is also important: on non-polar surfaces the hydrocarbon tails of the surfactants will sit on the fiber surface; on polar surfaces, the hydrophilic heads will be attracted (fig. 1a). Natural fibers carry a negative charge in water, and the positive 'head' of cationic surfactants will attach to cotton at a magnitude greater than that of anionic surfactants (Weatherburn and Bayley, 1952). For non-polar fibers, the interaction with the hydrocarbon portion of the surface active agent may be independent of the character of the hydrophilic head (fig. 1b). Surfactants can wet out polymeric surfaces with very different critical surface tensions. Yet, blends of anionic and nonionic surfactants can be preferentially absorbed. Thus a blend of 70:30 anionic to nonionic surfactant solution can be absorbed inversely by a non-polar hydrophobic surface (Jönsson, et al., 1998).

5. FINISH

Though the type of fiber and type of soil will influence the selection of surfactant, the fiber itself can be engineered and modified by its finish. Durable press, permanent press resins, or 'easy care' finishes are applied after weaving and dyeing to modify the performance of a garment or furnishing textile. A cross-linked cotton is less hydrophilic, less polar than its untreated relative. Cross-linked cottons will swell less in water and function more like a polyester fabric: liquid oily soil will not 'roll up' with anionic surfactant; a nonionic surface active agent is required (Kissa, 1981). On the other hand, alkali-treated polyester is rendered much easier to clean than the untreated but infamous 'easy care' polyester tablecloths that tenaciously held oily stains. What was once a specialty soil and a tedious stain removal problem on a natural fiber may become a straightforward water-soluble one on a synthetic fiber like nylon or acrylic. Similarly, the natural fiber can be modified with (synthetic) polymers to resist staining. Fluorinated polymer finishes—Telfon coated—on natural fibers will enable them to repel the absorption of polar liquid stains (Regulatory Technical Information Center, 1985).

6. SAFETY ISSUES

Initially, safety issues were perceived to pertain to safety for the object or for the environment. The high pH of laundry surfactants rendered them too caustic for museum textile cleaning (Rice, 1966 and 1970). In consultation with the manufacturer, Procter and Gamble, Kathryn Scott found SDS a suitable surfactant for archaeological textiles (Scott, 1972). Ecologically, anionic surfactants with branched hydrocarbon hydrophobic tails - branched alkyl benzene sulfonates - were banned from commercial anionic surfactants in 1965 because they did not biodegrade. At that time, industrial studies were undertaken to determine the fate of a widely used nonionic surfactant, octylphenol ethyoxlate with 9-10 ethylene oxide units, along with other representative nonionic surface active agents. The scope of the term "environmentally acceptable biodegradation" was interpreted to mean a set of nontoxic products acceptable to the receiving environment (air, soil, or water), but principally as treatable by sewage treatment plants. The aesthetics of the downstream environment were also recognized (Mauser et al., 1969).

Back then, the difficulty lay in formulating consistent, accurate test methods to monitor the rate of degradation of organic compounds and, most especially, analytical measurements that would provide the precision and repeatibility required. Field tests with oxygen consuming microorganisms were undertaken but actual quantitative analysis of the ethoxylated chains had limited sensitivity (Burttschell, 1966). Throughout the 1970's, the limits of effective biodegradation were noted. Nonylphenol, a "moderately toxic" compound, was found to accumulate in a holding pond downstream from a carpet mill at eighty times the level of concentration in the plant effluent itself, which is 0.05mg/l versus 4.0 mg/l (Garrison and Hill, 1972). It was then postulated that the high level of nonylphenol was a result of anaerobic conditions, a theory refined by a more extensive 1984 European study on nonylphenols in sewage sludge. The latter study suggested it was possible that the aerobic microbial elimination of the hydrophilic EO groups and the sorption of the hydrophobe by the sludge led to the measureable, persistent residues (Giger, Brunner, and Schnaffner, 1984). In the studies, the causal agent was identified as nonionic alkylphenol ethyloxated surfactants. Broader ecological questions about the aquatic toxicity of these surfactants were also investigated, as part of the general policy of protecting waterways and water sources in the United States and Europe (Malle, 1984).

A second type of toxicological concern with alkylphenol ethoxylates emerged in the 1990's: one based on the potential hazard for biological effects, specifically to act like an estrogen. Hormonal effects from octylphenols and nonylphenols and their ethoxylated adducts were cited in studies publicized by the Environmental Protection Agency (EPA) (Federal Register, 1996). It should be noted that both nonylphenol ethoxylate and octylphenol ethoxylate have been categorized and sold as spermacides for some time (Merck Index, 1983). Several aquatic toxicity studies and small mammalian studies have focused on the hormonal effects of nonylphenol and octylphenol as alkylphenol ethoxylate degradations. The European community has acted to suspend the use of nonylphenol ethoxylates on this basis (Fields, 2000).

When the American EPA sought to include a priority testing list of alkylphenol ethoxylates, the Toxic Substances Control Act Interagency Testing Committee (ITC) had a problem trying to establish the Chemical Abstract Service (CAS) Numbers and chemical names associated with specific alkylphenol ethoxylates for 28 alkyl phenols and alkylphenol ethoxylates that were initially listed. Variations because of EO ratios (hence differences in physical properties), proprietary information, and idiosyncratic nomenclature have made it difficult to correlate CAS numbers with competing non ionic surfactants for the EPA and for the end-user. Nonylphenol ethoxylate is called "Nonylphenol polyethylene glycol ether" in the *Federal Register* and has 7 CAS numbers: #9016-45-9, #20636-48-0,#26027-38-3, #2606402-8,#27177-01-1,#37205-87-1, and #127087-87-0 (*Federal Register,* 2000). Analogs of Synperonic N (Alkasurf 630) with the CAS #68412-54-4 include a range of 9 to 30 moles of EO and HLB values from 4.6 to 17.1 (McCutcheon's, 1998).

Conversely, a single product may have more than one CAS number: Triton X-100, for example, has two CAS numbers, #9036-19-5 and #9002-93-1 for the same octylphenol ethoxylate, which older literature described as para-tertiaryoctylphenoxypolyethoxyethanol (Lashen et al., 1966). It should be noted that, as late as 1985, *McCutcheon's Volume 1: Emulsifiers and Detergents, North American Edition* did not list CAS numbers for products. The products were simply described by a general chemical classification or by the manufacturer's designated chemical formula. The emphasis was not on the precision of the formula but on the efficacy of the surfactant for certain processing operations, as described in brief "remarks."

7. DISCUSSION

Ironically, the current ecological concerns have propelled the museum world to reexamine its dependence on two nonionic surfactants: an octylphenol ethyoxlate (Triton X-100, Dow Chemical, in the United States) and a nonylphenol ethoyxlate (Synperonic N and ND, formerly ICI, in Great Britain). Some time ago European conservation literature sought to match the type of soiling with the surfactant and water quality: for mixed [substrate] collections in non-deionized water, an alpha-olefin sulfonate, and a fatty acid methyl ester alpha-sulphonate for very acidic soiling, and a nonylphenol ethoxylates for oily soiling (Hofenk de Graaff, 1982). Some literature had emphasized the use of builders, chelating agents, and anti-redeposition agents to overcome the short-comings of alkylphenol ethoxylates (Tímár-Balázsy and Eastop, 1998). Recent literature has focused on the necessity of matching the fiber properties with the surfactant, soiling type, and the role of the critical micelle concentration (Tinkham and Kerr, 2001, Francis, 2002). For the most part, the efficacy of a surfactant or surfactant mixture for cleaning antique fabrics has been determined experimentally using the standard industrial soil cloths created to simulate home laundry soils (Fields et al., 2004; Tinkham and Kerr, 2001; Lewis and Eastop, 2001).

Another response has been to seek a near substitute, like an alkyl ethoxylate with a primary alcohol, such as Triton XL-80N, but this method accentuates the short-comings of the replacement: it is propyloxylated, non-gelling, with differences in CMC, and a greater tendency for eye and skin irritation; Dehypon LS 45 also suffers in a comparison to Triton X-100 (Stravroudis, 1995a; Fields et al., 2004). Even closely related analogs can produce very different working properties: The Igepal CO nonylphenol-ethoxlates - again CAS # 68412-54-4 - include Igepal CO 530 “a deicing fluid for jet aircraft,” with an EO of 6 to Igepal CO-730 used as a “metal cleaner [and in] bottle washing formulations” while the HLB values range from 4.6 to 15.0 (McCutcheon’s, 1998). Information on the working properties of surfactants is not always easy to obtain because of the sales and acquisitions of surfactant units among chemical manufacturing firms. Triton X-100 was once a Rohm and Haas product; it was purchased by Union Carbide, and it is currently produced by Dow Chemical. Product literature has been produced by all three firms.

Tergitol	HLB	Moles EO	CMC ppm at 25° C	Cloud Point in °C at 1% wt conc	Dynes/cm at 0.1% conc at 25° C
#1: 15-S-5	10.6	5	--	insoluble	-24
#2: 15-S-9	13.3	8.9	56	60	9
#3: 15-S-12	14.7	12.3	110	89	20

Table 6. Secondary alcohol ethoxylate surfactant mixture proposed by Delcroix and Bureau, using tergitols (Dow Chemical).

Combining a series of nonionic surfactants or a mixture of anionic and nonionic surfactants to address the issues of residual fatty acids, salt residues, and particulates is a third attractive answer for surfactant selection (Delcroix and Bureau, 1990-1; Lewis and Eastop, 2001). For cleaning the protein fibers of antique carpets and tapestries, one European recipe combines a series of three secondary alcohol ethoxylates to achieve good fiber wetting with one, good oil in water micro-emulsification with a second, and good detergency with a third in a ratio 75% CMC, 45% CMC, and 30% CMC (table 6) (Delcroix and Bureau, 1990-1). However, their effective temperature range would ostensibly fall outside the 20°-30°C range in which antique textiles are wet cleaned. Combining selected surfactants also changes the functional temperature range; studies have indicated a mixture of ethoxylated chain lengths has a positive effect on the stability of oil in water and nonionic micro-emulsifications (Saito et al., 1990). Cloud point and temperature are also important for anionic-nonionic mixtures as are factors like the nature of the oil, any electrolyte concentration, any co-surfactant, and the type of salt. More polar soils may be removed most effectively just below the cloud points of nonionic surfactants. In fact, the ratio of the surfactants will change continuously because the surfactant with the higher ethylene oxide chains (6-9) will pull off the more polar oily soil components (Raney and Benson, 1990). The temperature best suited for a particular oily soil is known as its phase inversion temperature (PIT). The oily soil is most effectively removed slightly above its PIT and below the cloud point of the nonionic surfactant. While this is pertinent for nonionics with ethyoxylated chains and for cotton/polyester fabrics, it also begins to clarify the optimum temperature and ratio for anionic-nonionic mixtures (Raney and Benson, 1990; Raney, 1991; Jönsson, et al., 1998). In fact, for anionic-nonionic mixtures, the short-comings of the nonionic surfactant are more than mitigated by the addition of anionic surfactants. Such synergy is typically used for commercial formulations (Jönsson, et al., 1998).

Certainly, it is simpler to continue to use two of the most widely used (and cheapest) surfactants available, octylphenol ethoxylate and sodium lauryl sulfate. Multiple levels of understanding are needed to select suitable replacements for the particular octylphenol ethoxylate and nonylphenol ethoxylate surfactants previously used in museums. There is some merit with nonionic ethoxylated alcohols and with methylester ethoxylates as alternative surfactants (Cox and Weerasooriya, 1997). Yet, simple substitution may be more complex than anticipated because the nature of the soil, the fabric fibers, and the fabric finish may be different now than it was half a century ago. This complexity is compounded by obfuscating terminology as well as a lack of understanding of the features, physical chemistry, and working properties associated with modern surfactants and classic soaps. Our limited characterization of the soils on antique fabrics also conspires against our understanding.

ACKNOWLEDGEMENTS

Portions of this paper were developed in conjunction with course requirements for TC530, The Chemistry of Textile Auxiliaries, given by Prof. Peter J. Hauser at North Carolina State, Raleigh through the long-distance TOP program. I am grateful to the thoughtfulness of Tom Klaas of Testfabrics, Inc. As a fabricator of standard industrial soil cloths, he helped me consider more closely the efficacy of their use for museum studies.

REFERENCES

Boring, M. and P. Ewer. 1993. Report on Tests Performed to Determine the Optimal Concentration of the Surfactant Orvus WA Paste for Cotton. *ICOM Committee for Conservation preprints*. Vol. 1. 10th Triennial Meeting, Washington. Paris: ICOM. 289-292.

Boring, M. and P. Ewer. 1991. Surfactant Comparison Test. In *Postprints of the the Paintings and Textile Specialty Groups Joint Session,* Washington, D.C.: American Institute for Conservation 1:41-61.

Broze, G. 1994. Mechanisms of Soil Removal. *Detergents and Cleaners: A Handbook for Formulators* edited by K.R. Lange. Cincinnati: Hanser/Gardner Publications, 29-41.

Burttschell, R.H. 1966. Determination of Ethylene Oxide Based Nonionic Detergents in Sewage. *Journal* of *the American Oil Chemists' Society,* 43(6): 366.

Cox, M.F. 1994. Surfactants. *Detergents and Cleaners: A Handbook for Formulators* edited by K.R. Lange. Cincinnati: Hanser/Gardner Publications, 43-90.

Cox, M.F. and U. Weerasooriya. 1997. Methyl Ester Ethoxylates. *Journal of the American Oil Chemists Society* 74(7): 847-859.

Delcroix, G. and C. Bureau. 1990-1991. A new detergent formulation. *The Textiles Museum Journal* 29/30:58-64.

Federal Register 1996. *part VII: Environmental Protection Agency* Friday, February 2, 1996: 4192.

Federal Register 2000. 65(7) Jan 11,2000:1550.

Fields, J. 2000. Synperonic N. *Conservation on Line* 04-13-2000. http://cool-palimpsest.stanford.edu/byform/mailing-lists/cdl/2000/0463.html.

Fields, J.A., A. Wingham, F. Hartog, and V. Daniels. 2004. Finding Substitute Surfactants for Synperonic N. *Journal of the American Institute for Conservation* 43: 55-73.

Francis, K. 2002. Tapestry Cleaning: Characterization and removal of Soils. *Strengthening the Bond: Science and Textiles. Preprints of the North American Textile Conservation Conference, Philadelphia, 2002.* Philadelphia: Philadelphia Museum of Art, 47-53.

Garrison, AW. and DW. Hill. 1972. Organic Pollutants from Mill Persist in Downstream Waters. *American Dyestuff Reporter* 61(2):21 -25.

Giger, W., P.H Brunner, and C. Schaffner. 1984. 4-Nonyl phenol in Sewage Sludge: Accumulations of toxic Metabolites from Nonionic Surfactants. *Science* 225 :623-5.

Heald, S., L. Commoner, and M. Ballard. 1994. A Study of Deposits on Glass in Direct Contact with Mounted Textiles. *The Textile Specialty Group Postprints of the American Institute for* Conservation 3: 7-18.

Hofenk de Graaff, J. 1982. Some recent Developments in the Cleaning of Ancient Textiles. *Science and Technology in the Service* of *Conservation.* London: International Institute for Conservation, 93-95.

Jakobi, G. and A. Löhr. 1987. *Detergents and Textile Washing.* Weinheim, Germany: Wiley-VCH Verlag.

Jönsson, B., B. Lindmann, K. Holmberg, and B. Kronberg. 1998. *Surfactants and Polymers in Aqueous Solution.* New York: John Wiley & Sons.

Kajitani, N. 1987. Conservation Maintenance of Tapestries at the Metropolitan Museum of Art, 1987. *The Conservation* of *Tapestries and Embroideries.* Los Angeles: Getty Conservation Institute, 53-66.

Kaler, E.W. 1994. Basic Surfactant Concepts. *Detergents and Cleaners: A Handbook for Formulators* edited by K.R. Lange. Cincinnati: Hanser/Gardner Publications, 1-28.

Kissa, E. 1981. Mechanisms of Soil Release. *Journal of the Textile Research Institute* 51(7):508-513.

Kissa, E. 1987a. Evaluation of Detergency. *Detergency: Theory and Technology*, edited by W. Gale Cutler and E. Kissa. New York: Marcel Dekker, Inc., 1-89.

Kissa, E. 1987b. Kinetics and Mechanisms of Soiling and Detergency. *Detergency: Theory and Technology*, edited by W. Gale Cutler and E. Kissa. New York: Marcel Dekker, Inc., 193-331.

Lashen, K., F.A. Blankenship, K.A. Booman, and J. Dupré. 1966. Biodegradation Studies on a p, tert.-OCtyl-phenoxypolyethoxyethanol. . *Journal of the American Oil Chemists' Society,* 43(6): 371-376.

Lewis, J. and D. Eastop. 2001. Mixtures of Anionic and Non-ionic Surfactants for Wet-cleaning Historic Textiles: A Preliminary Evaluation with Standard Soiled Wool and Cotton Test Fabrics. *The Conservator* 25: 73-89.

Malle, K-G. 1984. Water Protection in Europe. *Journal of the American Oil Chemists' Society,* 61(2): 302-306.

Martin, A.R. and Fulton P., 1958. *Drycleaning Technology and Theory.* New York: Interscience Publishers, Inc.

Mauser, M. et al. 1969. The Status of Biodegradability Testing of Nonionic Surfactants. *Journal of the American Oil Chemists Society* 46(9): 432-440.

McCutcheon's Volume 1: Emulsifiers and Detergents, North American Edition. 1998. Glen Rock, N.J.: MC Publishing Company.

Merianos, J.J. 2001. Surface Active Agents. *Disinfection, Sterilization, and Preservation* edited by S.S. Block. Philadelphia: Lippincott Williams & Wilkins, 283-320.

Merck Index, 1983. 10th edition. Rahway, NJ: Merck, Inc., #6518 and #6601.

Mukerjee, P. and K.J. Mysels. 1971. *Critical Micelle Concentrations of Aqueous Surfactant Systems, NSRDS-NBS 36* [National Standards Reference Data Service, National Bureau of Standards]. Washington, D.C.: US Government Printing Office.

Nazaroff, W.W., L. G. Salmon, and G.R. Cass. 1990a. Concentration and Fate of Airborne Particles in Museum," *Environmental Sci. Technology,* 24(1):66-77.

Nazaroff, W.W. and G.R. Cass. 1991. Protecting Museum Collections from Soiling due to the Deposition of Airborne Particles. *Atmospheric Environment,* 25(5/6):841-852.

Patterson, H.T. and T. H. Grindstaff. 1977. Soil Release by Textile Surfaces. *Surface Characteristics of Fibers and Textiles* Part II edited by M.J. Schick. New York: Marcel Dekker, Inc. 445-494.

Preston, W. 1948. Some Correlating Principles of Detergent Action. *Journal of Physical and Colloid Chemistry* 52:84-97.

Raney, K.H. 1991. Optimization of Nonionic/Anionic Surfactant Blends for Enhanced Oily Soil Removal. *Journal of the American Oil Chemists Society* 68(7): 525-531.

Raney, K.H. and H.L. Benson. 1990. The Effect of Polar Soil Components on the Phase Inversion Temperature and Optimum Detergency Conditions. *Journal of the American Oil Chemists Society* 67(11): 722-729.

Regulatory Technical Information Center, 1985. Soil Release Finishes for Fibers and Fabrics: A Review of the Literature. Princeton, N.J.: Textile Research Institute, Report No. 21.

Rhee, H. and M.W. Ballard. 1994. "The Chemical Interaction of Surfactants with Fibers, Especially Silk. *The Textile Specialty Group Postprints of the American Institute for* Conservation 3: 28-37.

Rice, J. W. 1966. The Principles of Textile Conservation Science, No. VII: Characteristics of Detergents for Cleaning Historic Textiles. *Textile Museum Journal* 2(1):23-37.

Rice, J.W. 1970. The Principles of Textile Conservation Science, No. XIV: The Alkalies and Alkali Salts. *Textile Museum Journal* 58-61.

Saito Y., T. Sato, and I. Anazawa. 1990. Effects of Molecular Weight Distribution of Nonionic Surfactants on Stability of O/W Emulsions. *Journal* of *American Oil Chemists' Society*. 67(3):145-148.

Sanders, H.L. and J.M. Lambert, 1950. An Approach to a More Realistic Cotton Detergency Test," *Journal of the American Oil Chemists' Society,* 27:153-159.

Smulders, E. 2002. *Laundry Detergents*. Weinhime, Germany: Wiley-VCH Verlag. (Note: this book is almost a verbatim copy of Jakobi & Löhr without reference.)

Stravoudis, C. 1995a. Technical Exchange: Replacement for Triton. *Western Association for Art Conservation Newsletter* 17 (1):10-11.

Tinkham, R. and N. Kerr 2001. Effectiveness of Soil Removal by Two New Nonionic Surfactants, Orvus WA Paste, and Surfactant Blends. *Textile Specialty Group Postprints, American Institute for Conservation* 11:47-57.

Timar-Balazsy, A. and D. Eastop, 1998. *Chemical Principles* of *Textile Conservation.* London: Butterworth-Heinemann.

Weatherburn, A.S. and C.H. Bayley. 1952. The Sorption of Synthetic Surface-Active Compounds by Textile Fibers. *Textile Research Journal* 22: 797-804.

FURTHER READING

Gantz, G.M. 1968. Surfactant Structure and Performance. *American Dyestuff Reporter* 57 (23): 34-41.

Kajitani, N. 1979. The Preservation of Medieval Tapestries. *Acts of Tapestry Symposium November 1976*. San Francisco: Fine Arts Museums of San Francisco, 44-63.

Kissa, E. 1987c. Soil Release. *Detergency: Theory and Technology*, edited by W. Gale Cutler and E. Kissa. New York: Marcel Dekker, Inc., 333-369.

Miller, B. 1977. The Wetting of Fibers. *Surface Characteristics of Fibers and Textiles* Part II edited by M.J.

Schick. New York: Marcel Dekker, Inc. 417-445.

Scott, K. 1972. Private Communication.

Stravoudis, C. 1995b. Health and Safety: The Topic is Estrogenic Chemicals. *Western Association for Art Conservation Newsletter* 17 (1): 9-10.

Stravoudis, C. 2009. Sorting Out Surfactants. *Western Association for Art Conservation Newsletter* 31 (1):18-21.

Triton, Tergitol Specialty Surfactants Reference Chart. 1999. Union Carbide.

Triton X-100: Material Safety Data Sheet 1985 Rohm and Haas.

Triton X-100: Material Safety Data Sheet 1990 Rohm and Haas.

MARY W. BALLARD is the Senior Textiles Conservator at the Museum Conservation Institute, Smithsonian Institution. She received a BA from Wellesley College and an MA from the Institute of Fine Arts, New York University with a Diploma in Conservation in addition to apprenticeship training and course work here and abroad. She is a Fellow of the American Institute for Conservation and of the International Institute for Conservation as well as being a senior member of the American Association of Textile Chemists and Colorists. Address: Museum Conservation Institute, Smithsonian Institution, Museum Support Center, 4210 Silver Hill Road, Suitland, MD 20746. Telephone: 301-238-1210. Fax: 301-238-3709. Email: ballardm@si.edu.

IDENTIFICATION, CHARACTERIZATION & CARE OF MUD-COATED SILKS FROM SOUTHEAST CHINA & SOUTHEAST ASIA

DR. SHU HWA LIN, DR. ABBY LILLETHUN & DR. MARGARET T. ORDOÑEZ

ABSTRACT—Mud-coated silks from Southeastern China and Southeast Asia have received little attention from textile and dress scholars. Three presentations about the black-mud-coated silks from Southeast China and Southeast Asia presented in the Textile Specialty Group session at the 2009 AIC Annual Meeting sought to increase awareness of such silks for purposes of identification, collection, and preservation. Only the luster and drape of these black or black and reddish-brown silks engage casual observers, however, upon study they demonstrate specific techniques resulting in unusual properties. In addition, they may represent cultural meanings that due to rapid changes during the past two hundred years are fading from memory as traditional uses diminish. They apparently are rare in American collections or are present but unrecognized.

In recent years, new versions of mud-coated silks have emerged in Southeastern China, a development suggesting that both old and new variants of mud-coated silks will be included in collections in the future. The panel provided a basis for recognition and study of mud-coated silks through three subtopics: general context of mud-coated silks by Abby Lillethun; structure and physical characteristics of examples from Southeastern China by Shu Hwa Lin; and analysis and care of mud-coated silks by Margaret T. Ordoñez.

IDENTIFICACIÓN, CARACTERIZACIÓN Y CUIDADO DE LAS SEDAS RECUBIERTAS CON BARRO, PROVENIENTES DE CHINA Y DEL SUDESTE DE ASIA. POR SHU HWA LIN, ABBY LILLETHUN Y MARGARET T. ORDOÑEZ: RESUMEN—Las sedas recubiertas con barro, provenientes del Sudeste de China y del Sudeste de Asia han recibido poca atención por parte de los estudiosos de artículos textiles y vestimenta. Tres presentaciones sobre las sedas recubiertas con barro negro, provenientes del Sudeste de China y del Sudeste de Asia, presentadas en la sesión del Grupo Textil de Especialidad de la Asamblea Anual de AIC 2009, trataron de crear una mayor consciencia sobre dichas sedas, a los efectos de su identificación, recolección y preservación. Sólo el brillo y el drapeado de esas sedas negras o negras y marrón rojizas involucró a observadores casuales. Sin embargo, al momento del estudio, demostraron técnicas específicas que resultaron en propiedades poco comunes. Además, pueden representar significados culturales que, debido a los cambios rápidos durante los últimos doscientos años, se desvanecen de la memoria a medida que disminuyen los usos tradicionales. Dichas sedas son, aparentemente, raras en las colecciones americanas o están presentes pero no se las reconoce.

En años recientes, han surgido nuevas versiones de sedas recubiertas con barro en el Sudeste de China, un desarrollo que sugiere que tanto las variantes antiguas y nuevas de estas sedas recubiertas con barro se incluirán en las colecciones en el futuro. El panel proporcionó una base para el reconocimiento y el estudio de las sedas recubiertas con barro, mediante tres subtemas: el contexto general de las sedas recubiertas con barro, por Abby Lillethun, la estructura y las características físicas de ejemplos provenientes del Sudeste de China, por Shu Hwa Lin, y el análisis y cuidado de las sedas recubiertas con barro, por Margaret T. Ordoñez.

1. CONTEXT OF MUD-COATED SILKS FROM SOUTHEASTERN CHINA AND SOUTHEAST ASIA

Textiles colored or patterned with mud originate in several locations (Cardon 2007). This discussion, presented to the Textile Specialty Group, at the 37th Annual AIC Meeting, focuses on black mud-coated woven silks originating in southeastern China, and Cambodia and Thailand in Southeast Asia. A subtropical or tropical riverbed such as the deltas of the Pearl River (Zhū Jiāng, aka as Yue Jiang) in China, the Mekong River in southern Cambodia and Vietnam, and the Chao Phraya River in Thailand provides the requisite black iron-rich mud. These geographic locales also possess the intense sunshine used to bake the mud on the silk cloth.

Dyeing the fabric precedes the mud-coating process. Bi-colored or two-tone silks from southeastern China, called *jiāo-chou* and *xiang-yun-shā* with one black and one reddish-brown side, first are dyed with gambier (*uncaria gambir*) or *ju-liang* root to produce the reddish-brown base color (Cardon 2007; Hy 2006). Research suggests that solid black mud-treated silks from across the region may be dyed initially with indigo. After attaining the desired depth of shade through repeated dyeing and drying, hands or brushes spread the black mud on the dry cloth face. The hot sun bakes the mud in place. The smooth shiny surfaces that distinguish these silks imply a polishing or burnishing step, however, at this time the exact procedures and their timing within the mud-drying process remain unidentified.

1.1 MUD-COATED SILKS IN CHINA

Many names are used for jiāo-chou, a plain weave, and xiang-yun-shā, a leno weave, in Cantonese and in other languages (Hy 2007). For example, 'lacquered silk' and 'gummed silk' refer to their unusual visual characteristics. 'Guangdong silk' and 'Canton silk' refer to the Guangdong Autonomous Region (aka Canton) where these silks were, and still are, primarily made.

The wearing qualities of jiāo-chou and xiang-yun-shā suit the summer climate of the South China Sea coast. A slightly stiff, crisp hand, similar to silk gazar or organza, and resistance to moisture makes them comfortable in a hot, humid climate. Beyond their comfort qualities, they enjoyed a reputation for durability and easy washing. And thus, in the past they were used for everyday dress (Garrett 1987). However, the fabrics were expensive due to the use of high-quality silk, high thread counts, and the lengthy coloration and mud-coating process. Also, tiny symbols woven in the leno structure of traditional xiang-yun-shā contributed to its high cost while also providing cultural value.

Despite their high cost, these cloths have no associations with the Imperial elite class of the Qing Dynasty, which was established by the Manchu in the seventeenth century. Instead, the Han and other ethnicities used mud-treated silks. Across the region the affluent Han merchant class used the expensive cloth as a luxury item (fig. 1). Urban Han in Hong Kong used them for everyday ensembles. The Hakka and Hoklo, Han subgroups, used the fabrics sparingly for trim or in small accessory items. While some rural Han used mud-coated silks for everyday dress, by the mid-twentieth century most people in the region reserved them for special occasions. This shift in practice was also true of so-called 'boat people,' the Jing who live near Hong Kong, and the Tanka who live along the coastal rim of the South China Sea from Macau to Vietnam. Their lifeways upon the water gave them particular appreciation of the cloths' water resistance and durability (fig. 2) (Garrett 1987; Garrett 1994; Garrett 2007).

To date, garments located in collections in the west are few and they probably belonged to Han people. The Victoria and Albert Museum's jacket of 'gummed silk,' dates to between 1920 and 1950 (V&A: FE.78-1995, Garrett Collection: Wilson 2005). A woman's ensemble with black 'gummed silk,' dating to between 1875 and 1900, resides in the collection of the Powerhouse Museum in Sydney, Australia. Of blue glazed cotton and black silk, the ensemble came from a Chinese merchant family that originated in Guangdong (http://www.dhub.org/object/156328&img=13732, 13 October 2009). Two groups of bi-colored silk objects in the Honolulu Academy of Arts Antique Asian Costume Collection and in the University of Hawai'i at Mānoa (UHM) Costume Collection, date from the late-nineteenth to the mid-twentieth centuries and probably belonged to Han people who carried their valued mud-coated silk garments across the Pacific when leaving southeastern China. Other mud-coated silk clothing in US collections includes two women's summer ensembles, each consisting of a jacket and

Figure 1. (left) "The Toilet." The woman's garments are probably mud-coated silk. Her attendants wear other fabrics. Photograph by John Thompson, 1862–1872. John Thompson, *Illustrations of China and its People. A Series of Two Hundred Photographs, with Letterpress Descriptive of the Places and People Represented, Vol 1* (London: S. Low, Marston, Low and Searle: 1873–1874), Plate X.

Figure 2. (right) "Boat Girls." Two young Cantonese females ". . . dressed in modest simplicity." Their garments are probably jiāochou. Photograph by John Thompson, 1862–1872. John Thompson, *Illustrations of China and its People. A Series of Two Hundred Photographs, with Letterpress Descriptive of the Places and People Represented, Vol 1* (London: S. Low, Marston, Low and Searle: 1873–1874), Plate VII.

trousers at the American Museum of Natural History (AMNH). Berthold Laufer (1874–1934) collected them in Shanghai during a three-year (1901–1904) expedition in China for the museum (Note 1).

Following a rebellion and revolution in 1912, the Qing Dynasty's two thousand-year rule of China ended. Antonia Finnane explains that changes in fashionable dress from the late-Qing to the Republican eras reflect the transformations within Chinese social life. While movement toward westernized styles and a more western fashion system occurred, the imperative of Chinese identity also continued to affect dress. The government of the Republic of China negotiated its dual interests in modernization and in lifting pride in Chinese identity in various ways, including through dress. One directive required civil servants attending state ceremonies to wear western-style clothing made from Chinese textiles (Finnane 2008). This move highlighted the importance of textiles to the economy, but also to Chinese identity. Notably, Táng Shàoyí (1859–1938), the Republic of China's first Prime Minister, and Provisional-President Sun Yat-sen (1866–1925) were both from Guangdong, the home of China's silk industry. In addition their own Han identities, China's dominant ethnicity, would make them aware of the cultural significance of mud-coated silks.

Possibly mud-coated silks played a role in the transformation of fashionable dress during the shift to the Republic. A family photograph of the Táng Shàoyí family, ca. 1912 (fig. 3), includes three young women wearing ensembles with the new high-collared jacket style, but not made in the Imperial fashion of light colored silks. Instead, they wear a glossy, very dark fabric. Although the textile cannot be identified from the photograph, its shine and crisp appearance resembles mud-coated silk. The prospect that these young women from a political family rejected the old socio-political structure is clear and suggests they might choose to wear mud-coated silks to demonstrate their Han non-imperial, identities. Thus, the mud-treated silks that were valued by the merchant classes and sub-groups would symbolically represent the new more egalitarian social structure.

Figure 3. Detail of a photograph of Táng Shàoyí and family in Sichuan, c. 1912. The young women wear the fashionable high collared silhouette, three in textiles of very dark silk. J. O. P. Bland, *Recent Events and Present Policies in China* (London: William Heinemann, 1912).

1.2 MUD-COATED SILKS IN SOUTHEAST ASIA

Mud-coated silks from Southeast Asia are not as well understood as those from China. One key in deciphering their use in Southeast Asia is the contiguous coastline of China and Vietnam. Ethnic groups living in areas that cross the Sino-Vietnam border and the boat people of the South China Sea coast, discussed above, have used mud-coated silks. The Tanka (aka Danjia) wore jiāo-chou for its "easy to wash" and "waterproof as well as being cool to wear" qualities (Garrett 1987; Garrett 1994; Garrett 2007). The Jing, who are indigenous to Vietnam, dressed up in xiang-yun-shā and at the beginning of the twenty-first century use it for festival dress (Liao 1981; Ronghui 1992).

Two examples of mud-coated silks made in Southeast Asia are in Lillethun's collection and were examined for this study. These solid black silks possess intense shine, reflecting the name 'lacquered silk' as mentioned in some references to black Asian silks. Collected by Dr. Charles E. Mullin (1890–1953) in 1932, the two examples differ in hand. The pair of trousers (fig. 4), from Bangkok on the Chao Phraya River, drapes like silk bridal satin. Contrasting this heavy drape, the fine, figure-weave textile (fig. 5) from Cambodia has extreme suppleness. Mullin recorded that the Cambodian textile was "finished by hammering" (Note 2). While understanding the creation and use of mud-coated silks in Southeast awaits extensive research, discussion of the characteristics of these examples follows below.

Figure 4. Mud-coated twill-woven pants, collected 1932, Bangkok. Lillethun's collection.

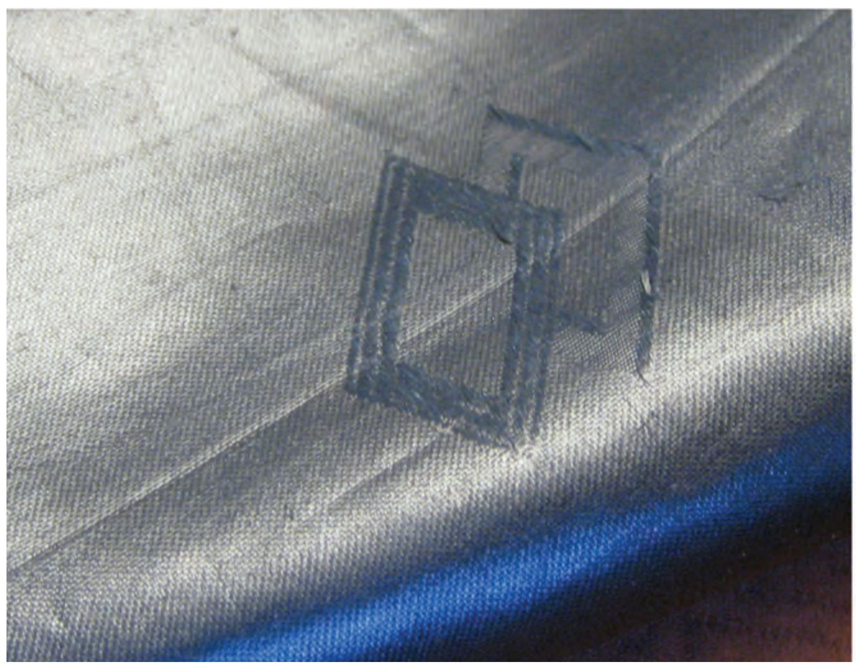


Figure 5. Mud-coated damask with indigo in black dye, collected 1932, Cambodia. Lillethun's collection.

1.3 CONTEMPORARY MUD-COATED SILKS

While mud-coated silks are seldom used in traditional contexts today, new versions emerged in the late-twentieth century for global commercial consumption. Guangdong remains the center of production. Designers specify weaves for their own lines. The new designs, including floral and geometric motifs, often manipulate the bi-colored nature of the silks for visual effect. Some include mechanical stretch.

Even as new designs enter the market, Chinese manufacturers employ the perceived authenticity of jiāo-chou and xiang-yun-shā to maximize sales (*Shenzen Daily*, May 17, 2007). Although the shiny surface attracts the modern consumer, some consumers especially desire to own products made through traditional techniques. This aspect of the textiles' origin fits the early twenty-first century trend toward heritage and authenticity common in luxury branding. The sustainability movement also provides marketers a tool for sales, however assumptions of ecological sustainability and manufacturing safety have not been substantiated.

Garments of mud-coated silk can be found at high and moderate price points. David Tang from Hong Kong was in the first wave of the silk's resurgence, selling his own designs at his Shanghai Tang emporiums (Wilson 2005). In Asia and Europe, several designers incorporate mud-coated silks in their contemporary fashions. Among Americans creating mud-coated silk fashions are two well-known designers, Vivienne Tam and Anna Sui. North American designers selling mud-coated silks in boutiques include Linda Loudermilk, Carol Lee Shanks, Monique Zhang (of Cicada), and Christina Kim (of DOSA). At a lower price point than these sources is Pearl River, a Chinese general store in Soho in Manhattan that sold jiāo-chou and xiang-yun-shā yardage and garments and used their own label in summer 2008.

2. STRUCTURE AND PHYSICAL CHARACTERISTICS OF EXAMPLES FROM SOUTHEASTERN CHINA

This section explores the characteristics of mud-coated two-tone silk fabrics from southeastern China. Historically worn in the summer in the hot, humid climate, they have a glossy black mud-coated finish on the front and a reddish-brown color on the back. The plain-weave cloths are named jiāo-chou, and leno-patterned textiles are called xiang-yun-shā. There are contemporary fabrics as well. Historical Cantonese jiāo-chou and xiang-yun-shā samples and contemporary xiang-yun-shā fabrics were examined for this study. Eighteen examples dating from the late-Qing Dynasty to the early-twentieth century from the Honolulu Academy of Arts Antique Asian Costume Collection and the UMH Costume Collection included eleven jackets, a dress, three ensembles with both jacket and trousers (figs. 6, 7), and three rolls of fabric. Contemporary samples were from the Lin's collection.

Figure 6. Traditional mud-coated silk Chinese-style jacket.

According to Qing Dynasty documents, jiāo-chou and xiang-yun-shā were available as early as the fifth century and were carried to many places by Chinese immigrants as early as the fifteenth century (Chou and Kau 1996). Merchants, wealthy people and their servants wore the costly mud-coated silk fabrics. Their high price probably

Figure 7. A pair of Chinese trousers made of mud-coated silk.

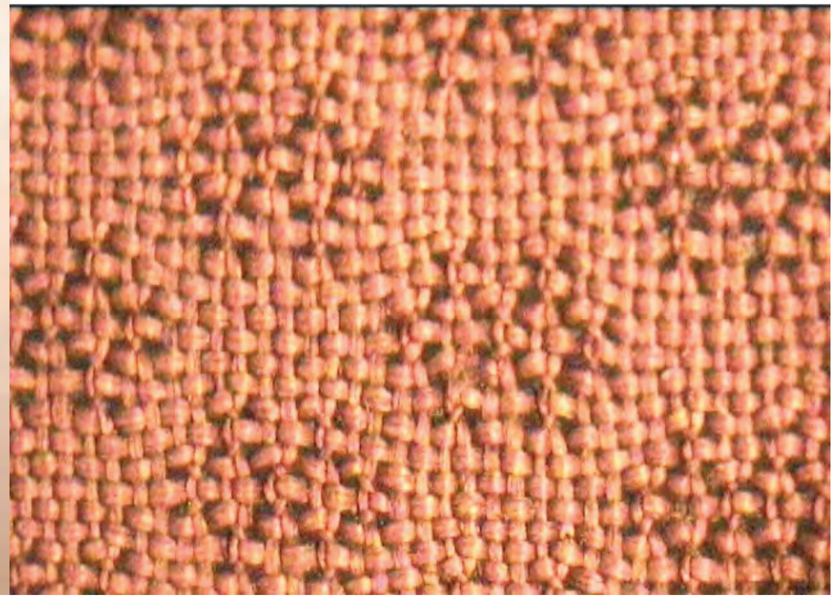


Figure 8. Xiang-yun-shā with circle motifs, UHM Costume Collection.

was related to their limited production possible only during the six months of the year with sufficient sunlight to bake the mud onto the fabrics.

A key characteristic of both jiāo-chou and xiang-yun-shā is their coloration (Chung 2004; Shan-Xi 1990; http://www.ycwb.com 2005); the examples in this study are black on one side and red to dark brown on the other side. A special dye source produces this distinctive color. Dyers dip silk fabric into a solution containing the extract of the ju-liang root, often more than twenty times. The result is the distinctive color and the stiff hand that results from the starch in the root. In an experiment, increased stiffness occurred after one application of ju-liang root dye. After dyeing, one side of the cloth is coated with a layer of iron-containing mud available in the Guangdong Province and then the fabric is laid in the sun for many days. The reverse side retains the brownish dyed color and the mud-coated side is black.

Jiāo-chou and xiang-yun-shā, similar in color and yarn construction—both use simple, single, no twist, multifilament yarns—have different fabric structures. Jiāo-chou is a plain weave while xiang-yun-shā has leno weave patterns. A leno weave is characterized by pairs of dislocated warp yarns that create spaces within the fabric structure. Although both jiāo-chou and xiang-yun-shā textiles are relatively light, thin fabrics, their thread counts are high (up to 144 x 134 ysi), supporting the assumption that they are high quality textiles. Fabric counts for jiāo-chou are higher than its leno-weave companion, which are as low as 85 x 88 ysi. This high fabric count in a plain weave does not allow air to pass through the fabric easily. The air permeability of the lower fabric-count leno weaves is much higher, indicating that comfort in a warm humid climate also would be greater. In the Chinese culture motifs play an important role in design due to the abundant meanings behind the different symbols. The various leno-weave patterns in the historic xiang-yun-shā textiles studied include circles (fig.

8), squares (fig. 9), diamonds or lozenges (fig. 10), bamboo basket weave or *manji* (fig. 11), and lattice patterns or wan-zi (fig. 12). Ancient Chinese textile designs often included diamonds. The most frequent pattern in the examples studied was the lattice. These five traditional designs have cultural significance, however, the patterns in the five contemporary examples examined are geometric and floral designs without traditional meaning (figs. 13–15). These contemporary mud-coated fabrics have a lighter coating of mud resulting in a much softer hand than historic Chinese mud-coated fabrics.

Figure 9. Xiang-yun-shā with square motifs,
UHM Costume Collection.

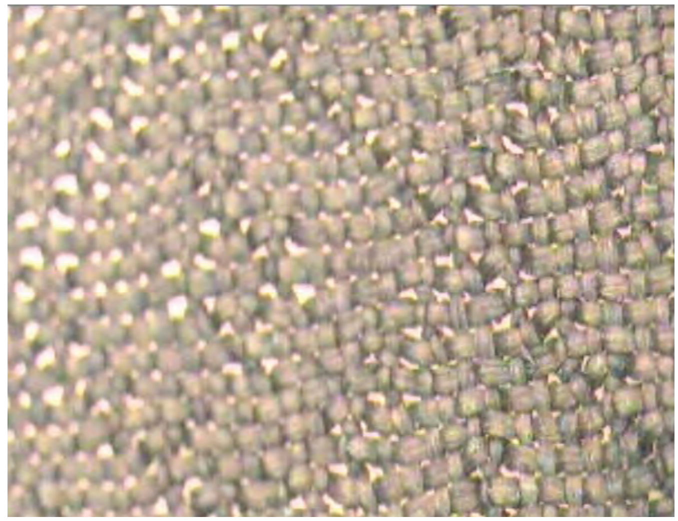


Figure 10. Xiang-yun-shā with diamond motifs,
UHM Costume Collection.

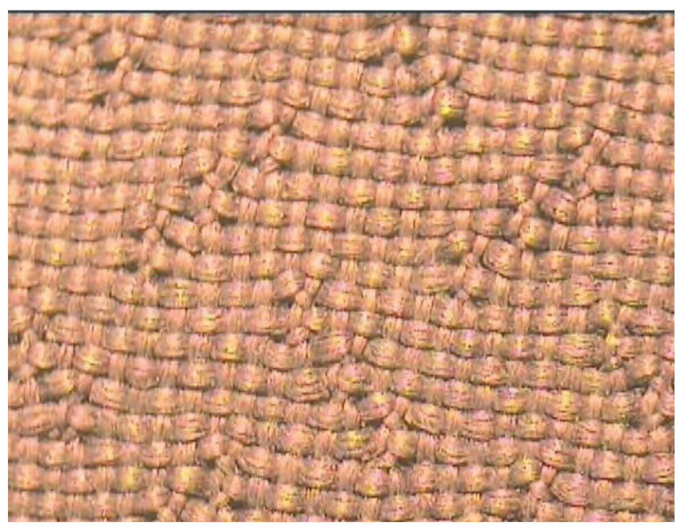


Figure 11. Xiang-yun-shā with manji motifs,
UHM Costume Collection.

3. ANALYSIS AND CARE OF MUD-COATED SILKS

Broadening the scope of fabrics beyond those in Hawaiian collections reveals that mud-coated fabrics also can be black on the back side. The dyes that produce the black color have not been identified yet in this study except that, as the literature suggests, some include indigo (fig. 5). This totally black silk damask from Cambodia collected by Mullen in 1932, tested positive for indigo and also has the requisite glossy black surface, but drapes much more than the typical jiāo-chou and xiang-yun-shā. It is a plain weave with a pattern created by warp

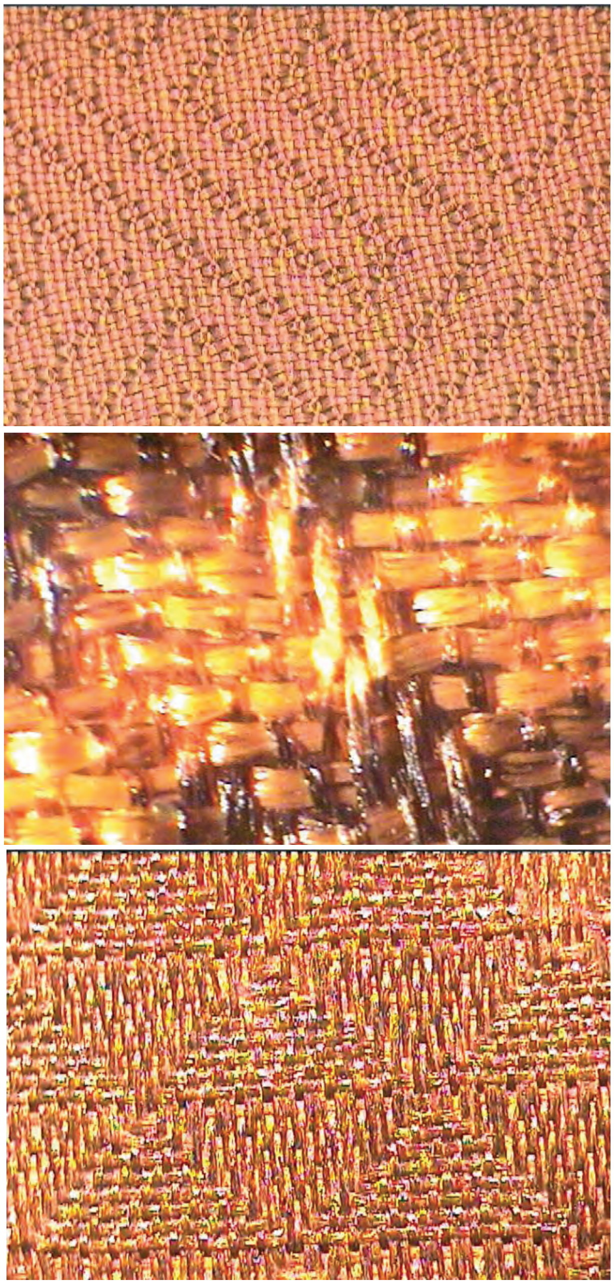
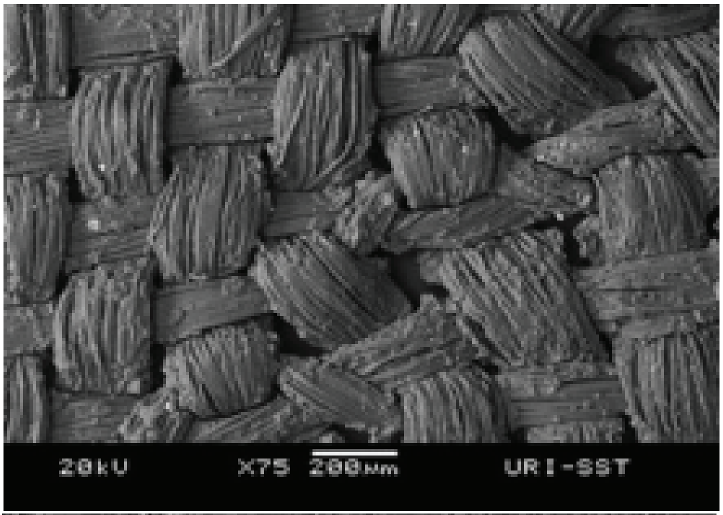


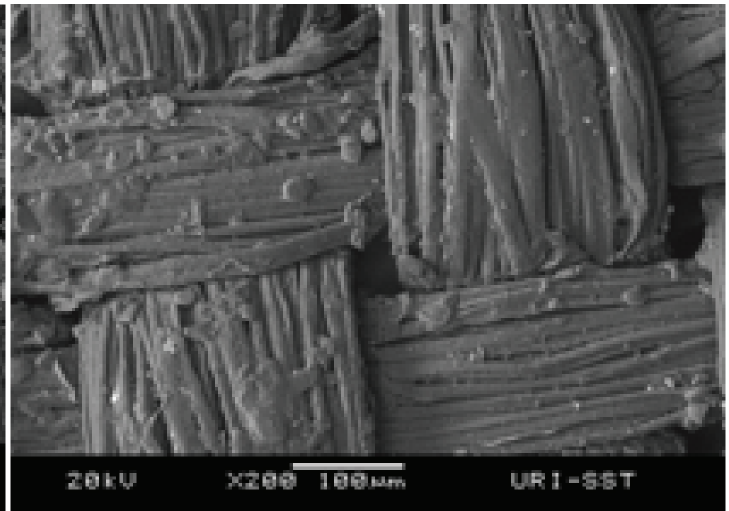
Figure 12 (upper). Xiang-yun-shā with wan-zi, lattice or maze-like motifs, UHM Costume Collection. Figure 13 (middle). Contemporary xiang-yun-shā fabric. Lin's collection. Figure 14 (lower). Contemporary xiang-yun-shā fabric, Lin's collection.

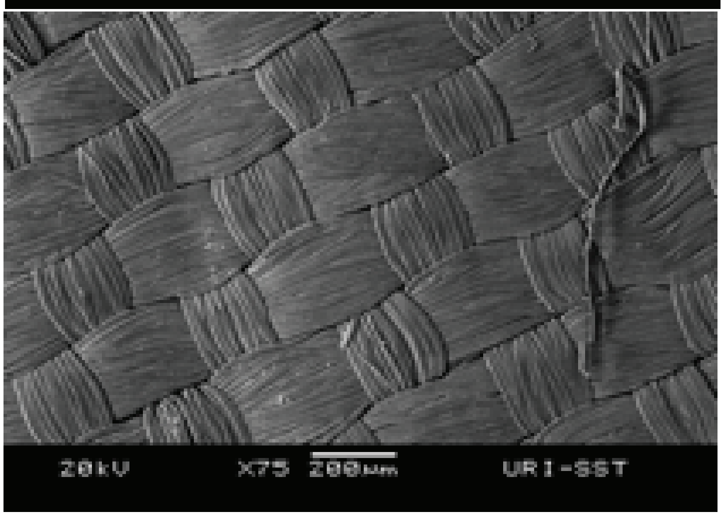
Figure 15. Contemporary xiang-yun-shā jacket.

floats. Besides having a different fabric structure, it has a lighter layer of mud than the traditional Chinese coated silks (figs. 16–19) and none of the stiffness associated with ju-liang root dyeing.

Another 1930s all-black fabric makes up a pair of pants collected in Thailand by Mullen (figs. 4, 20). This textile did not test positive for indigo. The warp-faced twill-weave fabric of the 1930s pants in figure 4 is heavier and stiffer than the patterned damask cloth also from the 1930s. The mud coating on the warp-faced twill-weave of the pants obscures the individual filaments in the yarns.







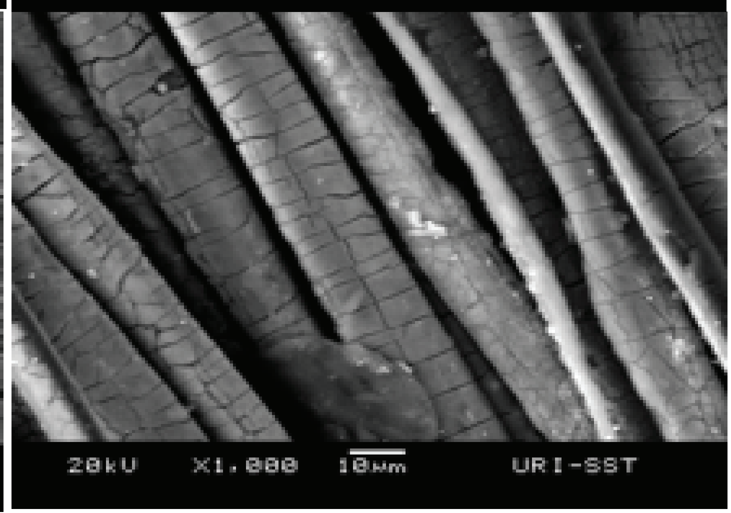
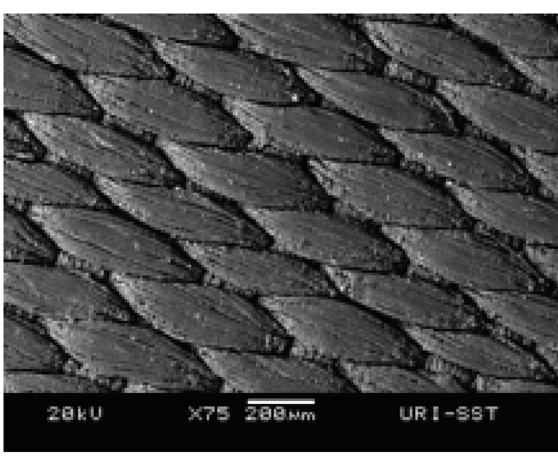


Figure 16 (top left). Surface of traditional xiang-yun-shā. Figure 17 (top right). Close-up of mud coating on xiang-yun-shā yarns. Figure 18 (bottom left). Surface of plain-weave ground of slinky damask. Figure 19 (bottom right). Close-up of mud coating on silk filaments in damask.



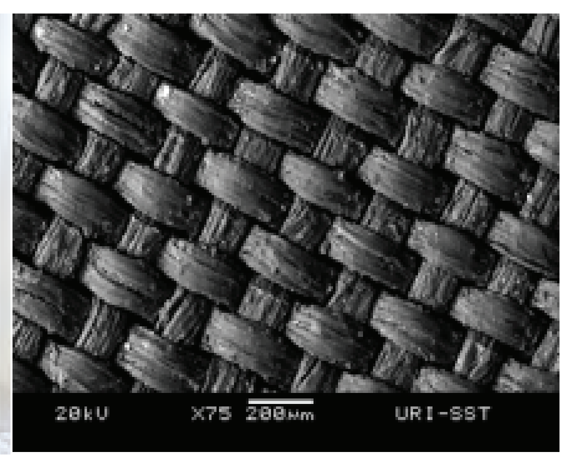



Figure 20 (left). Mud-coated 4/1 twill fabric in 1932 pants. Figure 21 (middle). Mud-coated plain-woven pants (purchased 2008). Lillethun's collection. Figure 22 (right). Mud-coated plain-weave fabric in 2008 pants.

The pant fabric has had starch added after the garment was made. A starch deposit lays along the edge of the seam allowances inside the pant legs. The mud-coated fabric of a contemporary pair of pants from the Pearl River store (purchased 2008) (figs. 21, 22) has an entirely different look from the two 1930s examples, but a heavy mud coating is obvious. Electron dispersive spectroscopy (EDS) on both pairs of pants, one from the 1930s and one contemporary, confirms that the mud contains a high amount of iron (Fe) along with silicon (Si), calcium (Ca), potassium (K), and aluminum (Al), which usually occur in soil. That any components of the mud react with the fiber or dyes while the fabric bakes in the sun has not been confirmed.

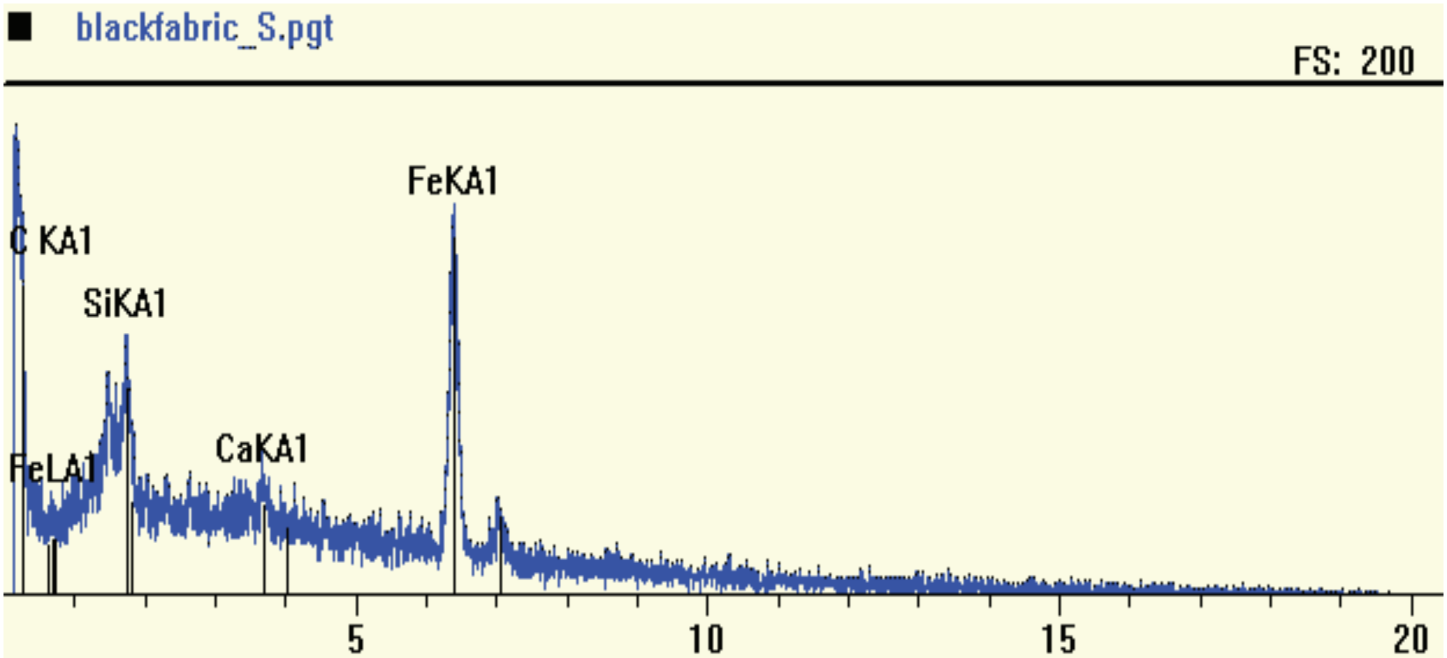
The mud coating on woven silk fabrics creates a hard-wearing, durable finish that, despite the cracks along the edges of the yarns, is virtually water proof. Drops of water on the mud surface retain their spherical shape for hours. The spaces in xiang-yun-shā allow liquid water to pass through, but without wetting the fabric.
So, how should the mud-coated silk fabrics be stored and cleaned? Are they cleanable? Owners of the new high-end boutique garments want to know; collectors and conservators may need care information. Contemporary care labels, when they exist, recommend dry cleaning. Older garments and those from other markets do not have care labels. Of course, sewing in a "Dry Clean Only" label does not ensure that the manufacturer actually tested the fabric for that treatment. One boutique owner recommended washing a garment in tea—no detergent action there.

Figure 23. Underarm area of jacket showing tides marks and mud loss.

Figure 24. Dyed silk filaments exposed where mud is lost on jacket.

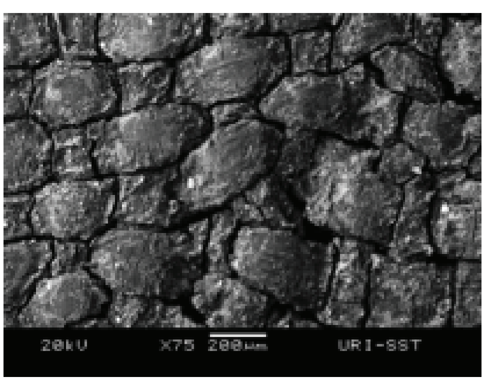
Treating a much-worn traditional jiāo-chou robe provided useful information (figs. 6, 23). From Lin's collection, the Mandarin-style robe had faint white tide lines in the back, typical of perspiration. White deposits on the front and lower sleeves could have been food. The mud coating had remained intact except along opening edges, seams, and the fabric buttons where abrasion exposed the red-orange silk filaments (fig. 24). An EDS analysis revealed the usual components of the iron-rich mud (fig. 25). SEM scans show a rather dirty surface (figs. 26, 27).

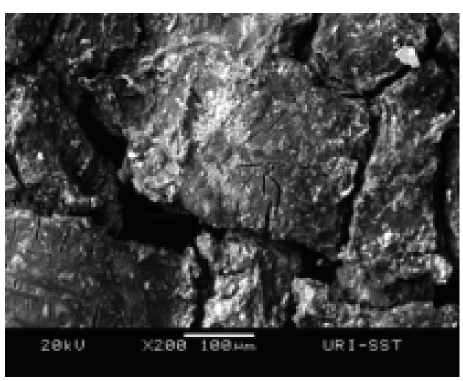
Using typical conservation techniques and a 0.2% anionic and nonionic surfactant solution at room temperature, Lin and Ordoñez wet cleaned the robe using only hand-tamping. The un-mordanted dye bled in both wash and rinse baths, as expected, but ultimately, no change in the interior color was obvious to the naked eye, although spectrophotometer readings would have measured differences more precisely. The perspiration tide lines lessened, but not the caked-on food. Pretreatment, perhaps under a microscope, might address removal of such



Element	Line	keV	KRatio	Wt%	At%	At Prop	ChiSquared
C	KA1	0.282	0.2304	68.52	90.46	24.0	14.28
Si	KA1	1.740	0.0094	1.66	0.94	0.2	0.45
Fe	KA1	6.403	0.2171	28.57	8.11	2.2	0.36
Ca	KA1	3.691	0.0101	1.25	0.50	0.1	0.34
Total			**0.4670**	**100.00**	**100.00**	**26.5**	**0.25**

Figure 25. EDS spectrum: sampling outer surface of jacket.





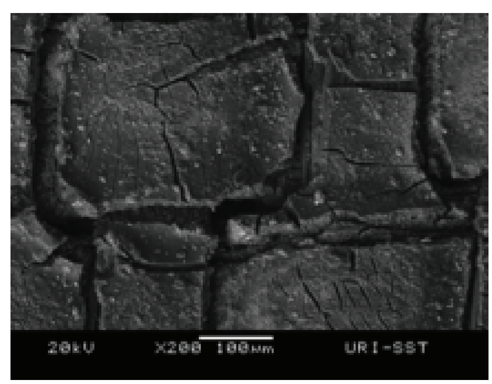


Figure 26 (left). Soiled surface of Chinese-style jacket. Figure 27 (middle). Close-up of surface before cleaning. Figure 28 (right). Close-up of surface after wet cleaning.

deposits. No fiber damage was visible. Also amazing, only a minute amount of solid material that could have been identified as mud coating showed up in any of the baths. The wet cleaning treatment removed noticeable amounts of soil from the fabrics (fig. 28). The fabric had wrinkles and creases that wet cleaning and steaming did not diminish. A steam iron and a pressing cloth on the back side of the fabric where silk yarns are more exposed than on mud-coated surface lessened creasing. This wrinkling suggests that mud-coated fabrics and garments should be stored with as few folds as possible.These results provide no basis for rejecting wet cleaning as a method of cleaning mud-coated fabrics. This technique most likely would be more gentle than commercial dry cleaning in a solvent, tumbling, and heating to evaporate the solvent, which would not remove water-based soils such as perspiration as well as water.

4. CONCLUSION

The three presenters aimed to provide information that could help those who work with collections identify and care for mud-coated silks. Their goal was partially met at the Textile Specialty Group meeting when several people commented that they had some fabric or garments made of mud-coated silk and now knew what they had. Hopefully, this recognition and knowledge will continue to spread.

NOTES

1. A solid black mud-coated silk ensemble: Jacket: Woman's Dress, Catalog No. 70/2341, Acces. No. 1901-69, Field No. 80; Trousers: Catalog No. 70/2342, Acces. No. 1901-69, Field No. 81. A jacket of open-weave black mud-coated silk with a blue silk underlay and matching blue silk trousers: Summer Dress, Catalog No. 70/2343, Acces. No. 1901-69, Field No. 82; Trousers: Catalog No. 70/2344, Acces. No. 1901-69, Field No. 83. Division of Anthropology, The Asian Ethnographic Collection, Berthold Laufer Collection, American Museum of Natural History.

2. The Mullin textiles and notes discussed here are in Abby Lillethun's collection.

REFERENCES

Cardon, Dominique. "Iron Mordants" in *Natural Dyes*. London: Archtype Publications, Ltd., 2007.

Chou, S. and S. M. Kau, *Chinese Clothing, Cap, and Gown Dictionary*. Shang-Hi: Shang-Hi, China, 1996.

Chung, Y. S. (2004). *Chinese Traditional Textiles and Dyed Material*s 3rd ed. Retrieved http://www.tdctrade.com/mne/chinese/chinatrade/textiles009c.htm, (Feb. 2, 2005).

D*Hub: Your Online Design Resource. "97/167/2 Outfit (*aoku*), women's, jacket and trousers, glazed cotton/gummed silk/linen, Hong Kong, 1875–1900." Powerhouse Museum, http://www.dhub.org/object/156328&img=13732, (June 2, 2009).

Finnane, Antonia. *Changing Clothes in China: Fashion, History, Nation*. New York: Columbia University Press, 2008.

Garrett, Valery. *Traditional Chinese Clothing in Hong Kong and South China* (Oxford: Oxford University Press, 1987.

Garrett, Valery. *Chinese Clothing: An Illustrated Guide*. Hong Kong, Oxford: Oxford University Press, 1994.

Garrett, Valery. *Chinese Dress: From the Qing Dynasty to the Present*. Tokyo: Tuttle Publishing, 2007.

Hy, Bonnie Tchien. *Hei Jiao Chou, La Soie Gommée Noire, ou Xiang Yun Sha, Toile de Soie aux Nuages Perfumés,* www.misschina.tm.fr: 2006 (June 20, 2007).

Liao, Ch'eng-chih ed., *Costumes of the Minority Peoples of China/Chung-kuo shau shu min tsu fu shih*. China: Chung-kuo jen min mei shu ch'u pan she, 1981.

Ronghui, Wei, ed. *The Chinese National Culture of Costume and Adornment*. Beijing: China Textile Press/Fang zhi gong y, 1992.

Shan-Xi, Li. *Chinese Costume Dictionary*. Shan Xi, China: Shan Xi People Publish, 1990.

Shenzen Daily. "Silk Fabric Gets Better With Age," May 17, 2007, http://paper.sznews.com/szdaily/20070517/ca2665914.htm, (November 25, 2008).

Young Cheng Evening News, "Xiang-yun-shā," http://www.ycwb.com (written in Chinese), (March 23, 2005).

Wilson, Verity. *Chinese Textiles*. Victoria & Albert Museum, Far Eastern Series, London: V&A Publications, 2005.

DR. SHU HWA LIN, Assistant Professor at the University of Hawai'i, Mānoa, teaches textile science and apparel production data management courses in the Family and Consumer Sciences Department. She received her PhD from Florida State University. Her research centers on Chinese textiles and clothing for people with special needs. She recently developed a video on Chinese imperial robes, the first in a series on Qing Dynasty garments and accessories. E-mail: LinS@ctahr.hawaii.edu.

DR. ABBY LILLETHUN, Associate Professor at Montclair State University, teaches in the Department of Art and Design. Her current research topics are dress in the Aegean Bronze Age and 20th-century cross-cultural exchange from Asia to western textiles and dress. She is coeditor with Dr. Linda Welters of *The Fashion Reader*, which will soon be out in a second edition. E-mail: lillethuna@mail.montclair.edu.

DR. MARGARET T. ORDOÑEZ, Professor at the University of Rhode Island, teaches textile conservation, historic textiles, history of western dress, and textile science courses in the graduate program offered by the Textiles, Fashion Merchandising and Design Department. Her research involves textile conservation, historic textiles, and archaeological textiles from 17th-century southern New England; 5th-century Copán, Honduras; and 18th- and 19th-century Iceland. E-mail: mordonez@mail.uri.edu.

REMOVAL OF SOME OLD RESINS FROM ANCIENT PILE-TEXTILES: AN APPLIED STUDY ON A TURKISH RUG

DR. MOHAMED MAROUF & MEDHAT SABER

ABSTRACT—Animal glue is considered one of the most important natural glues and was used for many purposes, especially for strengthening fragile objects including archaeological textiles, either as an adhesive, a consolidant, or as a supporting layer. Animal glue turns the treated textile into a rigid, fragile, discolored and opaque material. Many investigative and analytical methods were applied to record the degradation affects; i.e. SEM-XRF, Binocular and light microscopy. The main objective of this research, presented at the Textile Specialty Group session at the 2009 AIC Annual Meeting, is to detect the aspects of harmful effects as well as the best methods to remove the old glue without damaging the textile substrate including the fibers and dyes. The availability of the Turkish rug as a case study facilitated the publication of this research. Use of dimethyl formamide (DMF) as an organic solvent, a surfactant Orvus WA 1% (as a detergent) and sodium carboxymethyl cellulose (SCMC) 1% (as a sequestering agent) resulted in the successful separation of the aged, cross-linked animal glue.

ELIMINACIÓN DE VIEJAS RESINAS DE ARTÍCULOS TEXTILES DE PILA ANTIGUOS: UN ESTUDIO APLICADO A UNA ALFOMBRA TURCA. POR MOHAMED MAROUF, PHD Y MEDHAT SABER: RESUMEN—El pegamento animal está considerado como uno de los pegamentos naturales más importantes y fue utilizado para diversos propósitos, especialmente para el fortalecimiento de objetos débiles, que incluyen artículos textiles arqueológicos, ya sea como adhesivo, consolidante o como una capa de soporte. El pegamento animal convierte al artículo textil tratado en un material rígido, frágil, descolorido y opaco. Se aplicaron diversos métodos de investigación y analíticos para registrar los efectos de la degradación, es decir, SEM-XRF, microscopía binocular y óptica. El principal objetivo de esta investigación, presentado en la sesión del Grupo Textil de Especialidad en la Asamblea Anual de AIC 2009, es detectar los aspectos de los efectos nocivos así como también los mejores métodos para eliminar el pegamento antiguo sin dañar el sustrato textil, que incluye las fibras y las tinturas. La disponibilidad de la alfombra turca como un caso de estudio, facilitó la publicación de esta investigación. El uso de formamida dimetil (DMF, por sus siglas en inglés) como solvente orgánico, un tensoactivo, Orvus WA 1% (como detergente) y celulosa carboximetil sódica (SCMC, por sus siglas en inglés) 1% (como agente aislante) resultó un la separación exitosa del antiguo pegamento animal de unión cruzada.

1. INTRODUCTION

Natural resins such as animal glue, casein, starch, gum Arabic, and gelatin can often be found on old textiles. These resins were used for many purposes in the conservation of archaeological textiles such as a consolidant, adhesive, support, and as a display and storage material. Although the natural resins have several advantages such as simple application, reversibility, control in viscosity degree, and activation with water, they also have some disadvantages, for example, rapid degradation and instability. In addition, there is a lack of knowledge about the possible interactions of these polymers with the substrate (Hansen 1990). Natural resins are susceptible to many physical and chemical changes many years after application on a textile, or even after a short time according to the type of resin, the application method, and the environmental conditions e.g. (light, temperature, air pollution, and relative humidity. In addition, resins can be susceptible to microbiological attack. These changes depend on the molecular structure of the resin, absorbed photon energy and chemical /physical effects of the added materials and can take several forms such as rigidity, shrinkage, brittleness, enzymatic breakdown and yellowing. Furthermore, flexibility and tensile strength are decreased and the pH value of the substrate can change. This article presented to the Textile Specialty Group, at the 37th Annual AIC Meeting will address the degradation aspects of the resins and determine a conservation method to remove the old glue from the rug, and the pile layers especially, previously treated with natural resins.

2. THE SCIENTIFIC DOCUMENTATION OF THE TURKISH RUG

The Turkish rugs are considered one of the most important parts of the archaeological Textiles at the Al Jazera (Civilization) museum in Cairo, Egypt. The Turkish rug that has been chosen for this applied study was examined in order to identify weave structure, type of used knots and number of warp and weft threads as shown in table 1 and figure 1. The rug was treated in the past by using animal glue as an adhesive and cotton fabric as a support layer.

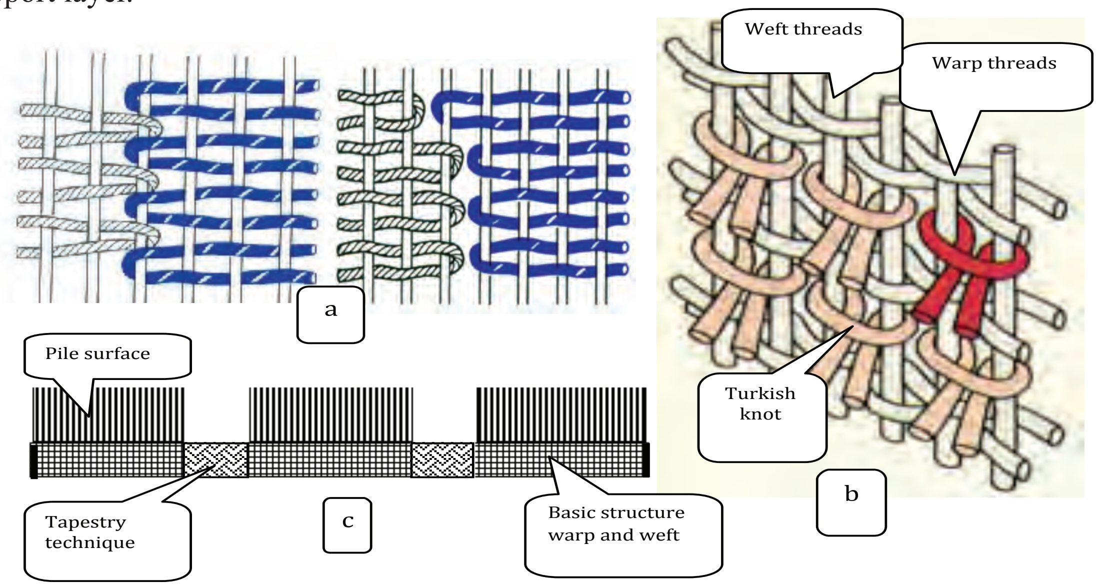


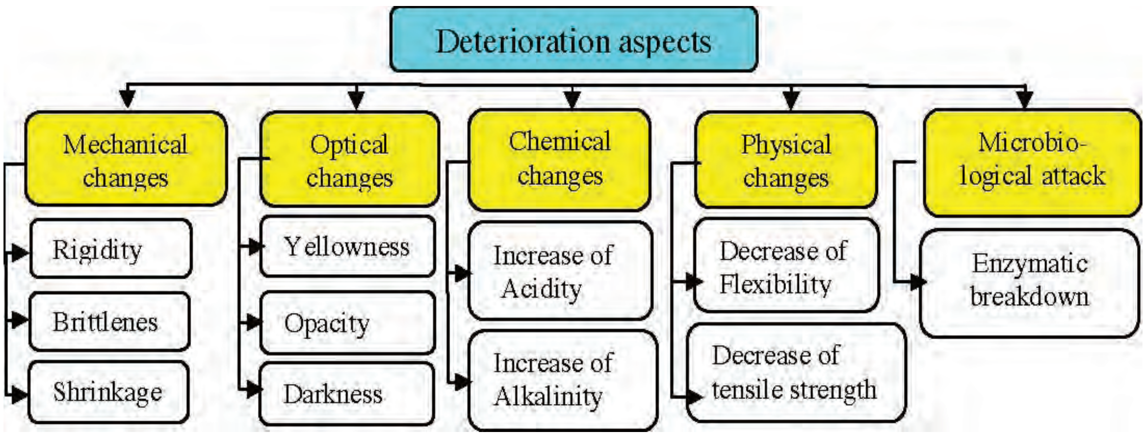
Figure 1. Weave structure of the Turkish rug: a) tapestry technique used in the texts and arabesque decorations, b) weave structure of the knotted pile, c) cross section of the Turkish rug.

Description	Data
Date	16^{th} Century
Dimension	160 x 106 cm
Design	Turkish prayer rug (Mostafa 1953)
Fibers	Wool for pile; cotton for warp and weft threads (Perry 1985)
Weave structure	Knotted pile; tapestry technique for the decoration (Black 1994)
Type of knots	Turkish knot or *Ghiordes* knot (Allane 1995); see figure 1
Number of knots	Knots/cm2 = 100 knots
Number of warps	Warp threads/cm = 20 threads
Number of wefts	Weft thread among every two rows of knots = 2 threads
Decoration	Arabesque motifs and texts from the *holy Qur'an*; Islamic arch (*Al Mehrab*) – see figure 2
Colors	Eight colors
Museum (owner)	The civilization (*Al Jazera*) museum in Cairo
Previous Treatment	The rug was treated in the past by using animal glue as an adhesive and cotton fabric as a support layer see figures 3 and 4

Table 1. Description details of the Turkish rug.

3. DIAGNOSIS OF THE DEGRADATION ASPECTS OF THE GLUE

Rigidity, brittleness, cleavage, yellowness, and decrease of flexibility of the weave structure, while shrinkage, opacity, breakdown and immigration of the glue adhesive, these are mainly observed degradation aspects of the Turkish rug previously treated with animal glue. These aspects can be divided to the following categories:



3.1 MOVEMENT OF THE GLUE ADHESIVE

The glue adhesive emigrated from its place as an adhesive for the support layer behind the rug to the pile surface due to exposure to high temperature and light during museum exhibition. This emigration occurred unevenly over the area of the rug in about 30 areas on the rug surface (fig. 2), causing an agglomeration in the stiff grains of glue among the fibers in the pile surface, covering about 28% of the total area of the rug (figs. 2-4).

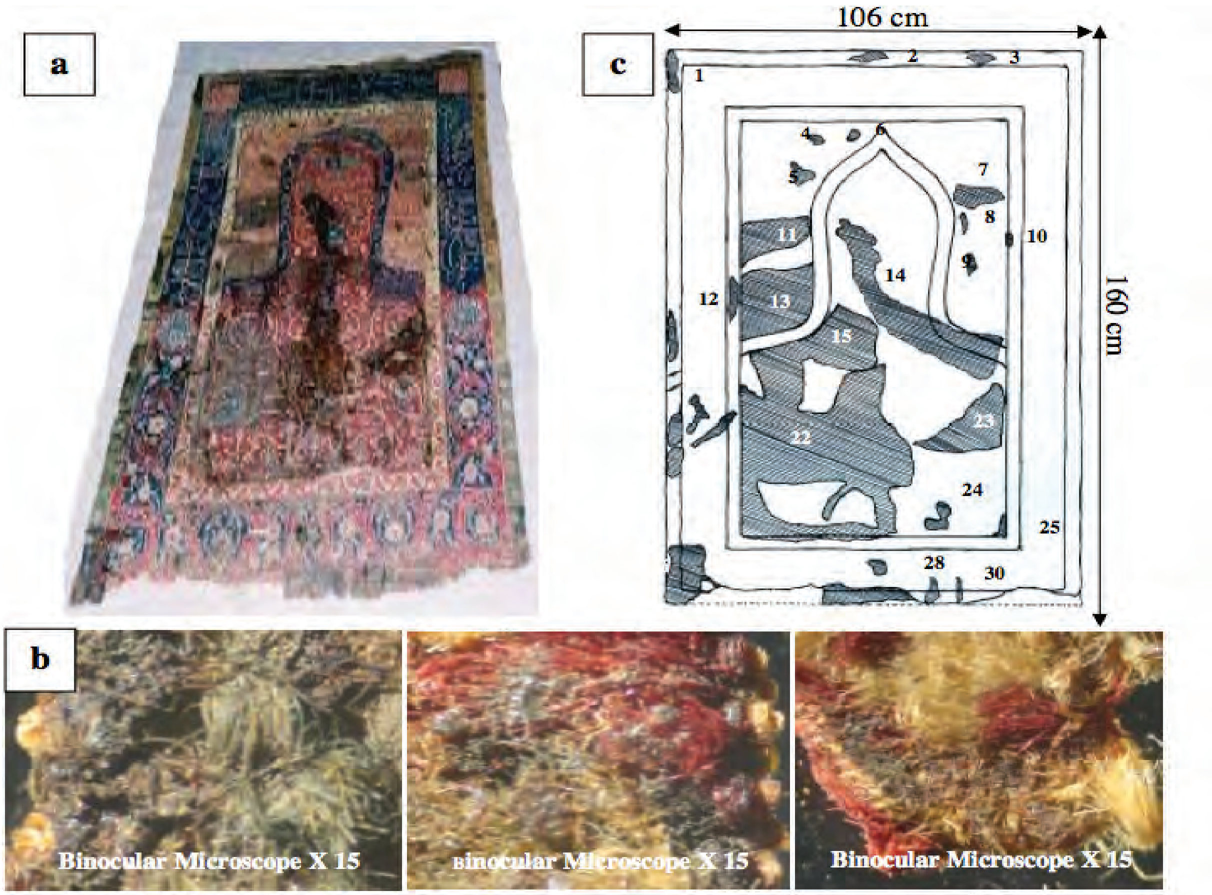


Figure 2. a) glue penetrated from the back to the pile surface, b) binocular microscope images show migration of old glue to the pile surface and showing as stiff black spots in some areas, c) diagram showing areas that were affected by the penetration of the glue.

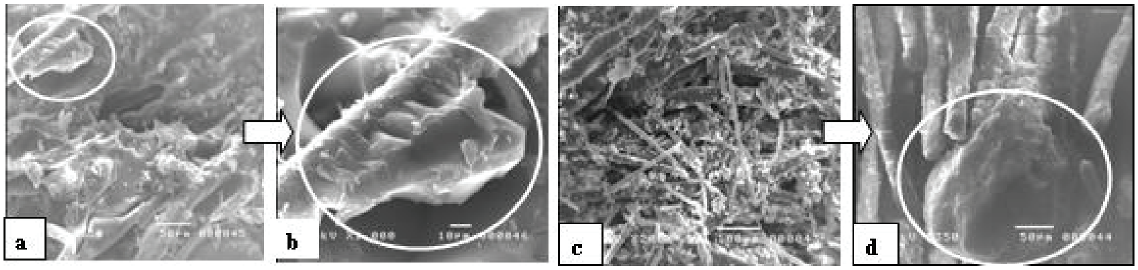


Figure 3. SEM images show adhesion of the glue with pile threads after it emigrated from back to the pile surface. Note the grains of the glue agglomerated in the pile threads.

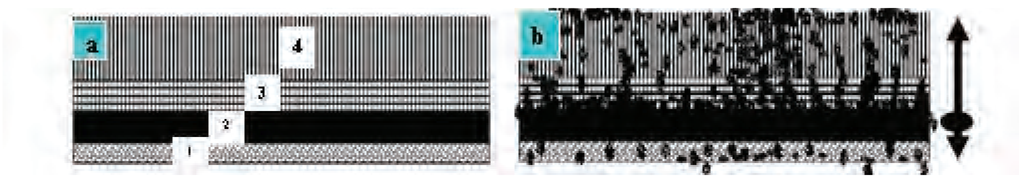


Figure 4. a) The principal components of the treated rug: 1-support layer, 2- animal glue, 3- the ground layer (warp & weft), 4- the pile surface. b) emigration direction of the old glue from the back to the pile surface.

3.2 DECREASE OF FLEXIBILITY AND TENSILE STRENGTH OF THE WEAVE STRUCTURE.

Several changes occurred in the physical properties of both the applied glue and the textile structure; e.g. decrease of flexibility and tensile strength (fig. 4). Furthermore, changes occurred in the optical properties; for example, yellowness, and opacity due to exposure to air pollution, photochemical reactions, high temperatures and relative humidity. These changes were especially evident in the glue as it penetrated from the back of the rug to the pile surface (fig. 5). This damage occurred in the glue because it formed additional cross-linking which hardened the resin. Also, the glue contains "large numbers of carbonyl groups and double bonds, so it absorbs in the near ultraviolet and can yellow over time" (Schaeffer 2001: 66). The glue used in this rug became susceptible to enzymatic breakdown by microbiological attack (fungi and bacteria) (fig. 6).

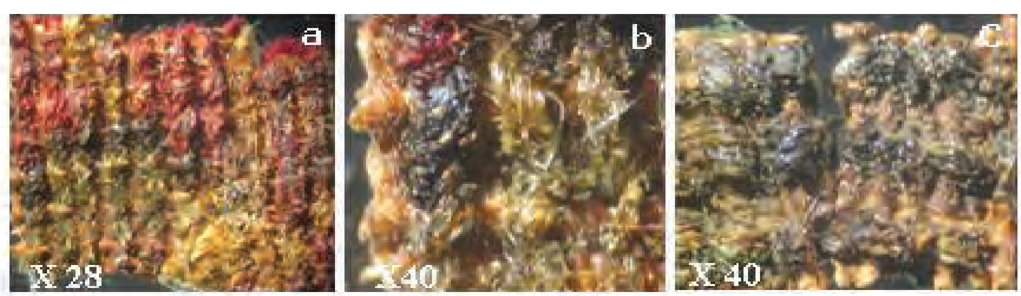


Figure 5. Binocular microscope images show yellowness, opacity and rigidity of the weave structure on the back of the rug.

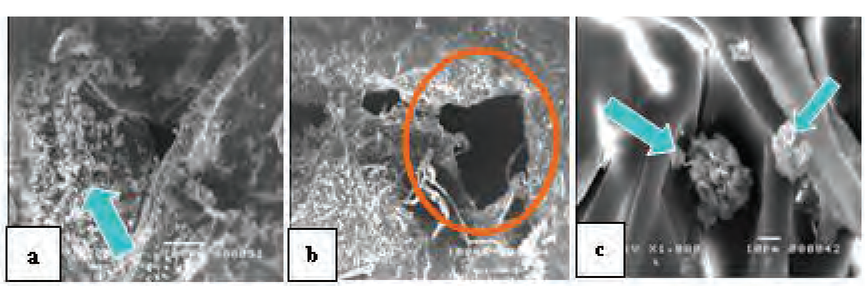


Figure 6. SEM images show the glue which was infected by microorganisms, especially in the hollows and degraded areas.

3.3 MECHANISM OF DECAY OF ADHESIVE

Due to the instability of the adhesive, it was exposed to several hydrolytic, thermal and photochemical reactions. These reactions lead to decay and breakdown of the glue layer in several forms: shrinkage, cleavage and separation of the fibers or the weave structure (fig. 7). Then, "degradation of the polymer become autocatalytic, that is, the products of breakdown tend to catalyze at a faster and more extensive rate of degradation than the primary processes. One of the first products of thermal deterioration, even under mild conditions, the adhesive is very reactive, highly toxic oxidizing agent NO2" (Shashoua 1992, 114), an air pollutant. So the polymer became susceptible to increased acidity effects. Furthermore, the reorganization of the polymer chain in the adhesive layer continues steadily even under ambient conditions. "If the relative humidity or the temperature fluctuates, the shrinkage and expansion of the chains follow these changes, causing tension in the adhesive film. This can lead to cracking and crazing on the adhesive surface. These processes explain the cracking and crazing, rigidity and brittleness of some textiles treated with animal glue as a sizing, ground or adhesive. The hard, solid animal glue may result in damage to the fibers which it has been applied to" (Timar-Blazasy & Eastop 1998: 121).

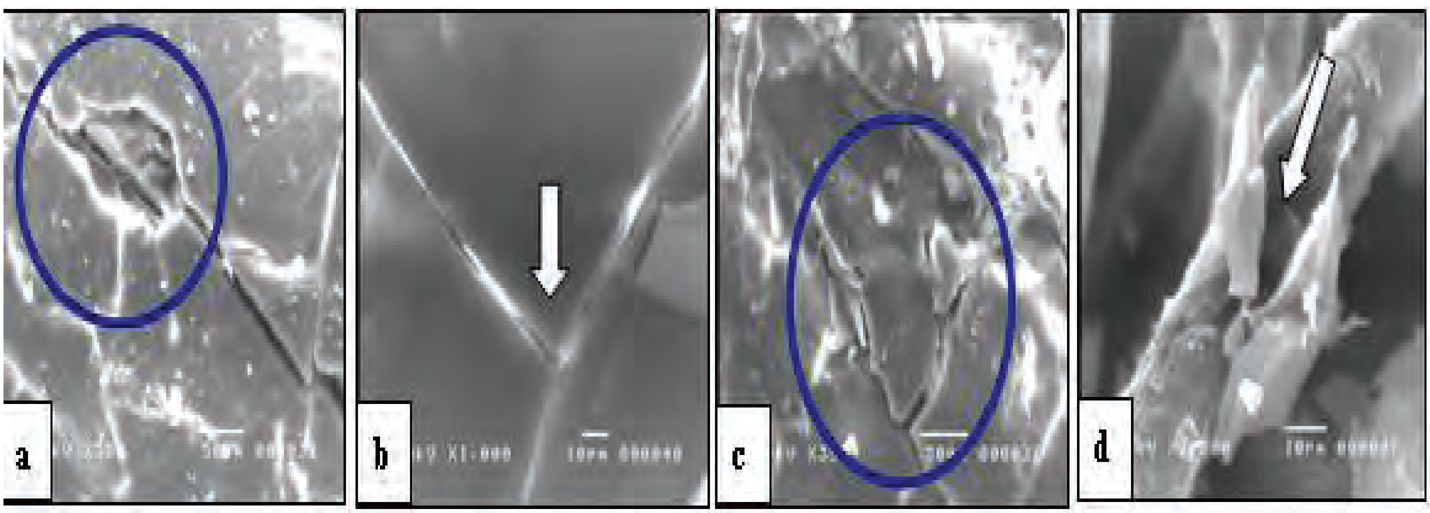


Figure 7. SEM images show degradation aspects of the old glue as a direct result of hydrolytic, thermal and photochemical reactions.

4. CHEMICAL AND PHYSICAL PROPERTIES OF ANIMAL GLUE

There are many types of animal glue such as skins glues, derived from cattle, sheep hides, and rabbit skin, bone glues, derived from most farm animals, and fish glues (i.e. isinglass). "These types are made up of proteins (polyamides), principally collagen, with many other components. Collagen molecules are held to each other by a few covalent and many hydrogen bonds. The molecules are partly hydrolyzed on heating in water to produce a soluble product with a molecular weight in the range 20,000- 250,000. The minimum amount of swelling occurs around pH 4.8. The gel will melt on heating, about 30-50°C for animal glues. Gelatine is soluble in few solvents at room temperature, e.g. 2,2,2-trifluoroethanol, and formamide. Water, glacial acetic acid, ethane-1,2-diol and dimethyl sulphoxide require heating. Gelatine can be insolubilized by reacting it with trivalent metal ions, tannins or aldehydes. It is degraded rapidly in acid (pH<3) or alkaline (pH>9) conditions and by enzymes" (Horie 1987: 142-43).

"Extreme heat destroys the whole glue material. In water, the hydrophobic side groups of glutine chains try to turn into the inner side of the protein chains pressing out of the water. At the same time, the polar hydrophilic side groups on the outside of the chains bond considerable numbers of water molecules by secondary hydrogen bonds. As the water evaporates during film formation the tensions caused by the hydrophobic side groups decrease, so the chains tend to take their more normal position, while the polar side groups still keep the bound water in equilibrium with the environmental humidity. If film formation is carried out at a temperature above the Tg of the animal glue, the polymer chain segments take the place of the evaporating water molecules and form an even film. First a gel is formed, which then solidifies to form a solid film" (Timar-Blazasy & Eastop 1998: 120).

5. ANALYSIS

The samples were analyzed by using X-ray fluorescence (XRF) with attached scanning electron microscope (SEM) for the identification of found elements on fibers and glue adhesive before and after the removal and washing processes. The sample sizes varied from single fibers to bundles and to 25mm square patches. All of the samples were mounted on cupper stubs with spectroscopically pure gold paint, coated with 10-20nm of spectroscopically pure gold in a vacuum evaporator, and viewed at 20 or 30keV in a SEM with attached energy X-ray fluorescence (Koestler 1985). The elements found in the samples before and after removing the adhesive are listed in Table 2 and seen in figures 8-10.

No	Elements	Sample No 1	Sample No 2	Sample No 3	Average		Sample No 1	Sample No 2	Sample No 3	Average
		Before removing the glue					After removing the glue			
1	C	22.03	25.05	25.55	24.21		0.00	0.00	0.00	0.00
2	Mg	0.00	0.13	0.28	0.14		0.00	0.00	0.00	0.00
3	Al	1.77	0.98	0.41	1.05		1.50	0.00	13.59	5.03
4	Si	0.80	1.05	0.69	0.85		4.62	8.69	29.57	14.29
5	Cl	0.00	0.00	0.00	0.00		3.18	29.49	3.98	12.22
6	P	0.00	0.15	0.00	0.05		0.00	0.00	0.00	0.00
7	S	2.09	0.69	0.42	1.07		0.00	0.00	3.84	1.28
8	K	0.63	0.26	0.13	0.34		0.00	0.00	5.31	1.77
9	Ca	3.64	0.78	0.13	1.52		2.69	15.67	20.21	12.86
10	Ti	0.00	0.00	0.00	0.00		0.28	0.40	2.81	1.16
11	Fe	1.21	0.30	0.39	0.63		3.83	6.04	16.35	8.74
12	Cu	1.12	0.00	0.27	0.46		0.84	6.46	3.39	3.56
13	Zn	0.00	0.00	0.00	0.00		0.61	4.81	3.04	2.82
14	O	66.70	70.62	70.73	69.35		0.00	0.00	0.00	0.00
	Total	99.99	100.01	99.00			17.55	71.56	102.09	

Table 2. Found elements on the fibers before and after removing the glue.

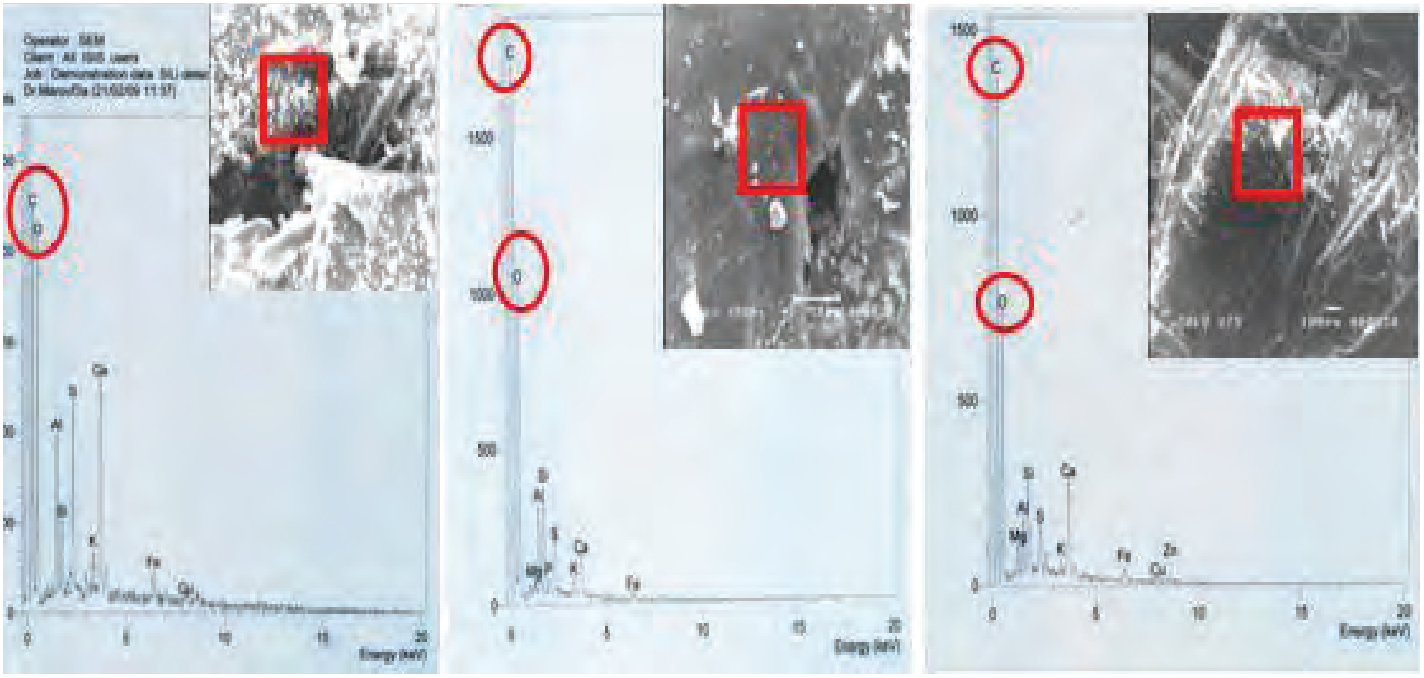


Figure 8. Results of analysis of the samples before treatment using (XRF) with (SEM). The basic elements found in the glue (C, O, S and P) as well as the metallic mordant (alum) and dirt compounds (Si, Ca, Fe, Al, and K) from the glue and surface pile were found.

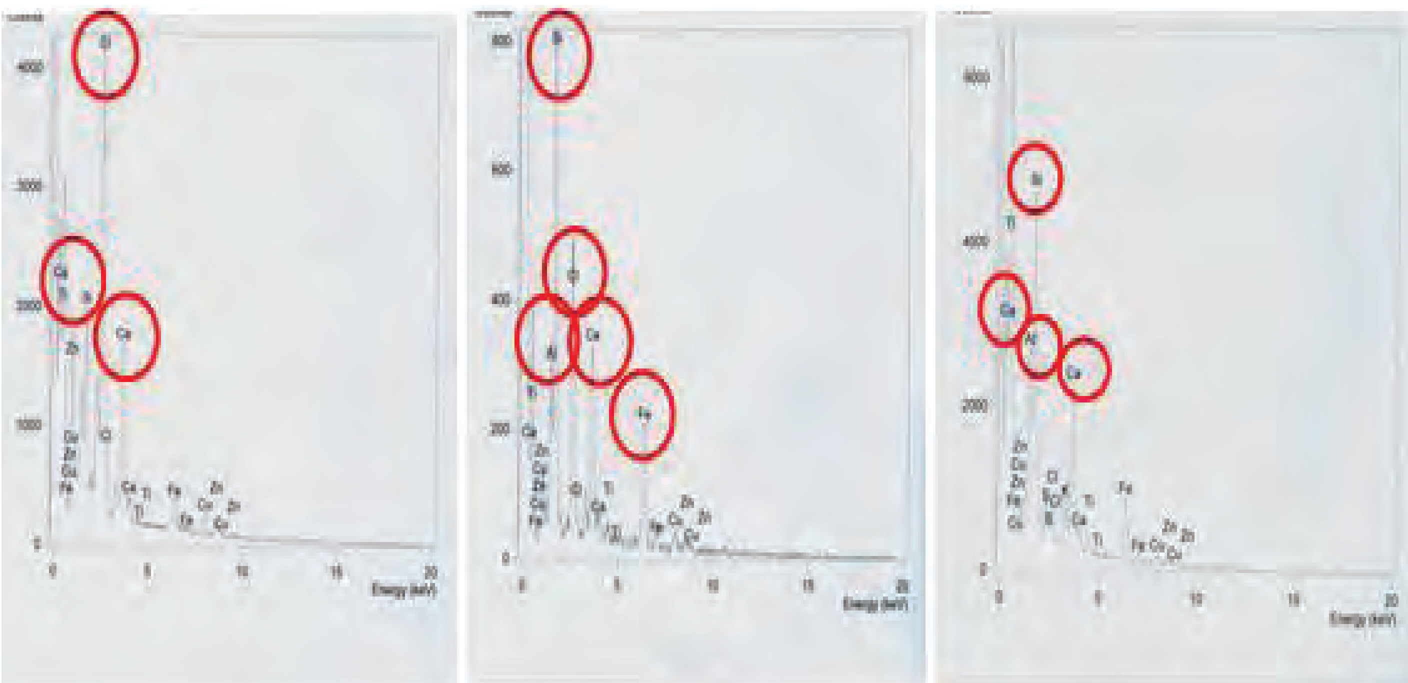


Figure 9. Results of the analysis after treatment. The glue elements (C, O, Mg and P) are no longer present, indicating that the treatment succeeding in removing the glue adhesive.

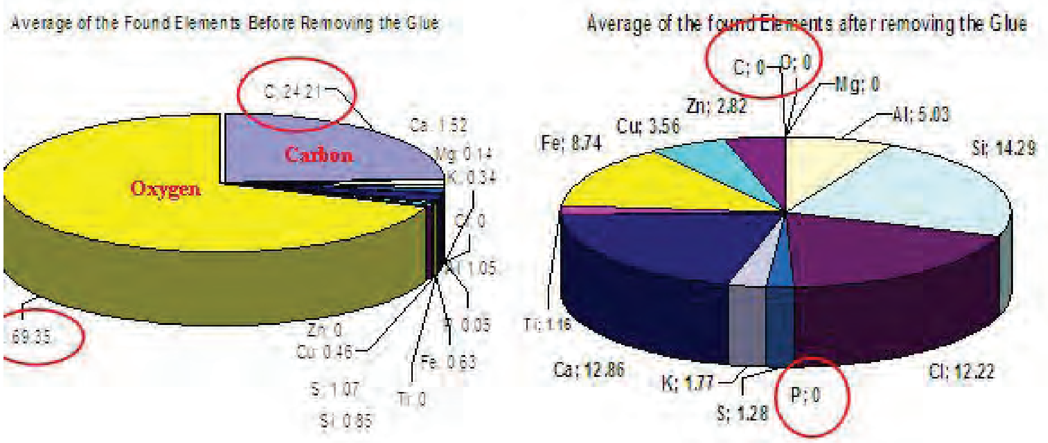


Figure 10. Diagrams show the average of the found elements before/after removing and washing processes.
O and C are the basic elements found in the samples before treatment, but are no longer present after treatment.
Al, Cl, Ca and Si may be the metallic mordants on the fibers.

6. CLEANING THE RUG

6.1 PREPARATION FOR SOLVENT-CLEANING

Steps included (fig. 11):

a. Measurement of the color fastness by using distilled water and selected solvent.
b. Mechanical cleaning by using different soft brushes to remove loose particulates.
c. Facilitate mechanical removal of the adhered support fabric using a wet poultice to swell the glue layer.
d. Mechanical cleaning of the swelled glue and adhering support fabric.
e. Preparing washing tray from wooden beams and polythene sheet (Plenderleith 1971).
f. A loose sheet of polyethylene was useful as a support for the rug when it was lifted out of the wash tank.

6.2 REMOVAL OF THE GLUE ADHESIVE

Dimethyl formamide solvent is one of the nitrogen compounds [HCON (CH3)2] and is a very polar solvent. "It dissolves oxidized natural resins polyurethane and polycarbonate, and swells epoxy resin" (Timar-Blazasy & Eastop 1998: 182). Also, it is one of the most dangerous solvents especially to human health, because the harmful vapour of dimethyl formamide is irritating to the skin, eyes and respiratory system. A mask fitted with an appropriate filter should be worn. Care must be taken to select protective gloves that are resistant to this group of solvents (Commoner 1984). In this stage, the rug was submerged in the prepared tray with about 25 liters of dimethyl formamide using soft brushes to help remove the agglomerated glue in the weave structure; this process continued for about 15 minutes (fig. 11d). After finishing this step, the rug was submerged again in the prepared tray with a washing solution of Orvus WA 1% surfactant as an anionic detergent with a pH of 7 (Montcrieff 1992). Sodium Carboxymethyl Cellulose (SCMC) in a 1% solution was used as a sequestering agent. Sequestering agents can "also act as soil carriers, partly by forming complexes with the metal ions of soil and partly by their dispersing, emulsifying and stabilizing properties. Sequestering agents can suspend soil in soft water and also in tap water, if added in excess to initially soften the tap water (Timar-Blazasy & Eastop 1998: 207). The rug was in the bath for about twenty minutes to remove the bonded dirt and residues of the glue (fig. 11e) and then was removed, blotted and air-dryed (fig. 11f).

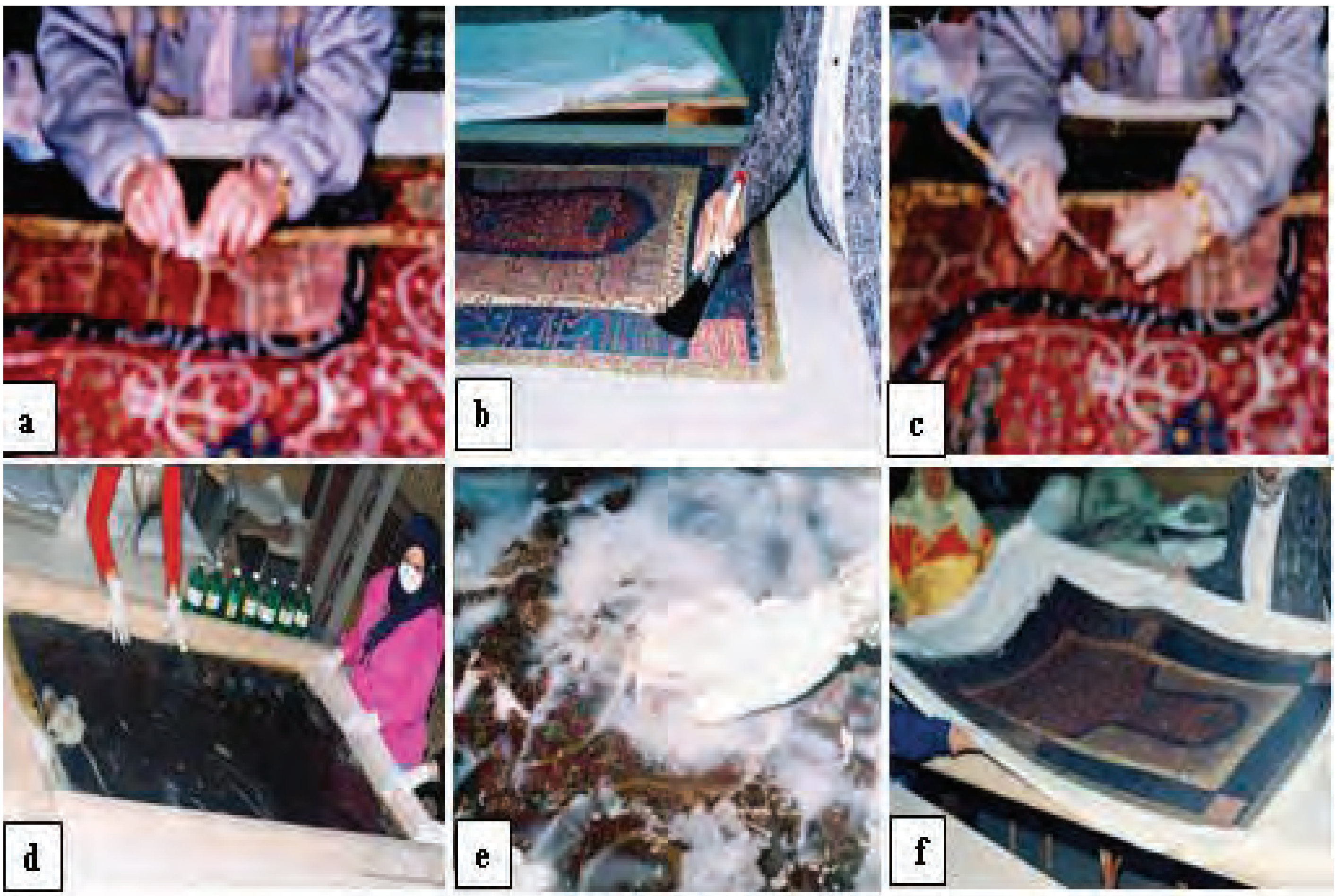


Figure 11. a) spot test with select solvent applied to each color in order to determine color fastness, b,c) mechanical cleaning to remove loose dusts and swelling glue, d) glue removal process with dimethyl formamide, e) washing process with Orvus WA surfactant, f) transferring from washing tray and drying with cotton towels.

7. STABILIZING THE RUG AFTER CLEANING

Since the rug suffered from many problems, for example, weakness and loss of the flexibility in the weave structure as well as brittleness and rigidity, several areas required stabilization. Linen fabric dyed with natural dyes was used as a new support layer for these areas. The rug was mounted on a wooden frame covered with the linen fabric for overall support and placed on exhibition in the museum (fig. 12-13).

Figure 12. Stages of stabilization of the rug after cleaning: a) the construction steps of the basic exhibition frame from wood and raw linen fabric, b, c) sewing the rug to the museum exhibition framework, d) fragments of the borders and edges of the rug which were affected by deteriorated old glue. After removing the glue, the separation parts were supported on dyed linen fabric as a new support., e, f) Details of some of the degraded areas before/after treatment by using sewing technique and dyed linen fabric as a new support layer.

Figure 13. Before treatment on the left; after treatment on the right.

8. RESULTS AND DISCUSSIONS

Using natural resins such as animal glue, gum Arabic, and starch may result in several problems to the treated textiles whether as an adhesive or as a consolidant, especially when these resins are exposed to the many deterioration factors. Use of SEM, XRF and binocular and light microscopes are very efficient in detecting degradation aspects of archaeological textiles. Handling of previously treated textiles with natural resins requires special precautions, in particular the rigid resins. The treated textiles are in a fragile condition and are susceptible to breakdown in inappropriate environmental conditions or even under museum conditions in a temperate climate. Since the resin penetrated the weave structure of the pile of the rug and fully impregnated the fiber, this object can only be treated by a complete immersion in the appropriate solvent bath. The poultices and mechanical cleaning were not sufficient to remove the deteriorated resin, especially in the pile. Although dimethyl formamide is one of the most dangerous solvents, especially for human health, it was the only solvent that could remove the glue adhesive from the rug without any harmful effects on the fibers or the dyes. So for safety purposes a mask fitted with an appropriate filter and protective hand-gloves were worn as a protective procedure for this solvent. Sewing technique of the rug on dyed linen fabric as a new supporting layer is one of the best methods to support deteriorated textiles, especially with this object, which was suffering of brittleness and degradation. This branch of the field of textile conservation still needs further scientific studies to solve many problems related to the textiles that are previously treated with natural or synthetic resins, either as an adhesive or consolidant. In addition, deterioration aspects and mechanisms of degradation of the treated textile with resins require more research studies in the future.

ACKNOWLEDGMENTS

The authors wish to thank Dr. Zahi Hawaas (head of superior council of Archaeology), professor M. Said Ibraheem (head of Sohag University) and Dr. Mona Shawqi director of Al-jazera museum. Also, we are indebted to the team of assistant conservators in Al-jazera museum, analyzers of electronic microscope unit in Sohag University to help in preparing the samples for analysis and the AIC (American Institute Conservation), especially Patricia Ewer (Textiles Conservator) for her great efforts.

REFERENCES

Allane L. 1995. "Kilims- A Buyer's Guide" Thames and Hudson Ltd, London.

Black, D, 1994.The Atlas of Rugs and Carpets, Thames and Hudson, London.

Commoner, L. 1984. Personal protective equipment for conservators: gloves and hand protection. In *Journal of American Institute Conservation 23:2.* 153-158.

Hansen, E, F. and Agnew, N. 1990. Consolidation with moisture-curable isocyanates: polyureas and polyurethanes. *ICOM Triennial Meeting*: Dresden, Germany. 557-562.

Horie C.V. 1987. Materials For Conservation – Organic consolidants, adhesives and coating. Butterworths: London.

Koestler, R. J. et al. 1985. Identification of Dyeing Mordants and Related Substances on Textile Fibers: A Preliminary Study Using Energy Dispersive X-Ray Spectrometry. In *Studies inCconservation* 30:2. p. 58-62.

Moncrieff, A. et al; 1992. Cleaning. In *Conservation Science Teaching Series*: Vol. 2, London.

Mostafa, M. 1953. The Turkish prayer rug. Cairo.

Perry, J. P. et al. 1985. Identification of textile materials, 7th Ed., The Textile Institute Manchester, UK.

Plenderleith, H. J. et al. 1971. The Conservation of Antiquities and Works of Art. Textiles: London.

Schaeffer,T. T. 2001. Effects of light on materials in collections. The Getty Conservation Institute: Los Angeles, CA.

Shashoua,Y. et al. 1992. Degradation of cellulose nitrate adhesive. In *Studies in Conservation* 37:2, p.113-119.

Timar-Blazasy, & Eastop, D. 1998. Chemical Principles of Textile Conservation. Butterworth Heinemann: Oxford.

FUTHER READING

Rhee, H. and Ballard, M. W. 1993. Residues of Surfactant on Silk. In *ICOM Triennial Meeting*: Washington, DC. 327-329.

MOHAMED MAROUF, PHD is Assistant professor in Textile Conservation, Conservation Dept. Faculty of Arts, Sohag University, Egypt. Email: marouf30@yahoo.com.

MEDHAT SABER is Textile Conservator, Egyptian Museum, Egypt. Email: Zom_xp@yahoo.com.

WATERLOGGED TEXTILES RECOVERED FROM THE H. L. HUNLEY: IDENTIFICATION & CONSERVATION OF TEXTILES BELONGING TO LT. GEORGE DIXON

JOHANNA RIVERA, PAUL MARDIKIAN AND STEPHANIE CRETTÉ

ABSTRACT – Due to the dynamic nature of the marine environment, the survival of waterlogged textiles is extremely rare and occurs only in very particular burial environments. This paper will discuss textile remains that were excavated from the *H.L. Hunley*, a nineteenth-century Confederate submarine. The submarine was recovered in 2000 and excavation of the crew compartment took place in 2001, 2002 and 2003. During the excavation, archaeologists removed the skeletal remains of the eight crew members along with numerous artifacts embedded in sediment. Among those artifacts were remnants of clothing associated with the commander of the submarine, Lieutenant George Dixon. Due to the nature of the site and the deteriorated condition of the textile, the remains were block-lifted in order to properly excavate, analyze and conserve them safely in the laboratory. Conservators working on the textile material devised a technique whereby the block-lifted soil and associated artifacts were kept fully immersed during the process of excavation, study and cleaning. Identification of the fibers was made using variable pressure scanning electron microscopy (VP-SEM) and Fourier transform infrared spectroscopy (FTIR). Results indicate the presence of protinaceous and cellulosic fibers, and establish that protein based fibers appear to be more resistant to decay than cellulose based fibers which appear more susceptible to bacterial attack.

TEXTILES SATURADOS DE AGUA RECUPERADOS DEL SUBMARINO H.L.HUNLEY: IDENTIFICACION Y CONSERVACION DE TEXTILES PERTENECIENTES AL TENIENTE GEORGE DIXON, POR JOHANNA RIVERA, PAUL MARDIKIAN Y STEPHANIE CRETTÉ: RESUMEN – Debido a la naturaleza dinámica del entorno marino, la supervivencia de artículos textiles saturados de agua es extremadamente rara y se produce sólo en entornos de entierro muy particulares. En este trabajo se analizarán los restos textiles que fueron excavados del H.L. Hunley, un submarino confederado del siglo XIX. El submarino fue recuperado en el año 2000 y la excavación del compartimiento de la tripulación se realizó en los años 2001, 2002 y 2003. Durante la excavación, los arqueólogos extrajeron restos óseos de ocho miembros de la tripulación junto con diversos artefactos incrustados en sedimentos. Entre dichos artefactos se encontraban restos de tela relacionados con el comandante del submarino, el teniente George Dixon. Debido a la naturaleza del lugar y a la condición deteriorada del artículo textil, los restos se levantaron en bloques para poder excavarlos correctamente, analizarlos y conservarlos en forma segura en el laboratorio. Los conservadores que trabajaban en el material textil, diseñaron una técnica por medio de la cual el sedimento levantado en bloque y los artefactos relacionados se mantuvieron completamente sumergidos durante el proceso de excavación, estudio y limpieza. La identificación de las fibras se realizó mediante el uso de microscopía electrónica de barrido con presión variable (VP-SEM, por sus siglas en inglés) y espectroscopía infrarroja transformada de Fourier (FTIR, por sus siglas en inglés). Los resultados indican la presencia de fibras proteináceas y celulósicas y establecen que las fibras a base de proteínas parecen ser más resistentes al deterioro que las fibras a base de celulosa, las cuales parecen ser más susceptibles a los ataques bacterianos.

1. HISTORY AND EXCAVATION

The night of February 17, 1864, the confederate submarine *H.L.Hunley* attacked and sank the *USS Housatonic* off the coast of Charleston, South Carolina but then mysteriously vanished with the crew of eight. Lost at sea for over a century it was located in 1995 and raised on August 8, 2000. The hand-cranked vessel was brought to the Warren Lasch Conservation Laboratory to be analyzed and conserved in a controlled environment (Mardikian, 2004).

WATERLOGGED TEXTILES RECOVERED FROM THE H. L. HUNLEY: IDENTIFICATION & CONSERVATION OF TEXTILES BELONGING TO LT. GEORGE DIXON

During the excavation of the crew compartment in 2001, 2002 and 2003, 11 tons of sediment and 1400 artifacts were removed from the submarine. After the sinking of the submarine, the bodies of the crew members were gradually covered with sediment exposing their clothing to the environment. As a result of differential decomposition of the bodies and exposure to the marine environment, clothing from the crew was found scattered throughout the submarine and in very poor condition. Seven out of the eight crew members' bodies were found disarticulated along the bottom of the submarine at their crank positions; their bodies were embedded in sediment and had almost no textile associated with them. However, the body of the commander of the submarine, Lieutenant George Dixon, was found in a different state of preservation. His body was located underneath the forward conning tower. Sediment rapidly entering the submarine through the forward conning tower covered his body and contributed to a much better preservation of his clothing than the other crew members (fig. 1).

Figure 1. Remains of Lt. Dixon in the submarine prior to block-lifting. Details of his torso and the textile draped over it (©FOTH).

Unlike the other crew members, Dixon's body was covered with various pieces of waterlogged and degraded textiles at the time of the excavation. Several attempts were made by archaeologists to carefully remove this textile using traditional excavation methods; however, it was found that even the fine mist of water delivered by a spray bottle caused damage to the fabric. Due to the degraded state of the textile, the important archaeological information and the position of his body within the submarine, Dixon's remains had to be removed in seven block-lifts. Each of these blocks would contain personal artifacts, a portion of his skeleton, part of his garments and all of the sediment and concretion surrounding him (fig. 2). After being removed from the submarine, the blocks were supported, protected and taken to the laboratory for monitored excavation and documentation. All the blocks were maintained at 4°C in city water in a walk-in cooler specifically designed for the long-term storage of these fragile materials (Mardikian, 2004).

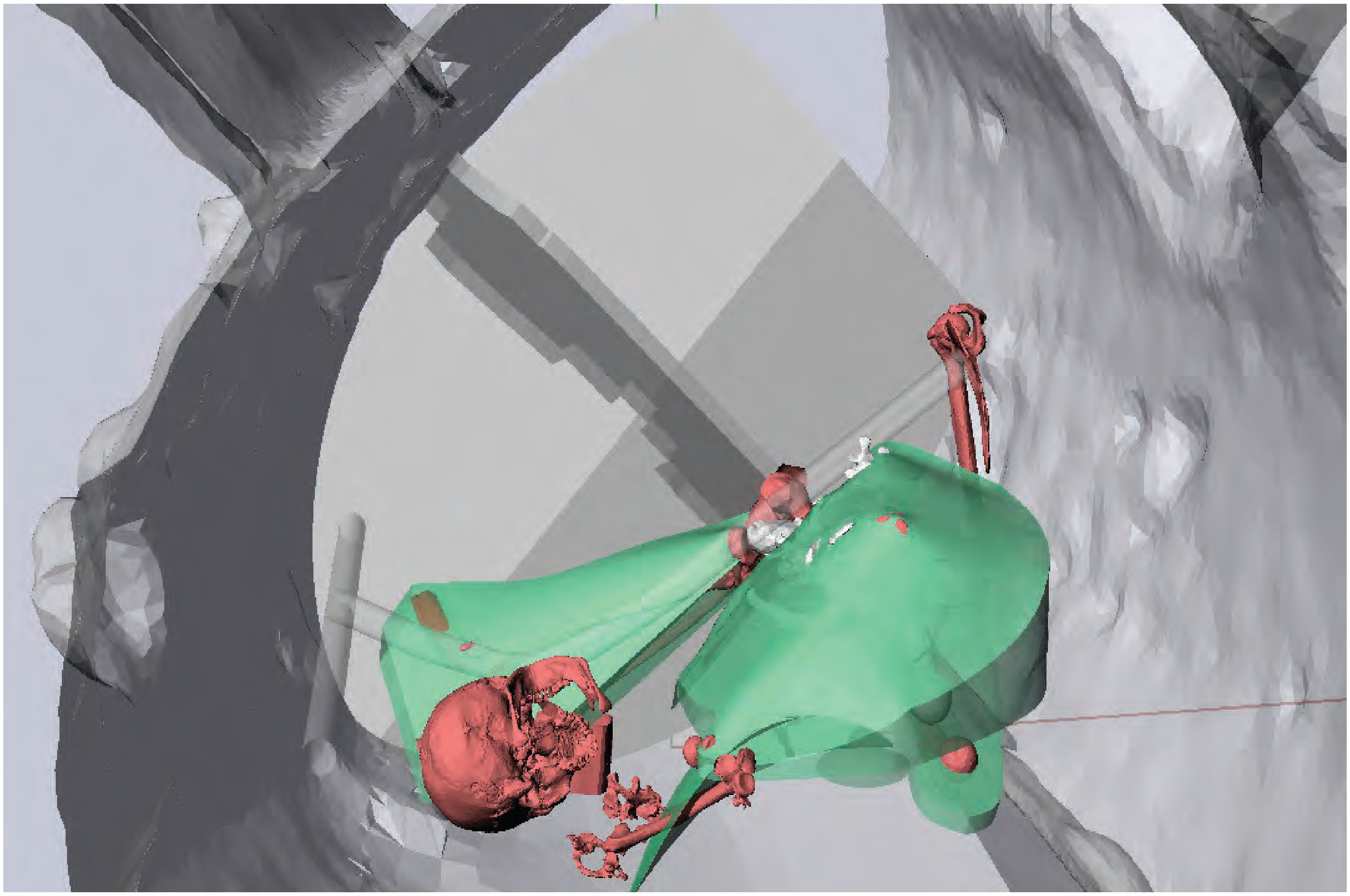


Figure 2. 3-D image of the submarine's site plan and Lt. Dixon's remains under the forward conning tower. The portions in green show 3 of the 7 block-lifts removed. The two main blocks (right side of the image) correspond to his torso, block 36 and 37; on the left side block 47 corresponds to his legs and part of the trousers (©FOTH).

2. BLOCK-LIFTS EXCAVATION

Once in the laboratory, the block-lifts were fully documented, x-rayed and CT scanned revealing dozens of artifacts embedded within the sediment (fig. 3).

In preparation for the excavation, two of the main block-lifts (numbers 36 and 37 belonging to Dixon's torso) were supported with a fiber glass cast and protected using plastic film. In order to excavate these blocks, an immersion technique was implemented in which the block was submerged in a tank filled with water and using a stream of water the sediment was carefully removed allowing for safe retrieval of artifacts and skeletal remains (fig. 4). Some of the artifacts removed from Dixon's remains included a gold pocket watch, a pair of opera glasses, silver suspenders, a pocket knife, dozens of buttons, a diamond ring and brooch. Once the small artifacts and skeletal material were removed from the tank, conservators were able to focus on cleaning the textile that was covered with sediment.

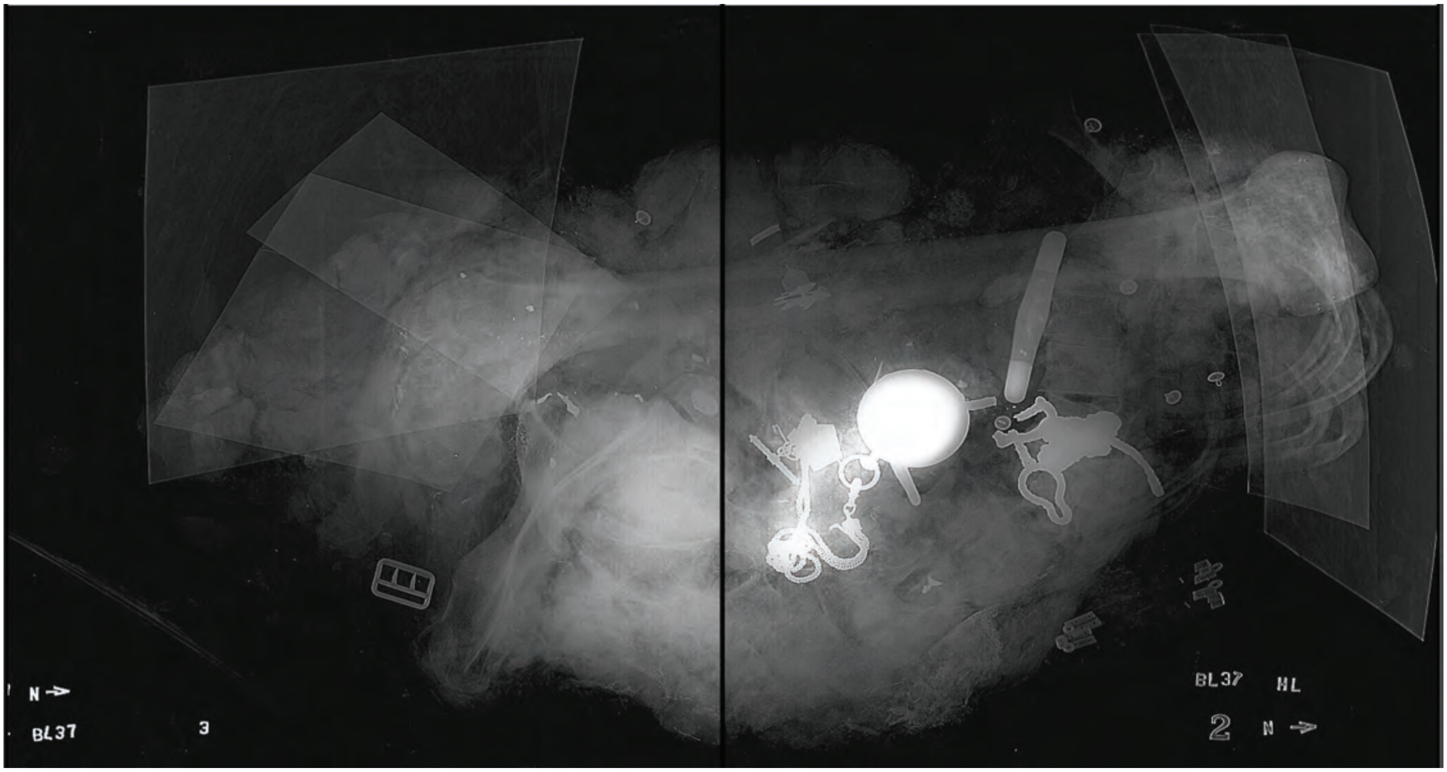


Figure 3. X-ray of Lieutenant George Dixon's lower torso. The image shows BL 37 before the removal of skeletal remains, artifacts and textile. Artifacts such as a pocket watch, a pocket knife, suspenders buckles and buttons were identified.

Figure 4. Underwater excavation and sediment removal of Dixon's BL 36, which corresponds to the left side of his torso (©FOTH).

During the excavation of Block 36 (BL 36), four different types of fabrics were uncovered. These fabrics were highly degraded making their manipulation extremely difficult. Therefore, it was determined that the safest way to handle them was to completely remove them from the block of sediment before proceeding with the excavation. Some of the materials were sampled and retained for analytical purposes. Once the most fragile textiles were removed, the excavation continued gradually reducing the sediment from the textile. This led to the discovery of part of a vest (fig. 5).

The excavation of Block 37 (BL 37), on the contrary, revealed several smaller pieces of textile which probably belong to different items of clothing. This block was in much poorer condition, because part of it was concreted to the submarine's hull. During the excavation of this block, archaeologists noticed another type of thicker and darker textile draped over Dixon's left side and part of the submarine's forward pump. This particular textile was different from the one found during the excavation of the BL 36 and it is thought be part of a jacket.

Figure 5. Image of the vest. The vest is comprised of two wool layers plus a lining layer.
In more detail some button holes (right side) and a pocket can be seen (©FOTH).

3. ANALYSIS AND IDENTIFICATION OF TEXTILE

New equipment recently acquired by the Clemson Conservation Center include the Hitachi S-3700N, which is an ultra large chamber variable pressure scanning electron microscope (VP-SEM), and the Bruker Tensor 27 Fourier transform infrared spectrometer (FTIR), equipped with a Hyperion 2000 Infrared Microscope. These were employed for an in-depth examination of each type of textile removed from both block-lifts.

3.1 VARIABLE PRESSURE SCANNING ELECTRON MICROSCOPE

The advantages of using a VP-SEM, or low vacuum SEM for this investigation are two-fold: It allows not only the analysis of vacuum sensitive materials such as moist or liquid samples, but also the imaging of non-coated, non-conductive materials with minimal local surface charging. These factors become a necessity when dealing with severely degraded waterlogged materials. Indeed, it is important to preliminarily analyze specimens wet, to avoid shrinkage and any other changes that may occur through drying. In addition to variable pressure conditions, a Deben Specimen Cooling Unit (CoolStage, Deben Ltd.) was used to control water evaporation from the wet textile samples. The Coolstage guarantees temperature ranges from $+50^{o}C$ to $-25^{o}C$ as a function of the SEM chamber pressure. By cooling wet specimens, water evaporation may be slowed down or stopped altogether, depending on the SEM chamber pressure. For instance, at room temperature water will evaporate very quickly causing significant changes to the sample structure, such as shrinkage. However, manipulation of the Coolstage temperature in conjunction with the pressure in the chamber not only prevents water evaporation from the sample but also enables the ability to operate at a higher vacuum which provides a better signal to noise ratio and thus clearer images. Once examined wet, the samples were desiccated in a controlled environment and imaged once again with the VP-SEM.

3.1.1 SAMPLES ANALYSIS

Textile samples from both block lifts were taken using small soft brushes. This was found to be the best way to manipulate the fragile textile underwater. Samples were kept wet until analyzed.

Sample 8021 belongs to the main piece of the vest from BL 36. Figure 6 shows fibers completely embedded in sediment. The sample was analyzed wet and identified as cashmere wool. The scale pattern observed under the SEM assisted in identifying these fibers as cashmere, based on the uniformity in thickness and the distance between the scales (The Textile Institute, 1985).

Sample 8023 was found lying directly on top of the vest and throughout both block-lifts 36 and 37. The sample was extremely fragile, retained some red color, and the weave was very apparent. Due to the fragility of the textile it was not possible to remove a yarn for a better analysis. The analysis of the wet sample showed that the textile was covered with a thick slime which could not be removed prior to analysis and prevented positive identification of the fiber (fig. 7). During examination with the SEM tubular formations were also observed, which have since been identified as anterior parts of marine isopods.

The sample was then desiccated and analyzed. During the drying process, however, this specimen exhibited an unusual drying pattern. It shrank by almost 50% and the film that covered the surface of the textile solidified, completely obscuring the underlying fibrous matrix. Under the SEM (fig. 8), the film appeared like a thin, translucent layer that had an unknown organic composition. We have formulated two possible explanations for the

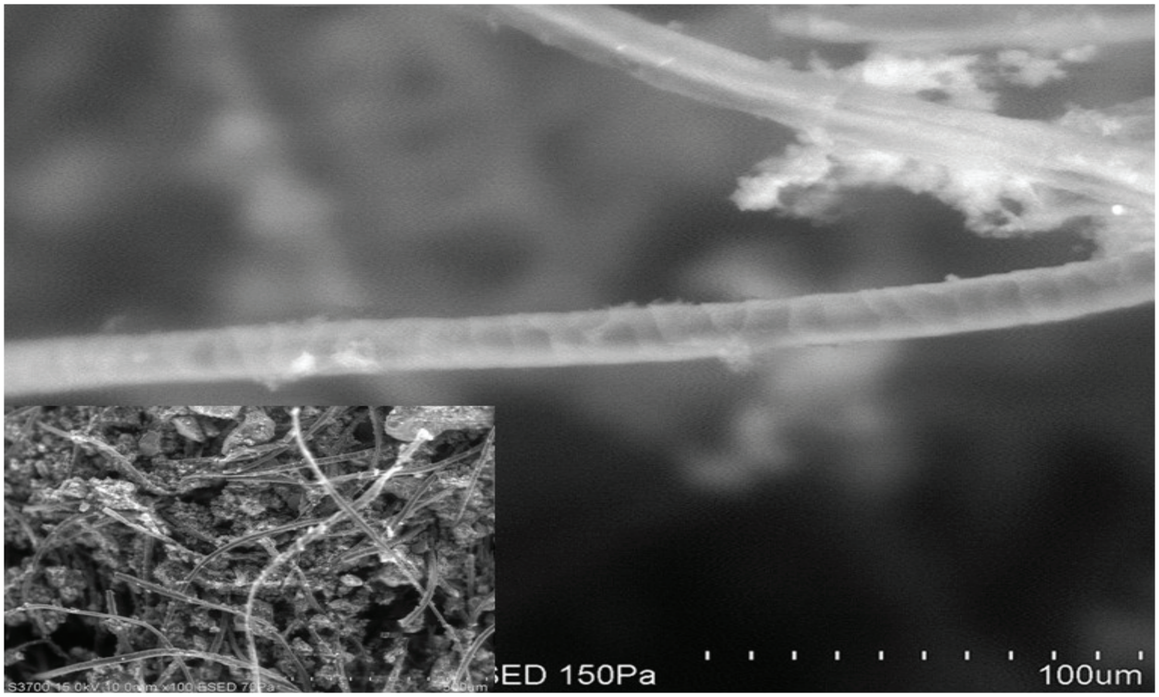


Figure 6. Photomicrographs of wool fibers. The main image shows one wool fiber of cashmere. This fiber was analyzed wet. In the bottom left image, the wool sample was analyzed dry; the shrinkage of the fibers due to the desiccation was obvious. No other major changes were observed (©FOTH).

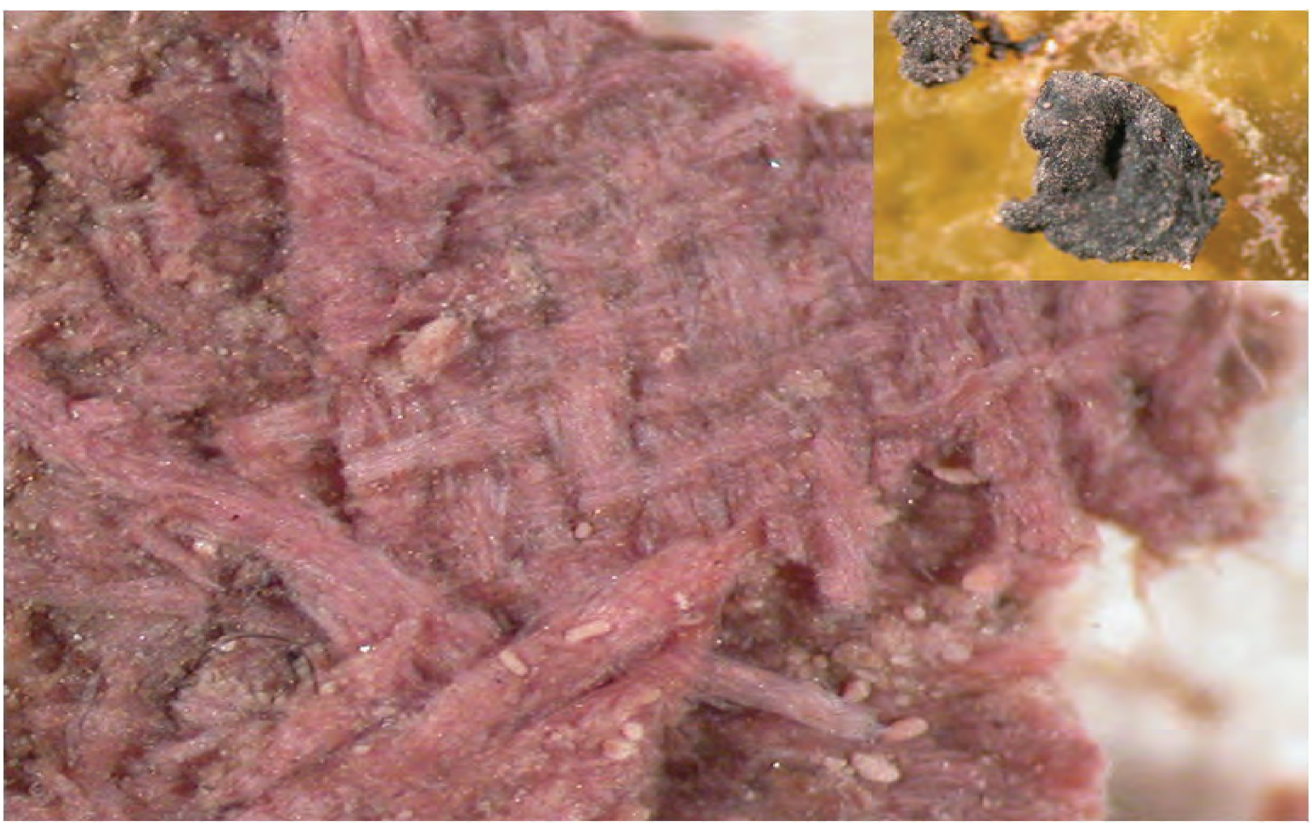


Figure 7. Image of sample 8023. The main image shows the wet sample of reddish woven wool. The top right image depicts the same sample after drying. It had collapsed, shrank, and changed its color as well (©FOTH).

presence of the film and unusual degradation of the textile. One, that adipocere (hydrolyzed fatty tissue) associated with Dixon's remains may have contaminated the fibers (M. Jacobsen. Personal communication), or two, that the unusual degradation is associated with bacterial or fungal activities. Due to the significant change in the sample matrix, and since no fibers could be isolated from the specimen, it was not possible to make a positive identification of the material.

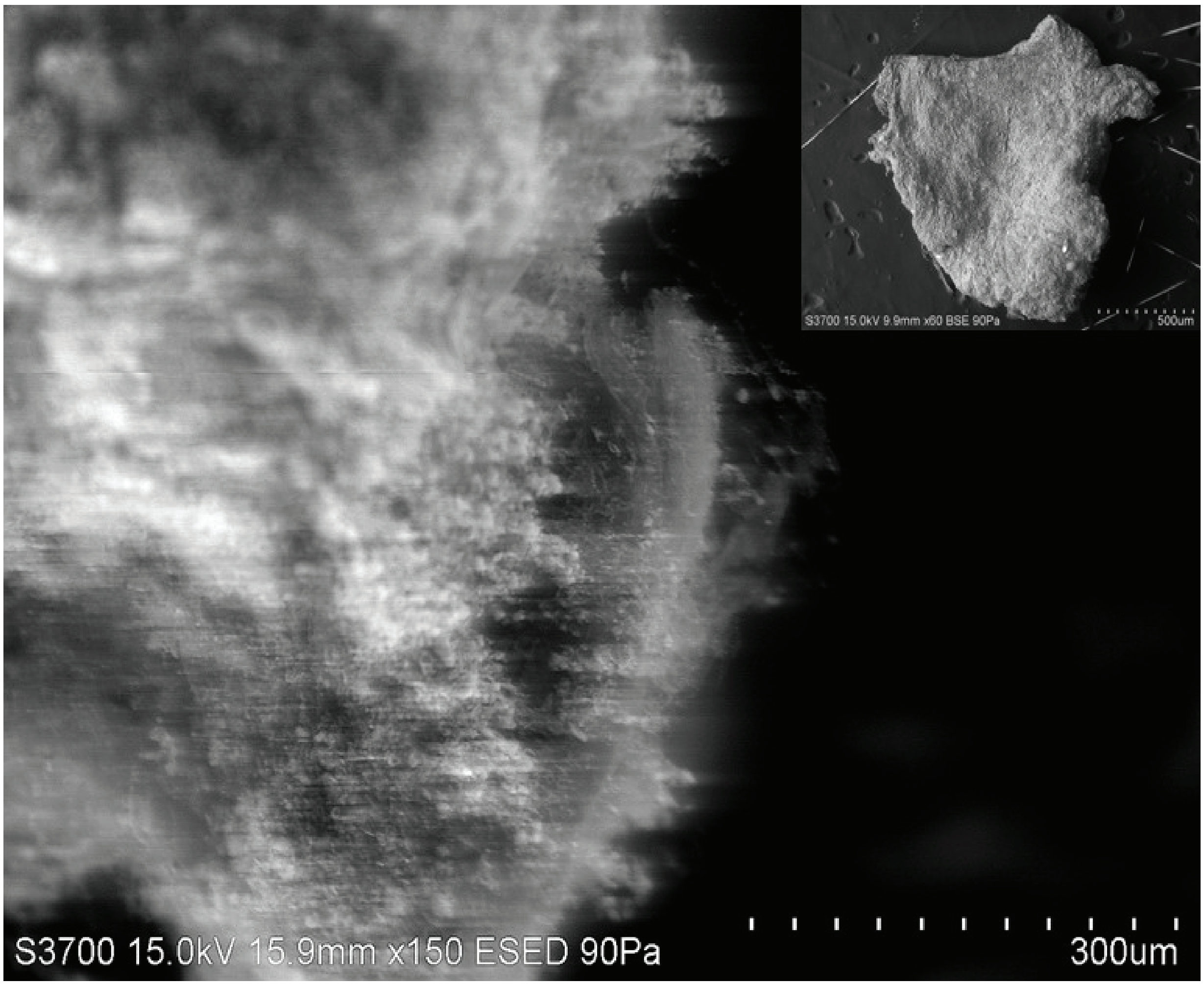


Figure 8. Photomicrographs of sample 8023 at a 150x magnification. The main image shows the sample analyzed wet. A thin layer of a soft translucent slime mixed with sediment covered the sample which makes it difficult to analyze. The top right image shows the sample after drying (©FOTH).

Sample 8024 was part of the lining found in between the wool layers and folds from BL 36 and BL 37. The lining sample may be comprised of different materials depending on the part of the garment. It was not possible to assign to which garment this lining could have belonged, since different lining fabrics were encountered in both BL 36 and BL 37. This sample was analyzed wet and both wool and cotton fibers were identified

Sample 8025 (fig. 9) was found inside of the wool vest's folds and seems. These threads were part of a weave in which the sturdier material survived (possible warp) and the weaker weft disappeared, leaving only some remains on top of the warp. Use of the VP-SEM equipped with the Coolstage permitted identification of the sample as cotton, and observation of a significant amount of sediment and dirt covering the textile material (fig. 10). Moreover, after desiccation and drying, the sample fibers collapsed and shrank leaving part of the cotton's underlying epidermis exposed.

Figure 9. Image of sample 8025. The main photograph depicts a wet sample of cotton warp yarns with remnants of a cotton weft. The degraded weft is likely due to the use of lower quality cotton. The image on the bottom left shows the yarn after drying (©FOTH).

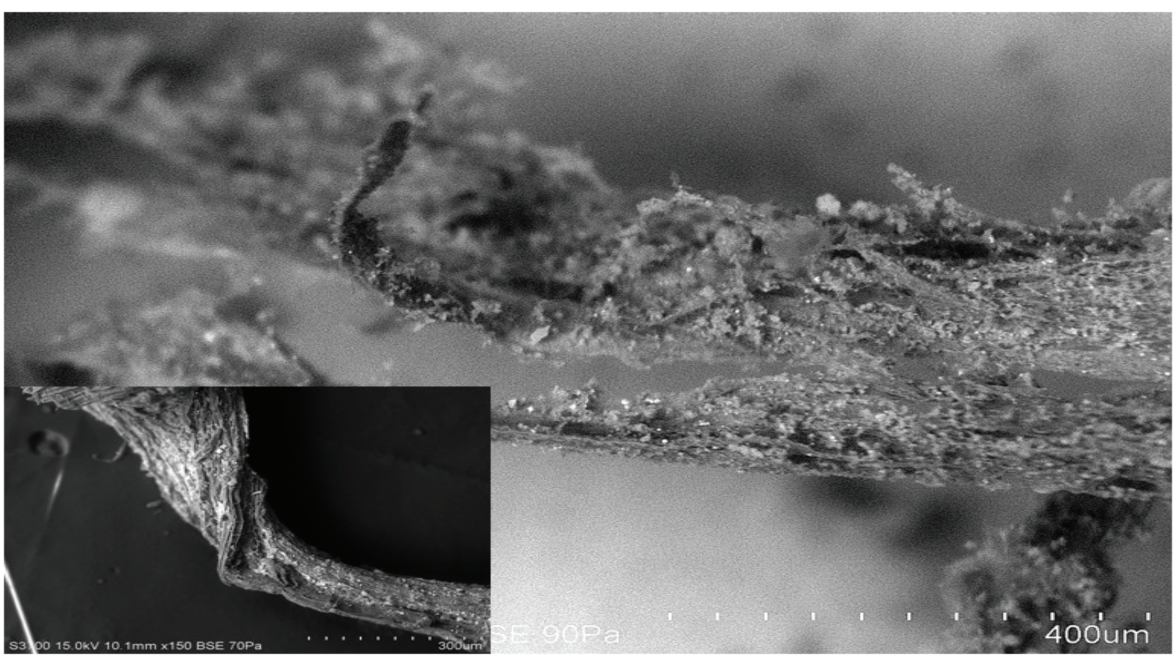


Figure 10. Photomicrographs of sample 8025. The larger image depicts a wet yarn of cotton fibers. The bottom image shows the dry yarn which collapsed and shrank exposing part of the epidermis (©FOTH).

3.2 FOURIER TRANSFORM INFRARED SPECTOMETER

FTIR analysis was performed on a Bruker Optics TENSOR 27 FTIR spectrometer equipped with a HYPERION 2000 FTIR microscope using an aperture 15X objective. The data was collected and manipulated using the Bruker Optics OPUS, v.6.5, software. A few fibers of each sample were air dried on a 3mm thick ZnSe plate and absorbance spectra collected using 64 scans and a resolution of $4cm^{-1}$ cm^{-1}. A background spectrum was collected for each sample.

3.2.1 SAMPLE ANALYSIS

The spectra from sample 8021 (sample of the vest) and sample 8024 (sample of the lining) were compared with a wool reference sample from Testfabrics. The results showed that the FTIR spectra of the control wool and both samples were very similar. Some minor differences were observed but this may be due to the degradation of the fabric and the sediment contamination. Although sample 8024 showed what appeared to be cotton fibers under the SEM, only spectra similar to wool were observed with the FTIR analysis.

The spectra of sample 8025 (taken from the seams of the vest) was compared with a control cotton sample from Testfabrics. The bands of both spectra were very similar although some differences were apparent due to degradation of the fabric. Sample 8023 (red unidentified sample) was compared with the wool and cotton spectra from samples 8021 and 8025. Some similarities were observed between the peaks of sample 8023 and both cotton and wool peaks (fig. 11). However, this sample was so degraded that it was not possible to positively identify this material as cellulose based, or protein based fibers. Further analysis using other techniques will be carried out in the future.

4. CLEANING PROCESS

After the assessment and identification of the different textiles found in the main two block-lifts, wool was the only fiber that could withstand the cleaning process. The rest of the fabric was so severely degraded that it was not possible to remove the sediment. Prior to cleaning, scanning electron microscope – energy dispersive spectrometer (SEM-EDS) analysis was carried out on sample 8028, which was a wool sample from the vest, to identify possible contaminants on the wool.

4.1 ENERGY DISPERSIVE SPECTROSCOPY BEFORE CLEANING

As the SEM scans the sample surface with its electron beam, characteristic X-rays are emitted to balance the total energy of a given atom. The emitted X-rays or energies are unique to each element from which they originated. Such an event allows for qualitative and quantitative analysis of samples. Thus, energy dispersive spectrometers (EDS) are detectors integrated into a SEM to separate X-rays of elements into an energy spectrum. The Oxford Instruments INCAx-act analytical silicon drift energy dispersive detector was employed for this study. Elemental composition of materials down to the spot size (few microns) and maps over broader areas were created to identify which types of contaminants were present in the different fabric specimens.

The main contaminants found on sample 8028 were magnesium, aluminum, silicon, iron and chromium (Table 1). Magnesium, aluminum and silicon are elements from the sediment composition, while iron is most likely coming from the surrounding corrosion products. Finally, chromium was an unexpected element, but it is believed to be part of the dying process. Textiles colored with natural or synthetic dyes of a mordant type were fixed on fibers by metallic compounds. During the Civil War era, chromium compounds prevailed in such processes (Nriagu, 1988). Moreover, traces of chromium may constitute the first time that a dye is detected in textile remains from the *H.L.Hunley* due to the fact that dyes usually degrade after such a long time underwater.

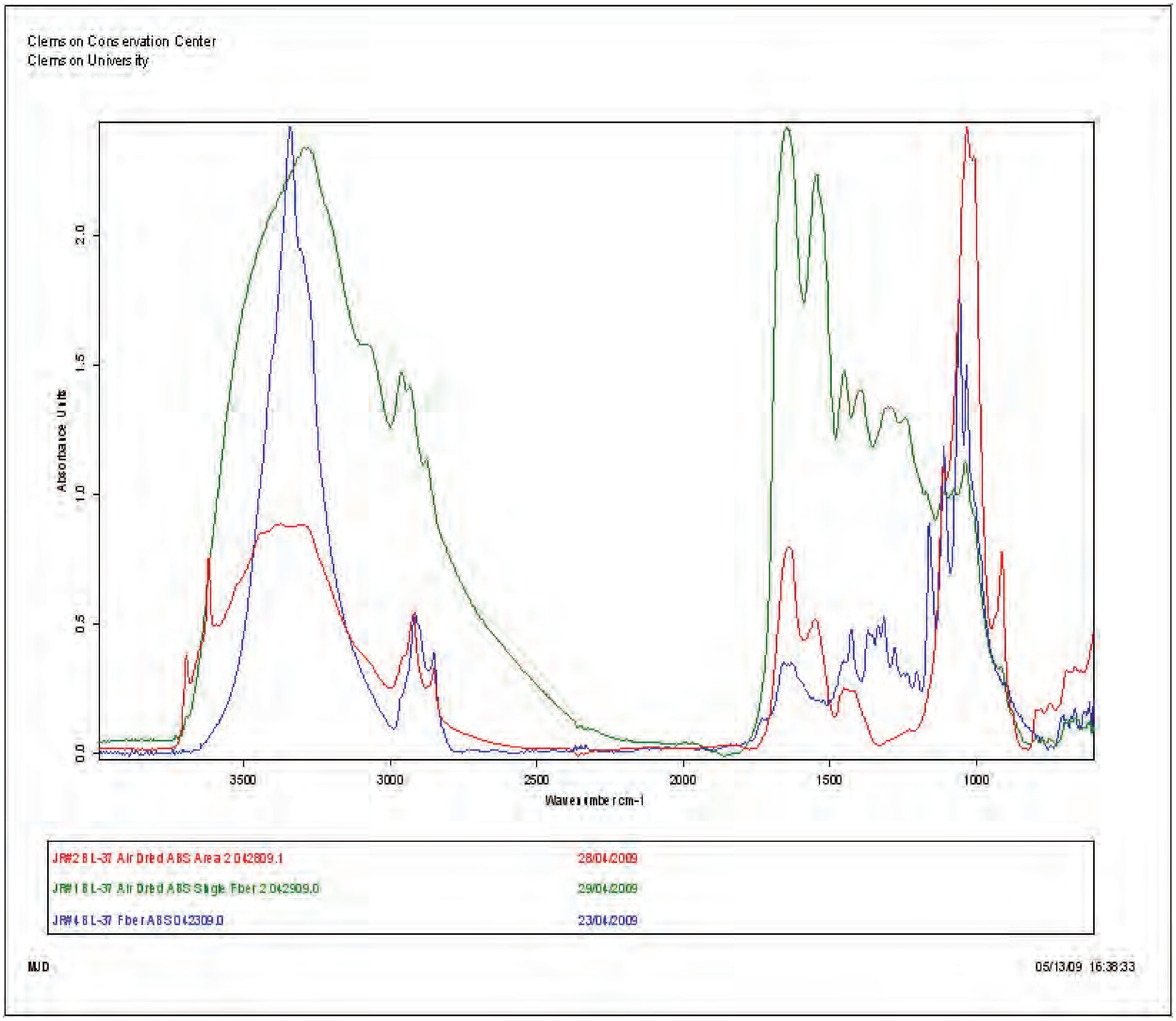


Figure 11. FTIR spectra of the wool and cotton fibers. The green color band shows the wool sample 8021 spectra which earlier was compared with a Testfabrics control wool and found to be similar with minor differences likely due to degradation. The blue color band shows the cotton spectra of sample 8025 also compared with a Testfabric control cotton, and the red spectra shows sample 8023 which has some similarities with both cotton and wool spectra but its identity remains undetermined (©FOTH).

Mg	Al	Si	P	S	K	Ca	Cr	Fe	Zn
2.58	5.08	13.89	0.16	1.92	0.65	1.12	0.58	5.53	0.67

Table 1. Weight percentage average of elements from wool sample 8028, detected by EDS before cleaning with surfactant.

4.2 CLEANING WITH SURFACTANTS

Thorough testing for soil removal was performed using three different surfactants. These were chosen according to their pH and cleaning qualities. The surfactants chosen for the testing were Orvus WA Paste, Dehypon LS45 and Synperonic A7. After testing small samples with all the surfactants it was decided to use a dilute solution of the nonionic surfactant Synperonic A7. With a pH of 5.66, Synperonic A7 demonstrated better cleaning properties and an ability to prevent sediment re-deposition. Prior to cleaning, the textile fragments were placed between layers of netting and fine gauze to keep them protected and secured during immersion. Synperonic A7 was used at room temperature at a 1.5 % v/v solution and diluted 20 more times with de-ionized water; only soft brushes were used for the cleaning in which the textile was gently tapped with the brush to loosen the sediment. The cleaning protocol consisted of several washing and soaking stages, followed by rinsing and soaking in de-ionized water.

Although attempts to clean with ultrasonic baths were made, this was considered too risky for the fragile textile. Stronger chemicals were not used either due to the fragile condition of the fibers, except where iron staining was obvious. In such a case, a 5% w/v ammonium citrate solution was used for two days. Although the pieces that were treated with ammonium citrate appeared to be visibly cleaner, the wool appeared to be weaker and more fragile after this treatment. While these changes could have been related to the waterlogged state of the fiber or bacterial attack, the difference in appearance between samples cleaned only with surfactants and samples cleaned with ammonium citrate was obvious. These changes could not be fully explained at this point, which is why this treatment was only used on a few pieces that were severely stained with iron. To date, only wool pieces from BL 37 have been completely cleaned. The vest from BL 36 is currently undergoing cleaning.

4.3 ENERGY DISPERSIVE SPECTROSCOPY AFTER CLEANING

4.3.1 EDS OF SAMPLES CLEANED WITH SYNPERONIC A7

EDS was performed on wool sample 8030 after cleaning with the surfactant (fig. 12). Since only superficial cleaning was carried out, the elimination of contaminants was not as drastic as compared to when chemicals are used. In this case, superficial cleaning was considered to be the best approach for very fragile textile. After cleaning, the presence of magnesium and calcium decreased drastically and silica and some other contaminants disappeared (Table 2). However, not surprisingly the presence of iron did not change since no chelating agent was used for the majority of the pieces. On the other hand, the amount of chromium was found to be higher compared to the rest of the detected elements.

Mg	Al	Si	S	K	Ca	Cr	Fe	Cu
0.88	5.78	11.17	8.45	0.69	0.48	3.28	8.86	0.63

Table 2. Weight percentage average of elements detected by EDS of sample 8030 after cleaning with surfactant.

4.3.2 EDS OF SAMPLE CLEANED WITH SYNPERONIC A7 AND AMMONIUM CITRATE 5%

After cleaning with Synperonic A7 and ammonium citrate, wool sample 8031 was analyzed with SEM-EDS (fig. 13). The SEM image shows a cleaner fabric but also some damage mainly splitting along the fibers. Similar damages were also noticed at the end of some of the fibers, where a *brush-end* appearance was evident

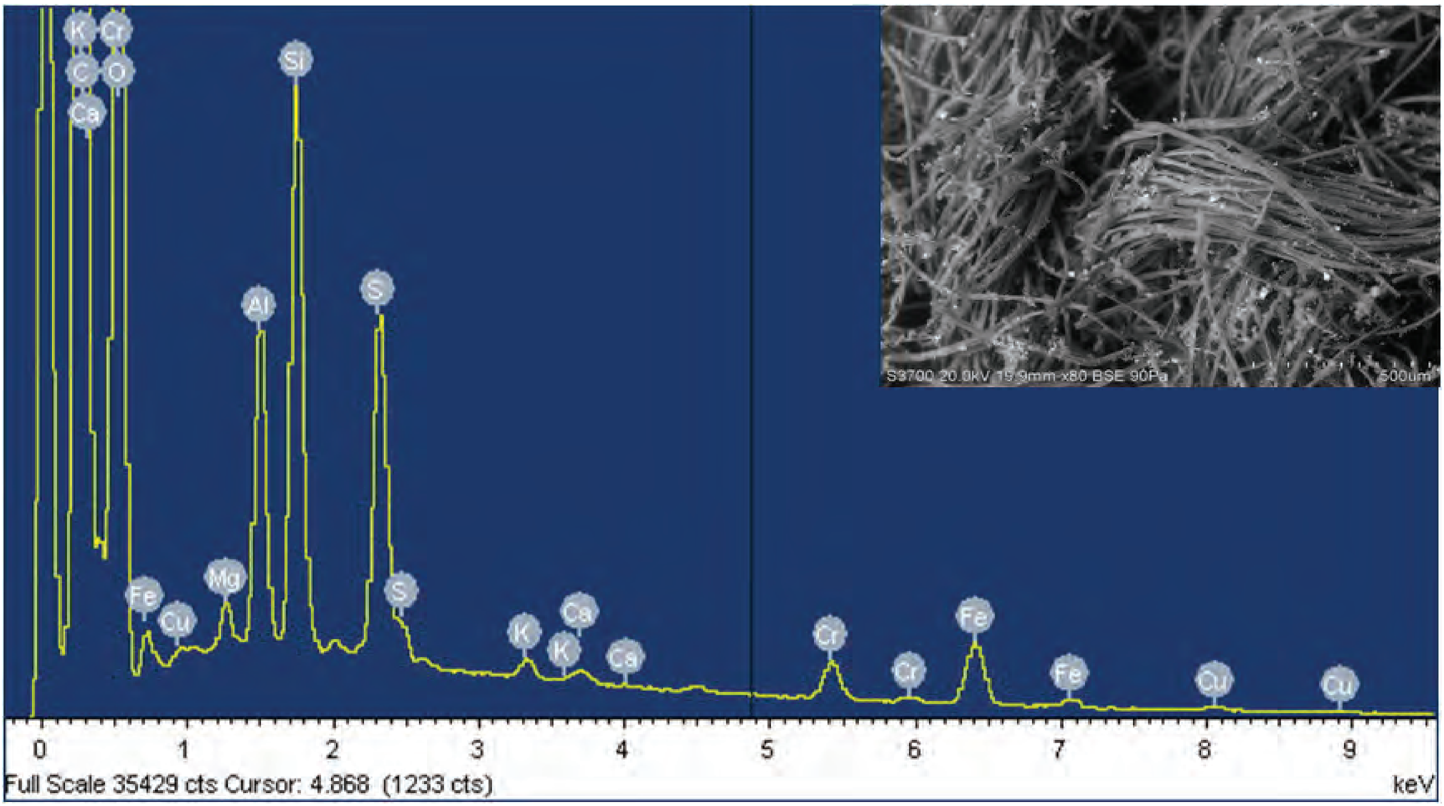


Figure 12. Weight percentage average of elements detected by EDS of sample 8030 after cleaning with surfactant.

(The Textile Institute, 1985). Some swelling of the fibers was also observed. The elemental analysis, performed by EDS, showed the removal of calcium and magnesium, as well as the considerable reduction in aluminum, silicon, sulfur, and iron (table 3).

C	O	Al	Si	S	Cr	Fe
59.13	30.85	1.23	2.19	3.73	0.62	2.25

Table 3. Sample 8031. Weight percentage average of elements detected by energy dispersive spectroscopy after cleaning with surfactant and soaking in ammonium citrate 5%.

4.4 DRYING STUDY

After several weeks of rinsing in de-ionized water, the textile is currently being prepared to be dried. Various tests have been performed to evaluate the best drying techniques. These include air drying, atmospheric freeze-drying (i.e. non-vacuum freeze drying) and vacuum freeze drying.

Air drying was tested on a limited number of small samples. Distortion of the fibers became obvious after a few days. The fibers shrunk considerably and the weave became stiff and brittle. This method was thus considered unacceptable for this kind of textile. Two small samples were subjected to atmospheric freeze-drying (i.e. non-vacuum freeze drying). One was placed in a freezer at -30°C (-22°F) and the other one in a freezer at -12°C (10°F). This technique allows water in a frozen state to be removed from a thin material by sublimation

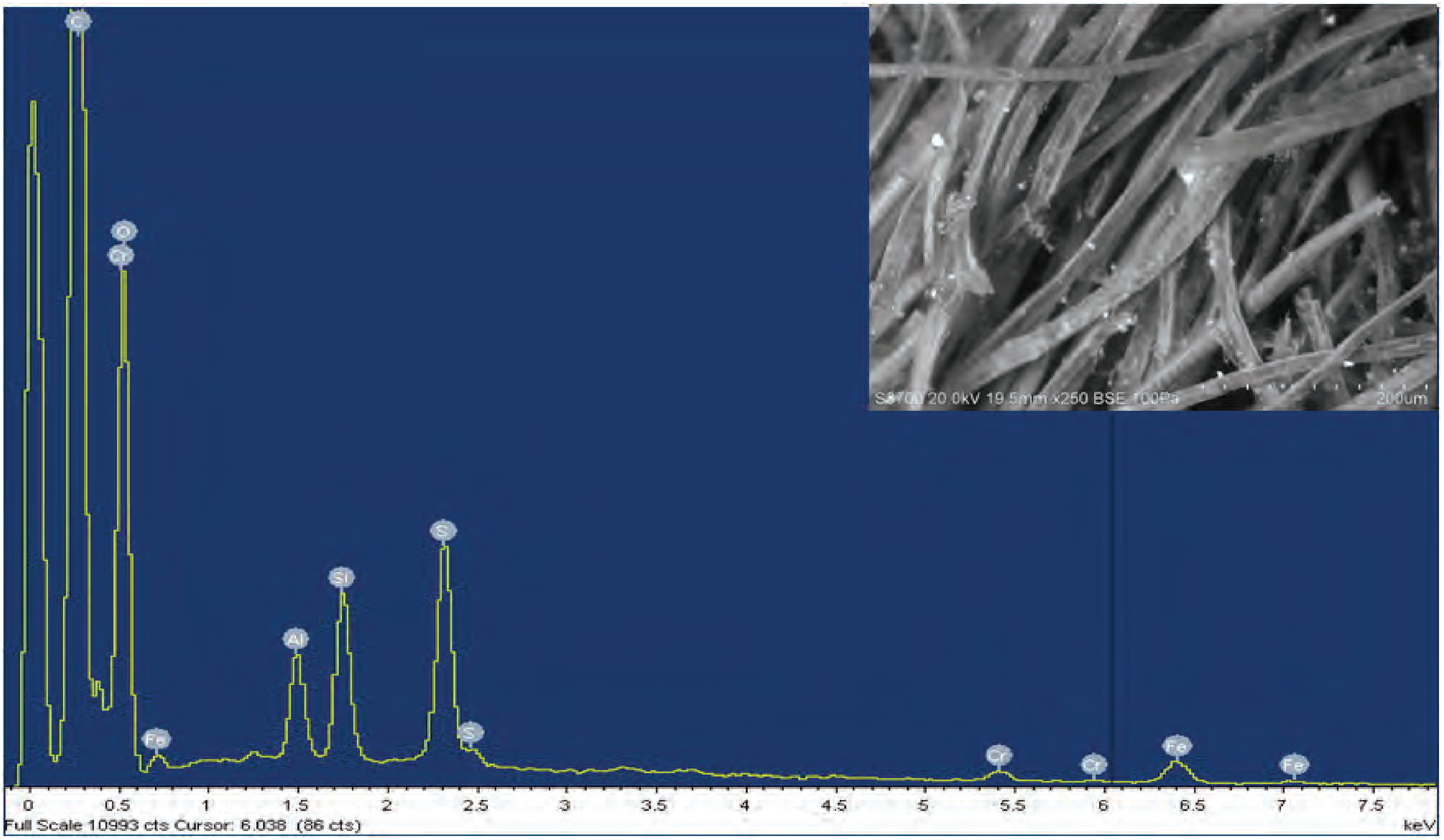


Figure 13. Sample 8031. Weight percentage average of elements detected by energy dispersive spectroscopy after cleaning with surfactant and soaking in ammonium citrate 5%.

in which the ice is slowly converted into water vapor condensing on the colder surface of the freezer. However, it may take several months for a larger piece of textile to dry. It took about six months for the sample to dry at -30°C compared to two months at -12°C. No visible changes were noted in either case.

Vacuum freeze drying was evaluated on a small wool sample that was previously frozen -30°C/-22°F) for three days. This sample was moved into the freeze dryer (Virtis 24Dx48) and treated for approximately a week at the coldest temperature setting (-46°C / -50.8°F).

The drying study is near completion, and it is believed that the best and safest approach would be non-vacuum freeze drying. Although atmospheric freeze drying takes longer, the process can be easily controlled and appears to be less risky for extremely degraded textiles. In vacuum freeze drying the sublimation may be too rapid and may cause structural damage to the fabric. Other studies (Jakes and Mitchell, 1992) have suggested that vacuum freeze drying may be detrimental to the fiber structure as well.

5. CONCLUSION

The excavation, identification and conservation of waterlogged textile associated with the commander of the H.L Hunley submarine, Lieutenant George Dixon has proven to be a technical challenge. Analysis of samples of the waterlogged fibers by variable pressure scanning electron microscopy (VP-SEM) and Fourier transform infrared spectroscopy (FTIR) provided valuable information about proteinaceous and cellulosic fibers present and their state of degradation after submersion for 136 years in seawater. Excavation of the block lifts undertaken whilst the blocks were fully immersed has proven to be a viable option for the handling of the extremely degraded and fragile textile fragments. Cleaning and drying techniques were also evaluated and their effect on the fibers assessed. Future treatment of the remaining lifted blocks will occur once the conservation protocols have been further refined and tested.

ACKNOWLEDGEMENTS

The authors would like to acknowledge senior archaeologist Maria Jacobsen for providing key information about Lt. Dixon, the crew and the associated artifacts in the submarine prior to excavation. Thanks also to Dr. Michael Drews for his expertise with the FTIR analysis and to archaeologists Michael Scafuri and Benjamin Rennison for their support with positioning block-lifts and providing 3D images of the site plan. We also would like to thank Liisa Nasanen and Alex Miniere for their help with the editing of this paper.

REFERENCES

Jacobsen, M. 2009. Conversation with the author, January.

Jakes, K., Mitchell, J. 1992. The recovery and drying of textiles from a deep ocean historic shipwreck. *Journal of the American Institute for Conservation.* Vol.33 (3): 343-353.

Mardikian, P. 2004. Conservation and Management Strategies Applied to Post-Recovery Analysis of the American Civil War Submarine H.L. Hunley (1864). *The International Journal of Nautical Archaeology.* 33 (1):137-148.

Nriagu J.O., Nieboer, E, eds. 1988. Chromium in the Natural and Human Environments*. Advances in Environmental Science and Technology Vol.20*. Wiley and Sons.

The Textile Institute. 1985. Identification of Textile Materials. Seventh Edition. Manchester.

FURTHER READINGS

Catling, D., Grayson, S. 1998. *Identification of vegetable fibers*. London. Archetype Publications.

Fields, J., Wingham, A., Hartog, F., Daniels, V. 2004. Finding substitute surfactants for Synperonic N. *Journal of the American Institute for Conservation.* 43: 55-73.

Fisher, S. 1998. The effect of freeze-drying on selected properties of wool fabric. *Textile Specialty Group Postprints*. Vol. 8: 53-61.

Gillard, R., Hardman, S., Thomas, R., Watkinson, D. 1993. Recent advances in textile studies using FTIR. *Conservation Science in the U.K. Preprints*. Glasgow: James & James Science Publishers Ltd. 71-76.

Gillard, R., Hardman, S., Thomas, R., Watkinson, D. 1994. The mineralization of fibres in burial environments. *Studies in Conservation*. 39: 132-140.

Hofenk de Graaff, J.1982. Some recent developments in the cleaning of ancient textiles. *Science and technology in the service of conservation.* IIC congress, Washington.

Peacock, E. 1996. Characterization and simulation of water degraded archaeological textiles: a review. *International Biodeterioration & Biodegradation*. *Elsevier Science Limited.* 35-47.

Tímár-Balázsy, A. and Eastop, D. 1998. *Chemical principles of textile conservation.* Butterworth - Heinemann Series in Conservation and Museology. Oxford: Butterworth-Heinemann.

Von Bergen, W. and Krauss, W. 1942. *Textile Fiber Atlas*. American Wool Handbook Company. New York: Textile Book Publishers.

Technical Information. Synperonic A7. http://www.conservation-by-design.co.uk/.

JOHANNA RIVERA obtained her Bachelor of Fine Arts with a Major in Art Theory and History from the Universidad de Chile in 2004, and continued her studies at the University to obtain her Postgraduate degree in Conservation and Restoration of Cultural Heritage. Her thesis research, which addressed conservation of marine artifacts, took her to Switzerland, where she participated in the conservation of metal artifacts from *El San Diego*, a Spanish galleon lost off the Philippines in 1600. Before graduating, Johanna worked for a variety of museums and conservation laboratories. Johanna joined the H.L.Hunley Project at the Clemson Conservation Center in 2005. Her work has included excavation of the submarine's interior, conservation of metals and waterlogged organic artifacts, conservation of the textile collection, analysis and photo documentation. Address: Clemson Conservation Center School of Materials Science and Engineering, Clemson University, 1250 Supply Street, North Charleston, SC 29405, Telephone: (843) 744-2974 ext. 20, Facsimile: (843) 744-1489, Email: jrd123@clemson.edu.

THE CLEANING OF AN 18TH CENTURY FINGER WOVEN WOOL SASH: A PRACTICAL TWIST ON COMMON WET CLEANING METHODS

CATALINA HERNANDEZ & SUSAN HEALD

ABSTRACT – A cleaning methodology was devised for a late eighteenth-century finger woven wool sash from the Great Lakes region. The sash, one component of an outfit to be highlighted in a long term exhibition at the National Museum of the American Indian, was heavily soiled with dark discoloration, a stiff, gritty hand and was too fragile to put it through immersion wet cleaning. Drawing on the authors' previous experiences with wet "contact" cleaning, and non-surfactant cleaning alternatives taught by Richard Wolbers, a successful strategy was developed employing a sprayed citric acid chelating solution, and a conductivity-adjusted rinsing solution that approximated the conductivity of the soiled sash. The treatment strategy removed significant soiling from the sash, resulting in a brighter appearance and a softer hand.

RESUMEN – Una metodología de limpieza fue desarrollada para un cinturón tejido en lana del siglo diez y ocho, proveniente de la región de los grandes lagos. El cinturón, que es uno de los componentes de un traje que será destacado en una exhibición a largo plazo en el Museo Nacional del Indio Americano, presentaba bastante suciedad, la cual causaba manchas oscuras y generó una textura rígida y áspera. Gracias a la experiencia previa de los autores con limpieza en húmedo de "contacto", y basado en las alternativas al lavado con surfactantes dictadas, por Richard Wolbers, una estrategia exitosa fue desarrollada empleando una solución acuosa en espray de ácido cítrico como agente quelante, y otra solución acuosa para enjuague cuya conductividad fuera aproximada a la del cinturón. La estrategia de tratamiento removió una cantidad significativa de suciedad del cinturón, resultando en colores más vivos y una textura más suave.

1. INTRODUCTION

This paper was presented at the Textile Specialty Group Session of the American Institute for Conservation 37th Annual Meeting, Los Angeles. Traditional wet cleaning is a procedure that can provide improvements to the condition of a soiled textile, but at the same time poses considerable risks because of the physical stress the object is subjected to during repeated immersions. When preparing a finger woven wool sash belonging to an eighteenth-century outfit for a major exhibition at the National Museum of the American Indian (NMAI), several factors were taken into consideration when devising the treatment strategy. These factors included the importance of the sash and rest of the outfit within NMAI's collection; and the context of the outfit within the exhibition as a focal point, which placed significant importance on its aesthetic appearance and physical stability. Another consideration was the sash's condition: it was fragile and had a soiled appearance and gritty hand. Potential aesthetic improvements had to be weighed against the risk of putting the sash through wet cleaning.

After determining that a traditional surfactant-based wet cleaning treatment would be too risky based on the sash's condition, it appeared to the authors that the desired aesthetic and physical improvements to its condition could still be obtained if they searched outside of traditional wet cleaning treatments. This traditional procedure was re-designed to meet the needs of this particular object. The purpose of this paper is to explain how the authors designed a safe and effective aqueous cleaning treatment strategy that did not involve surfactants, by combining their treatment experience of contact cleaning with the information developed by Richard Wolbers and taught at his 2007 workshop Aqueous Cleaning Methods for Textile Conservators.

2. THE SASH AND THE FOSTER OUTFIT

The Foster outfit, so known because it was collected by or perhaps gifted to a young British Army officer named Lieutenant Andrew Foster, consists of the sash, a man's shirt, feather bonnet, leg bands, tobacco pouch, neck pendant, earrings, leggings, and moccasins. Foster acquired them between 1792-1795 when he served at Fort

Michilimackinac. This British fort was strategically located on Mackinac Island in the straights between Lake Huron and Lake Michigan, and was a hub of fur trade from eastern Canada to the western plains, with many peoples and cultures moving through the area in this time period. Many of the components that Foster collected, were made by indigenous hands, and utilized a variety of trade materials such as commercially produced cloth and yarn, glass beads, and silver brooches.

When Foster returned to England in 1800, it is likely that this collection went to his family in Warwickshire where it stayed until 1936 when it was transferred to a British museum (Hill and Hill, 1994). Thirty years later in 1966, George Gustav Heye acquired Foster's collection for the Museum of the American Indian, the precursor of NMAI. Heye exhibited the collection in a single display case with items lying on the case floor or pinned to the case walls. At this time it was not yet clear whether these objects were indeed intended to be worn as an outfit. In 1995, when the original museum was closed, the pieces were deinstalled and transferred to the museum's former storage facility in the Bronx. In 2001 the Foster collection was again moved to the NMAI's new storage facility at the Cultural Resources Center (CRC) outside of Washington DC. In 2006 some of the items were chosen to once again go on display as a focal point in the "Infinity of Nations" exhibition, representing one of the museum's earliest collections of ethnographic material.

3. INFINITY OF NATIONS: REASON FOR TREATMENT

The "Infinity of Nations" exhibition, developed as a semi-permanent exhibition for the George Gustav Heye Center in New York City, features approximately 800 museum objects which highlight the breadth of NMAI's collection and represent 10 geographic regions of the Americas. Each region has a focal point containing objects which can be dated to a specific time period and are associated with particular places or people. The Foster outfit is the focal point for the Woodlands region and examines how Foster might have come by his collection of Native American material; either as a result of a diplomatic gift from the Anishnaabe peoples seeking British alliance (Foster was "made a chief" according to his family's oral history), or as a result of collecting Indian "curiosities" while stationed in North America (Gantaume, 2009).

As with most of the exhibitions developed within NMAI, cultural consultants and academic scholars were invited to help select and interpret the collection items to be displayed in "Infinity of Nations." The conservation department also hosted conservation consultations to help conservators understand the context of the pieces and to discuss treatment options, particularly for objects serving as focal points for the exhibit. Dr. Ruth Phillips, art historian, and Michael Witgen (Red Cliff Ojibwe), historian, selected the Foster outfit during a curatorial consultation for "Infinity of Nations." They recommended Dr. Anton Treuer (Leech Lake band of Ojibwe), a professor of Ojibwe language, as a potential cultural expert for further consultation on treatment issues for the outfit, such as the polishing of the silver friendship brooches on the shirt and feather bonnet.

A conservation consultation with Treuer was held in 2008 to address how the objects would be displayed and what conservation treatments were appropriate for their cultural context. There was discussion concerning for whom these objects were actually made, how they were acquired by Foster and whether they were meant to be worn together as an outfit. Treuer gave his insights on historical context, materials and design, which led to discussion of how these objects were intended to look. When the consultation group placed components of the outfit on a mannequin to assess display options, the coordination in color scheme and design elements made it more evident that they were likely intended to be worn together as an outfit. Regarding many aspects of treatment, it has been learned from past consultations at NMAI that there are handling guidelines applied to certain types of objects, such as gender-specific items, which must not be handled by the opposite gender. Treuer conveyed that in his opinion there was no cultural handling or treatment protocol that needed to be observed within the museum context involving these objects, and that he trusted the conservators' professional expertise in determining how to stabilize and clean the pieces.

4. THE SASH: TECHNOLOGY AND CONDITION

This type of sash would have been used as a belt tied around the waist of the wearer to hold clothing together and to help carry equipment such as belt pouches or knife sheaths. Aesthetically, its design is very similar to that of the sashes made by the Métis peoples in Canada, sashes that are often referred to as "Centuire Fleche" (arrow belt), because of their beautiful multicolored arrowhead designs (Barkwell et al. 2006, 81). In this case, the sash is made of three separate finger woven strips: two narrow dark brown strips incorporating a zigzag row of white beads. These narrow strips are sewn to the sides of a wider piece which composes the main body creating the arrow head designs in brown, green, yellow, light blue and red lines. The wool yarns that compose the weave extend at both ends of the sash and are plied or braided together to form long fringes, making the sash approximately 127 cm long and 11 cm wide (fig. 1).

Figure 1. The Foster Sash. Catalogue No. 242004.000.
Courtesy National Museum of the American Indian.

The overall condition of the sash was relatively good, but there was concern about its structural stability and the soiling present over the surface of the wool fibers. Its general feel was gritty, stiff and slightly brittle, suggesting that the fibers must have suffered from some degree of deterioration and soil accumulation during prolonged display and repeated handling for travel. A few areas were also discolored by the soiling, giving the sash a patchy stained appearance that contrasted with the brighter colors found on the previously protected areas. There was little or no superficial particulate soiling that could be collected during surface cleaning with vacuum suction or with cosmetic sponges. Other condition issues consisted of a few scattered holes, broken stitching threads and broken yarns within the fringe.

5. TREATMENT OPTIONS

Surface cleaning of the sash proved difficult because vacuum suction, localized aqueous spot cleaning and cosmetic sponges not only removed little soiling, but dislodged considerable amounts of fibers from the fragile wool yarns. Therefore the authors looked for a cleaning method that would remove as much soiling as possible, humidify the wool fibers and improve the sash's overall feel in one procedure, while minimizing the amount of stress. Immersion surfactant wet cleaning would be a typical choice to achieve this. However, in this case overall immersion in a foaming surfactant solution followed by multiple rinses would be too physically stressful, causing more fiber loss and potential damage than would be acceptable, and thus aqueous contact cleaning was considered.

Aqueous contact cleaning without the use of a surfactant, if properly designed, is a procedure which allows for more controlled wetting and can result in even soil removal over the whole surface of the object. It also allows the conservator to focus cleaning on especially soiled areas. Typically only water is used for the procedure. It is sprayed onto the textile surface and then blotted with an absorbent material which receives the dissolved soil from the textile. Because it is not immersed and a surfactant is not used, no immersed rinsing is necessary and handling is minimized (Johnson-Dibb 1995).

Serendipitously, a few months prior to the sash cleaning, Richard Wolbers, Associate Professor and Coordinator of Science and Adjunct Paintings Conservator at the University of Delaware Art Conservation Program, presented the workshop "Aqueous Cleaning Methods" hosted by NMAI's textile conservation lab during the 2007 North American Textile Conservation Conference (NATCC). The first part of the workshop covered aqueous cleaning solution parameters: pH, ion species concentration, chelation, and surfactants. Though Wolbers has not published any information specific to cleaning textiles to date, his book "Cleaning Painted Surfaces: Aqueous Methods" discusses some of the same concepts presented in the workshop (Wolbers, 2000). Wolbers suggests that a potentially more efficient and safer alternative to the traditional wet-cleaning with surfactants is to control the solution's pH, the ion concentration or conductivity, and use a chelating agent. To clean the sash, it appeared that the concepts of chelation and conductivity control could be used in conjunction with a contact cleaning method, potentially removing more soiling than water alone.

5.1 ION CONCENTRATION

Wolbers emphasizes the importance of understanding the relationship between conductivity of the textile and that of the wash and rinsing solutions. Conductivity is the measure of a solution's ability to conduct an electrical current and is the inverse of resistivity, commonly used to measure deionized water. Wolbers estimates that the average conductivity of a soiled textile is between 300 – 600 micro Siemens (µS). Subjecting the textile to ion-starved deionized water would aggressively pull ions from the fibers until the solution reaches an equilibrium, placing significant stress on the fibers, especially if they are already degraded. If the conductivity levels of the solutions used are equal to or greater than that of the textile, then the pull of ions is less aggressive therefore reducing the potential for stress on the fibers. According to Wolbers the target conductivity for any cleaning solution, whether a surfactant or chelating solution, should range between the conductivity of the textile and twenty times that amount. Therefore, if the conductivity of the soiled textile is 400µS, then the cleaning solution's conductivity should be between 400 and 8000µS.

Solution	Conductivity	Resistivity	Dissolved solids
Deionized water	2 µS	500,000 Ω-cm	1 ppm
Reverse osmosis	100 µS	10,000 Ω-cm	50 ppm
Tap water	200 µS	5,000 Ω-cm	100 ppm
NaCl 2.25 g/L	450 µS	2,200 Ω-cm	227 ppm
Citric acid 5g/L	4,700 µS	210Ω-cm	2380 ppm

Table 1. Conductivity and resistivity values of different types of water and solutions used in treatment.

Table 1 gives some approximate examples of the conductivity and resistivity of several types of water and cleaning solutions prepared at the textile conservation lab at NMAI. Pure deionized water, is typically listed as 18 MΩ-cm, 0.055µS or 0.028 ppm dissolved solids; As seen in the table, as conductivity rises, resistivity decreases.

A Horiba Twin Cond conductivity meter B-173 was used in Wolber's NATCC workshop and during treatment of the sash. It works by dipping the end of the meter into a solution, or placing a drop of solution in the small well at the tip of the meter; the conductivity value is shown on a small screen. To measure the conductivity of any textile, a drop of water is placed on the fabric and sucked up and down with a small syringe or pipette, and then transferred to the tip of the conductivity meter. Measurements were taken from several areas of damage on the sash, which averaged 480µS.

5.2 CHELATING AGENTS

A chelating or sequestering agent works by bonding with di- and tri-valent metal cations to create a water soluble metal/chelate complex that renders the cations incapable of further reaction and allows them to be rinsed away. Chelating agents have different strengths (dissociation constants) which determine their ability to hold on to or "sequester" metal ions. A chelating agent for cleaning historic textiles must have the strength to hold on to metal ions in soil, but not so much strength that it could sequester metal ions used as mordants, which would cause dye bleeding. Three chelating agents were used in the workshop, from weakest to strongest: citric acid, nitrilotriacetic acid, and ethylene diamime tetra acetic acid (EDTA). In this case, the condition of the sash made it preferable to use a weaker chelating agent for treatment. Citric acid is a common naturally occurring organic acid and chelating agent that is also often used as an additive to enhance the efficiency of commercial detergents for its ability to sequester metallic soils in hard water, and as a food additive for preservation and flavoring (Budavari 1996). It is one of the weaker chelating agents, but works over a fairly wide pH range and tri-sodium salt of citric acid can also work as a buffer (Timar-Balaszy et al. 1998). It is for these reasons that citric acid solution was chosen for the wash solution for the treatment of the sash.

The metal/chelate complexes must be rinsed away from the textile in order to remove the di – tri valent cations in the soiling. By using a final salt solution containing monovalent ions, such as sodium or potassium, which approximates the original conductivity of the textile, ions are replaced, leaving the surface conductivity of the textile similar to what it was before carrying out the treatment here described A conductivity adjusted sodium chloride solution was therefore chosen as a rinsing solution to remove the metal/chelate complexes.

Two preliminary contact cleaning tests were performed to ensure that these options would indeed be effective for soil removal. The first test was carried out using distilled water alone, before considering alternatives presented in the "Aqueous Cleaning Methods" workshop. With distilled water a good amount of solubilized soil was absorbed into the blotters. The second test used a 0.5% w/v citric acid chelating solution. Though initially the citric acid did not remove as much soiling as distilled water alone, the rinsing solution used to flush out the citric acid removed almost twice as much soiling as distilled water, making it much more effective.

6. TREATMENT

Once the procedure and chelating agent were selected, the pH and conductivity of the sash were measured. pH indicator strips gave readings between 4.5 and 6.5; the average conductivity was 480µS. A chelating solution was made using a stock solution prepared by Wolbers for the "Aqueous Cleaning Methods" workshop, consisting of 25g of citric acid in 500 ml of deionized water, and buffered to a pH of 6.7 with sodium hydroxide. The stock solution was then diluted 1:10 in deionized water to make a working solution of 5g/L or 5% w/v. Its conductivity measured 4700µS, approximately 10 times that of the sash, placing it within an acceptable range between one and twenty times the conductivity of the textile. A rinsing solution using of 2.25g/L of sodium chloride was prepared; its conductivity measuring 450µS which was close to that of the sash.

Areas not being treated were protected with sheets of polyethylene and paper towels laid at the edges to absorb excess liquid. Blotting paper was placed under the area being treated, to absorb the solubilized soil that came through the textile.The sash was laid flat on a table, and areas of 20 x 15 cm were cleaned sequentially (fig. 2).

Figure 2. Blotting of the treated area of the sash, using thick blotter paper and a paint roller.

The treatment process involved the following steps:

1. Spraying citric acid solution over the area to be cleaned and allowing a standing time of 30 seconds.
2. Gently tamping to encourage movement of the solution through the textile, using a brush over a cotton flannel cloth which was lightly sprayed with the citric acid solution.
3. Repeating steps 1 and 2.
4. Blotting treated area with extra thick blotter paper and a paint roller, to apply even pressure.
5. Spraying rinse solution over the treated area and blotting using extra thick blotter paper. This was repeated an average of 3 times, 4 times if heavy soiling continued to come out of the textile.
6. Sandwiching the cleaned area between two pieces of thinner blotting paper until the whole of the sash had been cleaned.

During cleaning the same phenomenon was observed as during testing. Although soiling was removed during tamping (fig. 3), much more was removed during rinsing, which was clearly visible on the pieces of blotting paper used to receive the soiled liquid (fig. 4). Both sides were treated in the same manner. The sash was then laid flat over a large piece of cotton flannel, sprayed once more with the rinsing solution and covered with another piece of cotton flannel to wick away any residual water-soluble soil remaining in the textile through capillary action (fig. 5). A fan was placed at one end of the sash to accelerate the drying process.

Figure 3. Detail of the soiling absorbed by a piece of cotton flannel cloth used to cover the sash during tamping with a brush after spraying of the citric acid solution.

Figure 4. Detail of the soiling absorbed by a piece of thick blotter paper used to absorb the rinsing solution.

Figure 5. Detail of the cotton flannel cloth placed over the sash during drying showing residual water-soluble soil being wicked away from the textile.

Figure 6. Detail of a soiled area of the sash; before treatment on left, after treatment on right.

7. CONCLUSIONS AND RESULTS

There was a significant amount of soiling that was visible on the blotting paper and cotton flannel in the form of dark brown, grey and yellow stains as well as staining on the cotton flannel drying cloth. The importance of rinsing cannot be overemphasized; it is during the rinsing stage that the metal/chelate complexes formed by the chelating agent are actually removed from the textile, which is why removing as much rinsing solution as possible is also important. The fact that the drying cloth continued to visibly remove soluble soil from the sash during the drying process is evidence of this.

The pH and conductivity of the sash were re-taken after treatment; the pH range remained the same as before treatment (between 4.5 and 6.5). However, the conductivity measured 390µS (as opposed to 480µS originally), somewhat lower than expected, but still within a reasonable range.

The real success of this treatment can be readily seen on the appearance and texture of the sash (fig. 6). Not only was the staining much reduced and the brightness of the colors enhanced, but the feel of the wool yarns also improved considerably, as they lost their gritty stiff hand and became more supple, soft and pliable. Based on the success of the treatment of the sash, the authors would consider using this cleaning methodology again because of its potential efficiency for certain types of highly soiled, fragile textiles that could benefit from aqueous cleaning, but could not withstand a traditional immersion wet cleaning.

ACKNOWLEDGEMENTS

The authors would like to thank the members of the conservation department of the NMAI who participated in this project at the time, especially Sarah McNett, who presented a paper on the Conservation consultation for the Foster outfit and cleaning of the silver friendship brooches on the shirt and headdress, at the 2009 Canadian Association of Conservators conference.

REFERENCES

Barkwell, L., L. M. Dorion, and A. Hourie, eds. 2006. *Metis legacy II: Michif culture, heritage, and folkways. Canada: Library and archives Canada cataloguing in publication*. Saskatoon: The Gabriel Dumont Institute of native Studies and Applied Research. (Co-publisher). Winnipeg: Pemmican Publications. (Co-publisher).

Budavari, S., ed. 1996. *The Merck index*. 12th ed. White House Station, New Jersey: Merck Research Laboratories. 392.

Ganteaume, C. 2009. *Unpublished manuscript for Infinity of Nations Exhibition*. Suitland, MD: National Museum of the American Indian Cultural Resources Center.

Hill, T., and R.W. Hill, eds. 1994. *Creations journey: Native American identity and belief*. Washington DC: Smithsonian Institution Press. 183.

Johnson-Dibb, R. 1995. Contact cleaning of textiles. *AIC Textile Specialty Group Postprints*, ed. P. Ewer and B. McLaughlin. American Institute for Conservation 23rd Annual Meeting, St. Paul, MN. Washington DC: American Institute for Conservation. 35-37.

Timar-Balazsy, A., and D. Eastop. 1998. *Chemical principles of textile conservation*. Oxford: Butterworth-Heinmann. 221-225.

Wolbers, R. 2000. *Cleaning painted surfaces: Aqueous methods*. London: Archetype Publications LTD.

SOURCES OF MATERIALS

Horiba Twin Cond conductivity meter B-173
Horiba Instruments Ltd
Kyoto Close,
Moulton Park Industrial Estate,
Northampton.
NN3 6FL
+44 (0) 1604 542 500
Fax. +44 (0) 1604 542 699
enquiries.hil@horiba.com

Citric acid
Sigma-Aldrich
Customer Service
PO Box 14508
St. Louis, MO 63178
(1) 800-325-3010
Fax: 800-325-5052
http://www.sigmaaldrich.com/sigma-aldrich/home.html

Sodium Chloride
Cellomics
(Sold as Thermo Scientific brand)
100 Technology Drive
Pittsburgh
PA 15219 USA
+1 412-770-2326
Fax: +1 412-770-2224
http://www.fishersci.com/wps/portal/HOME?LBCID=73354240

Thick blotter
Archivart
40 Eisenhower Drive
Paramus, NJ 07652
(800) 804-8428
fax: (888) 273-4824
askarchivart@nbframing.com
http://www.archivart.com/

Cotton flannel
Testfabrics, Inc
415 Delaware Avenue
PO Box # 26
West Pittiston, PA 18643
(1) 570-603- 0432
Fax.: (1) 570-603-0433
testfabric@aol.com
http://www.testfabrics.com/

CATALINA HERNÁNDEZ is an MA Textile Conservation Graduate from the Textile Conservation Centre, University of Southampton (2007) and has a BA in Conservation and Restoration of Cultural Heritage from the Universidad Externado de Colombia (2003). As a Textile Conservator she has worked on archaeological, historic and ethnographic objects at the Museo del Oro de Bogotá, the Museum of London and the Textile Conservation Centre in the UK and as a Mellon Textile Conservation Fellow at the Smithsonian Institution's National Museum of the American Indian. Address: Cra. 16 No. 112-06. Apt. 401. Bogotá, Colombia. S.A.; catgoher@hotmail.co.uk.

SUSAN HEALD joined the National Museum of the American Indian in 1994, becoming senior textile conservator in 2001. She was the textile conservator at the Minnesota Historical Society from 1991-1994, and a Smithsonian Conservation Analytical Lab postgraduate fellow in 1990. She holds an MS in art conservation, textile major/objects minor, from the University of Delaware/Winterthur Museum, and a BA in chemistry/anthropology from George Washington University. Address: National Museum of the American Indian. Cultural Resources Center, 4220 Silver Hill Road, Suitland, MD 20746; healds@si.edu.

AN ALTERNATE APPROACH FOR RUG & CARPET CLEANING

DEBORAH LEE TRUPIN

THIS INFORMATION WAS PRESENTED IN THE TIP SESSION
OF THE 2009 TEXTILE SPECIALTY GROUP MEETING

ABSTRACT– This paper, presented as a "tip" in the Textile Specialty Group session at the 2009 AIC Annual Meeting, describes the use of a wet/dry vacuum to clean a rug from Staatsburgh State Historic Site. Because the large, heavy rug had red dyes that were not water-fast, an alternate to immersion wet cleaning was desired. The carpet was successfully cleaned using the Bissell Big Green Clean Machine. This paper describes the procedures used and discusses the pros and cons of using this technique for rug cleaning.

1. INTRODUCTION

A 1905 rug with cotton warp and weft and thick wool pile from Mrs. Mills's boudoir (office/sitting room) at Staatsburgh State Historic Site in Staatsburgh, NY, was heavily soiled from old coal soot. A previous non-conservation cleaning had caused dyes in both original and repair red pile yarns to bleed (figs. 1, 2). The site requested that the rug be cleaned as part of the boudoir's restoration. Besides improving its appearance, cleaning the rug would remove the coal soot and improve the prospects for preservation. The size (approximately 14' x 18') and weight (about 100 pounds) of the rug combined with the previous dye bleeding and tests that showed that the red dye would continue to bleed when wet argued against wet cleaning in the textile conservation lab.

Figure 1. Staatsburgh State Historic Site rug before treatment; partial view showing size of rug. Note that the very bright red-orange areas near the center are repair yarns that were removed before the cleaning treatment; these visually disturbing repairs covered stable areas of the rug's ground weave.

Figure 2. Staatsburgh State Historic Site rug before treatment; face, proper right bottom, showing red dye staining and overall soiling.

Figure 3. Tina Kane demonstrating use of Bissell Big Green Clean Machine to the author and Abby Zoldowski.

The first alternative approach considered was collaboration with a commercial rug cleaner. Discussions with a specialized rug cleaner recommended by Robert Mann of Denver (who has collaborated on such projects with textile conservator Jeanne Brako) did not prove fruitful. The next idea was to ask Cristina Carr at the Metropolitan Museum if she could recommend a rug cleaner. Instead, she suggested Tina Kane, who worked at the Metropolitan Museum and is also a textile conservator in private practice, specializing in tapestries and rugs. Tina described using the Bissell "Big Green Clean Machine" for similar rug cleaning projects. She said she had learned about the machine and its conservation applications from Ronnee Barnett, a conservator in private practice in New York's Hudson Valley, and Nancy Britton, upholstery conservator at the Metropolitan Museum. Tina was contracted to come to Peebles Island to test if this machine might be a way to clean this rug. Tina would also demonstrate techniques for using the machine. The testing showed that this would be a rather successful treatment for the rug (figs. 3, 4).

Figure 4. Detail of test cleaning area of Staatsburgh State Historic Site rug.

The "Big Green Clean Machine" is a type of wet/dry vacuum that was marketed to consumers for home floor, rug, and upholstery cleaning. Although the machine is no longer made, it can be purchased used. The body of the machine has an outer section that holds clean water and an inner one into which the used, dirty water is suctioned. It has a suction hose with a 3" wide nozzle and a spray grip, similar to that used on garden hoses. A tube connected to the hose feeds water to the spray nozzle that is just below the suction nozzle (fig. 5).

The use of the Big Green Clean Machine in conservation is a slight variation on the home methods. The manufacturer's instructions called for a proprietary rug and carpet cleaning fluid to be added to the water chamber. For conservation use, only clean water is put into the machine. Any detergent desired is applied manually. Cleaning a rug or carpet with this machine is essentially an alternative to, or variation of, other non-immersion and/or suction cleaning techniques used by textile conservators. Research in preparation for this paper showed that variations using other wet/dry vacuums had been published in Europe (Barnett 1998; Howard 1998).

Figure 5. Bissell Big Green Clean Machine.

2. METHODOLOGY

Before using the Big Green Clean Machine, the rug was vacuumed, then surface cleaned with vulcanized rubber (a.k.a. "dry" or "dry cleaning") sponges, then vacuumed again to remove any crumbs from the sponges. These last two steps were done just before a section of the rug was cleaned with the Big Green Clean Machine.

To facilitate access to the rug, it was rolled, pile side out, on a wide tube. The tube was suspended in Ethafoam cradles placed on the back side of the work tables. The padded work tables were covered with polyethylene sheeting, to keep the padding layers dry. Cotton towels were spread directly below the section of the rug to be cleaned. One end of the rug was unrolled, face up, onto the prepared work table. As cleaning progressed, the cleaned part of the rug was rolled onto another tube. This tube was suspended on Ethafoam cradles that were supported on footstools at the front side of the work table, below the work surface.

Working in sections about 12 – 20" wide x 20 – 24" long, the Staatsburgh State Historic Site rug was cleaned using the following technique (fig. 6):

1. Clear water was sprayed on and suctioned off twice. The section was then again lightly suctioned.

2. A non-ionic detergent solution[1] was sponged onto the rug. Because of the sensitivity of the red yarns, the detergent solution was not applied directly to the red areas. In the sturdier white, yellow, and green areas, the detergent solution was massaged into the pile with the sponge.

3. Clear water was sprayed and suctioned, then the section was suctioned again without spraying water. This step was repeated three times, providing three rinses. More water and less suction were used on the first rinse, while less water and more suction were used on the third rinse. Sampling of water removed by each rinse during the cleaning of one section helped to determine the number of rinses that were needed.

4. The section was then suctioned until only a minimal amount of water was being drawn up into the nozzle.

5. Red areas in the section were covered with blotting paper and a small bag weight. The entire section was covered with a cotton flannel cloth. The blotting papers and weights were left in place for about 1 hour, after which they were removed and the cotton flannel replaced. Because much of the water had been removed from the rug by the suctioning, the flannel was not applied as a drying cloth (i.e. it was not in close contact with the rug and was not expected to wick up any staining), but rather just to keep the rug protected from airborne soils as it dried.

6. At the end of a day's cleaning session (usually about 1/3 of the 14 foot width of the rug), the cleaned section was lifted to remove the towels below it and placed over a "drying hoop" - a semi-circular construction of Ethafoam hoops and polypropylene mesh. The cotton flannel was again placed over the rug.

7. A small fan was put at the end of the rug, blowing into the drying hoop, to dry the rug from below. A floor fan circulated air across the top of the rug (fig. 7). The fans were left on overnight.

3. DISCUSSION

The stages in cleaning the Staatsburgh State Historic Site rug with the Big Green Clean Machine were very similar to those observed during an immersion wet cleaning. The first wetting removed a small amount of soil and also generated suds in the machine's suction head, evidence of detergent being left from the previous cleaning. The first rinse after the detergent removed the most soil; it was at that point that the rug was visibly cleaner. The second and third rinses removed more of the detergent, but did not visibly remove more soils.

This methodology was very successful for cleaning this rug (fig. 8). A considerable amount of soil was removed, so that the overall tone of the rug changed from a grey-ish to a yellow-ish off-white. This tone is believed to resemble the original and is appropriate to the boudoir, which is painted a yellow-cream color and has gilded decorations and gilded furniture. After cleaning, the wool pile was more lustrous and had a softer feel. Although as expected, the red yarns continued to bleed, there was no additional staining on the rug; the bleeding was observed only on the blotters placed on the rug after cleaning and on the towels below it.

Figure 6. Cleaning the Staatsburgh State Historic Site rug with the Bissell Big Green Clean Machine.

Figure 7. Drying the Staatsburgh State Historic Site rug. The area just cleaned is raised on the Ethafoam and polypropylene mesh supports, with a small fan blowing through the raised "tunnel."

There are some drawbacks and considerations in using this method to clean a rug. The primary consideration is that the suction on the Big Green Clean Machine is quite strong. This is what makes the technique work well for bleeding dyes, but also presents a risk to less sturdy rugs. Some fiber was pulled from the rug as the cleaning progressed. The amount was judged acceptable and comparable to, or less than, what would have been lost in an immersion wet cleaning.

Several people in the lab took turns working on the rug. Attempts were made to standardize the rate of work and the amount of water used in each section. While the results do not show the different "hands," it was noted that each person worked at a different rate and used varying amounts of water.

Figure 8. Staatsburgh State Historic Site rug after treatment, detail, face, proper right bottom.

Cleaning a rug of this size with this technique took a tremendous physical toll. While immersion wet cleaning this type of rug is also very physically demanding, the hard work takes between one and three days, depending on the amount and type of set-up and clean-up needed. Cleaning with the Big Green Clean Machine took approximately 140 hours, spread over about 30 sessions. Because of the size of the rug, three to four people were needed each time the rug had to be repositioned. This was a bit of an imposition of colleagues and at times, a hindrance to advancing the work.

4. CONCLUSION

While not appropriate for every object, the "Big Green Clean Machine" may be a useful tool for some textile conservation cleaning projects. Thick rugs that are fairly sturdy but have yarns that are not water-fast are the most obvious candidates for cleaning with this machine. As with any cleaning method, the materials and techniques must be carefully tested before embarking on the treatment.

ENDNOTES

1. The detergent solution was: 10 g Synperonic N®, 5 g Sodium Citrate, 0.25 g sodium carboxymethyl cellulose (low viscosity) in 500 ml de-ionized water weight/volume, diluted 1:9 volume/volume in de-ionized water and that solution diluted 1:1 volume/volume in de-ionized water. About 200 ml of the diluted solution was used to clean each section of the rug. This mixture was adapted from that published by the Victoria and Albert Museum (Haldane 1999). Synperonic N has been banned in Europe, but is still permitted n the US. While generally environmentally concerned, OPRHP conservators feel that the amount of Synperonic N used in a few wet cleanings each year does not present a significant environmental risk. Fields, et al (2004) have published research on substitute surfactants for Synperonic N.

ACKNOWLEDGEMENTS

Thanks to Cristina Carr for suggesting Tina Kane, to Tina Kane for sharing and demonstrating her techniques, and to Nancy Britton and Ronnee Barnett for developing the idea for this technique. Thanks to Peebles Island Textile Lab volunteers - Joan Couch, Ann Langhauser, Pat Opar, and Pat Sweeney – for dry sponging and vacuuming the rug. Thanks to lab colleagues - Sarah C. Stevens, Abby Zoldowski, and Ruth Potter – for assistance with cleaning and to all Peebles Island colleagues who responded to endless requests for help in moving the rug. Additional thanks to Rich Clauss, Peebles Island photographer and to Sarah C. Stevens for videography.

REFERENCES

Barnett, J. 1998. The use of a domestic water extracting vacuum cleaner in the wet cleaning of carpets and tapestries. In International Perspectives on Textile Conservation, ed. A. Timar-Balaszy and D. Eastop. London: Archetype Publications. 29-31.

Fields, J.A., A. Wingham, F. Hartog, and V. Daniels. 2004. Finding substitute surfactants for Synperonic N. Journal of the American Institute for Conservation 43(1): 57-61.

Haldane, E-A. 1999. So That's Why Textile Conservation Has Such a Big Studio! V&A Conservation Journal 32: 17-20.

Howard, S. 1998. An introduction to the wet cleaning of carpets. In International Perspectives on Textile Conservation, ed. A. Timar-Balaszy and D. Eastop. London: Archetype Publications. 26-28.

SOURCES OF MATERIALS

Big Green Clean Machine – originally made by Bissell, no longer manufactured, but available from on-line sources such as E-Bay.

Polypropylene mesh – #XN-2170 - Industrial Netting,
7681 Setzler Pkwy N.
Minneapolis, MN 55445
800-328-8456 (in USA and Canada)
Phone: 763-496-6355
Fax: 763-496-6356
http://www.industrialnetting.com

DEBORAH LEE TRUPIN received an MA in art history and Diploma in Conservation from New York University's Institute of Fine Arts, Conservation Center. Since 1986, she has been Textile Conservator for New York State Office of Parks, Recreation and Historic Preservation's Bureau of Historic Sites (Peebles Island) in Waterford, NY. She is responsible for the conservation of the textile and upholstery collections of the 35 state-run historic sites, as well as for supervising the New York State Battle Flag Preservation Project. Address: New York State Office of Parks, Recreation and Historic Preservation, Bureau of Historic Sites, Peebles Island Resource Center, PO Box 219, Waterford, NY 12188. E-mail: Deborah.Trupin@oprhp.state.ny.us.

All images courtesy of Staatsburgh State Historic Site, New York State Office of Parks, Recreation and Historic Preservation.

DIGITIZATION VIDEO OF CHINESE LAST EMPIRE DRESS CODE

DR. SHU-HWA LIN

THIS INFORMATION WAS PRESENTED IN THE TIP SESSION
OF THE 2009 TEXTILE SPECIALTY GROUP MEETING

ABSTRACT—This project, presented as a "tip" in the Textile Specialty Group session at the 2009 AIC Annual Meeting, involves the production of an educational documentary DVD entitled, Threads of Majesty: Tapestry and Embroidery for Ranking Qing Dynasty Officials. The DVD will display Chinese textiles from the Qing Dynasty, which have been donated to the University of Hawai'i at Mānoa and talk about their significance in terms of rank and symbolism. The DVD will demonstrate the complexity of the dress of the Qing Dynasty by giving the viewers a visual presentation of the different garments that were worn. The DVD will also explain the different symbols, motifs, color patterns, and textile techniques, and how they can be interpreted to give us a better understanding about the important themes, beliefs, and ways of life during this time. The documentary will result in increased understanding and appreciation of this part of Chinese history. The reason behind preserving these artifacts in DVD form is because of their age and condition. These artifacts were brought to Hawai'i at least one hundred years ago and have suffered noticeable deterioration due to the humid climate of Hawai'i. The production of this DVD will preserve these artifacts in their current condition and also allow people to view, study and learn about them for many years to come.

1. INTRODUCTION

This project involves the preservation, study, and recording of a video as educational media of antique Asian textile collections, in particular, Chinese textiles from the Qing Dynasty at the University of Hawai'i (UH) at Mānoa. Due to successive waves of immigration from mainland China over the past two centuries, a number of Chinese Qing Dynasty court costumes can be found in various university costume collections in the United States, such as those at UH-Mānoa. Currently there are five dragon robes, twenty Mandarin officials' badges, eight unranked ladies' costumes, and two sets of ladies' jewelry in the UH-Mānoa costume collection. These artifacts represent sophisticated and skilled textile technologies and display complex motifs in design. Additionally, they were used to demonstrate political power and social rank during the Qing period and are therefore an important and valuable segment of the collection.

However, since these artifacts were brought to Hawai'i at least one hundred years ago, they have suffered noticeable deterioration. The conditions of the artifacts in general are fair to good, but a few pieces have deteriorated at an alarming rate (figs. 1, 2). Under Hawai'i's tropical weather conditions, special measures are needed to protect and preserve these artifacts. These items were donated by friends of the Department of Family & Consumer Sciences and are now in the UH costume collection. The artifacts are used by scholars in Hawai'i and are also used for teaching.

In addition to the high inherent value of the artifacts, one of the chief reasons for their preservation is the increased depth of understanding they can shed on the fine arts during Qing Dynasty. As consummate examples of imperial Qing period textiles, an under-exposed subject area in American fine arts circles, the increased publicity and educational promotion will contribute significantly to further awareness of Asian fine arts. To this end, several studies regarding Qing Dynasty dragon robes are currently being published, including one by the author, entitled 'Expressions of Political Rank and Economic Power.' Also, upon execution of the project to be described below, knowledge of these artifacts will be advanced through both local high schools and elementary schools.

Figure 1. Back view of leno weave dragon robe, partially stabilized by additional leno weave fabric.

Figure 2. Back view of yellow Kosse dragon robe, partially stabilized (covered) by tulle.

2. PRODUCTION OF A VIDEO DESCRIPTION OF THE CHINESE IMPERIAL COSTUME COLLECTION AT THE UNIVERSITY OF HAWAII AT MĀNOA

The purpose of this project is two-fold, consisting of the preservation and the promotion of the UH-Mānoa collection of Qing Dynasty textiles through production of a documentary video production. The following plan consists of two different steps that will be carried out in order to preserve and promote this special collection of textiles.

The first step will involve the research of the Chinese imperial costume at UH-Mānoa costume collection. The results of this research can be used to develop research strategies for preserving Chinese culture in the past and present. This research will involve examination of five examples of dragon robes, twenty Mandarin officials' badges, and other Chinese garments dating from early in the 20th century. The textiles will be analyzed using linen testers, SEM images, microscopes, visual examination, and artifact documents (figs 3, 4).

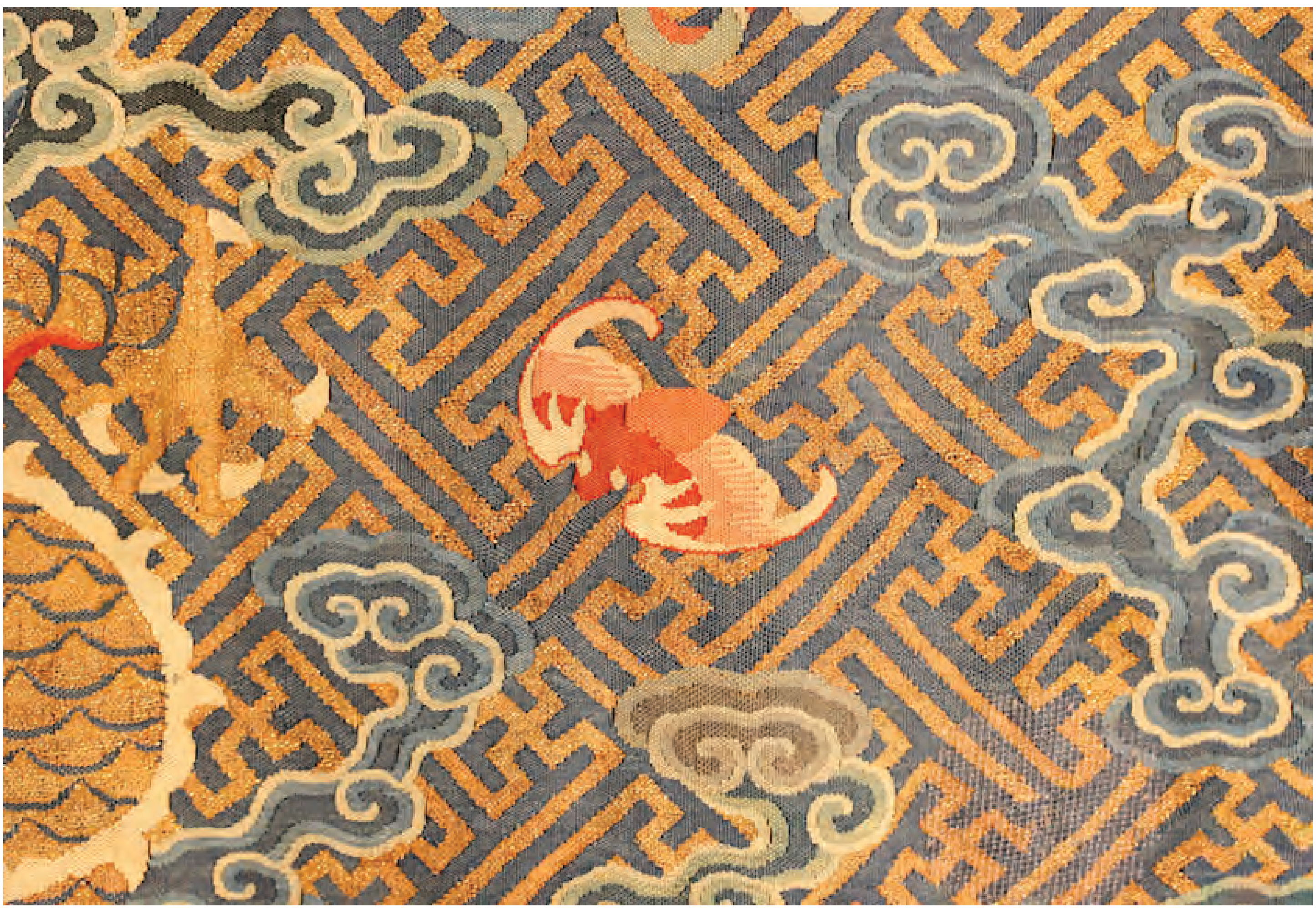


Figure 3. View of yellow Kosse dragon robe at bodice, partially stabilized (covered) by tulle.

Figure 4. View of yellow Kosse dragon robe at bodice, partially stabilized (covered) by tulle.

The second step of this project involves the development of a video production entitled Threads of Majesty: Tapestry and Embroidery for Ranking Qing Dynasty Officials, which have been sent to the Wong AV center at Sinclair Library at UH-Mānoa campus, as well as being presented at conferences.

DR. SHU-HWA LIN, Assistant Professor at the University of Hawai'i, Mānoa, teaches textile science and apparel production data management courses in the Family and Consumer Sciences Department. She received her PhD from Florida State University. Her research centers on Chinese textiles and clothing for people with special needs. She can be reached by phone: 808-956-2245, fax: 808-956-2241, or E-mail: Lins@ctahr.hawaii.edu. Mailing address: 2515 Campus Rd., Miller Hall 201, Honolulu HI 96822 USA.

All images courtesy of the UH-Mānoa costume collection.

USE OF GEL POULTICES FOR ADHESIVE REMOVAL

MAYA NAUNTON

THIS INFORMATION WAS PRESENTED IN THE TIP SESSION
OF THE 2009 TEXTILE SPECIALTY GROUP MEETING

1. INTRODUCTION

The following describes the application of solid gel poultices for stain and adhesive removal from textiles. The basic poultice consists of Methyl Cellulose in water. After solubility of the stain or adhesive is determined, a poultice is prepared. If the material to be removed is soluble in water, the poultice is used as is without addition of other solvents. If, however, the soil is soluble in some other solvent, it can be added to the poultice, after it is prepared.

MATERIALS NEEDED

- Methyl Cellulose
- Sodium Hydroxyde pellets
- Deionized water

EQUIPMENT

- Hot plate
- pH indicator strips

2. POULTICE PREPARATION

This recipe follows recommendations of the Dow Chemical company as found on their website: http://dow-wolff.custhelp.com.

- 30 g Methyl Cellulose powder
- 60 ml deionized water

One third of the water (in this case 20 ml) is heated to 90° C. All of the Methyl Cellulose powder is added to the hot water and mixed thoroughly ensuring complete wetting of all the powder. Then the rest of the water (40 ml at room temperature) is added to the blend and mixed again.

The resulting concentration of Methyl Cellulose is usually around 50% (weight to volume). However, the proportions do not need to be exact, as the consistency of the gel can be adjusted at any point by either adding more liquid (water or another solvent) to make it “wetter” or by adding Methyl Cellulose to make it “dryer”. I usually test the consistency of the poultice by handling it. If it feels too wet or too dry, I remedy the situation as described.

The pH of the resulting poultice is around 5.6-6, which is the usual pH of deionized water. To raise the pH of the poultice Sodium Hydroxyde is added at this point. First, Sodium Hydroxyde pellets are added to deionized water to create a stock solution that has a pH of 13-14. Then the solution of Sodium Hydroxyde is added to the poultice using a pipette until the pH of the poultice is around 8. In my experience 5-10 ml of Sodium Hydroxyde is sufficient.

It is best to let the poultice "rest" overnight before using it to ensure that all Methyl Cellulose particles have had the chance to fully swell in the liquid. The poultice can be kept at room temperature in a closed jar.
If the soil that has to be removed requires a solvent other than water, that solvent can be added to the poultice after it is prepared. If the resulting poultice is too "wet", the consistency can be brought back to "dry" gel by adding more Methyl Cellulose.

3. APPLICATION

The poultice can be used directly on the object. However, if additional isolation from the object is desired, an interleaving layer of glassine or japanese tissue paper can be used between the object and the poultice. It has to be noted, however, that in some cases the addition of the interleaving layer reduced the effectiveness of the poultice. After unsuccessful application of the poultice with the interleaving layer, the poultice was tried directly on the object and the soil was removed.

Glassine is cut to size and placed on the soiled part of the object. The poultice is manipulated to create a thin layer of dry gel. This can be done with one's fingers or alternatively, the gel can be spread with a spatula on a piece of Plexiglas. The poultice can be then cut precisely to cover only the soiled area. It is then placed over the glassine and pressed down with another piece of Plexiglas to ensure good contact with the soil. To that end, some light weights can be placed on the Plexiglas. The area is then covered with plastic to allow the solvent some time to work on the soil. Usually when first applying the poultice to a new object, the poultice and glassine are lifted after 10 minutes to assess the effectiveness of the solvent and to see if there is any adverse reaction with the object. This check is performed again at 30 and 60 minutes.

The duration of the application can vary. Sometimes the soil is dissolved quickly; other times poultice has been left in place for 24 and 48 hours. Usually, one application is not enough. After some soil has been removed into the poultice (the change in color is usually very pronounced), a new poultice is applied to the same area. Some cases were successfully done after 2 applications, some needed 5, others 10 and more.

4. ADVANTAGES

This technique is highly localized. If the poultice is sufficiently "dry" and/or the duration of the application is short, the solvent does not spread to the surrounding material at all. If the poultice is slightly "wetter" and/or the time of application is long (24-48 hours), the solvent can spread a little, resulting in a tideline. However, that can be remedied by another (shorter) poultice application to the same area (fig. 1).

The object does not need to be wet-cleaned after the soil removal.

5. POTENTIAL AREAS OF CONCERN

Some concern has been expressed at Methyl Cellulose possibly remaining on the object after the poultice application. In my experience, I have not seen any residue on objects, either visually, or under magnification up to 40x. Nor is there any change in the "hand" of the object; the treated area does not feel stiffer than the material around it. In addition, I want to point to the fact that Methyl Cellulose has been used for decades to size paper (among many other applications) and no adverse effects have been noted on the cellulose fibers. This of course, does not apply to protenatious fibers.

Figure 1. Before treatment on left and after treatment on right.

ACKNOWLEDGMENTS

The author would like to thank the following people: the staff of the Textile Conservation Department at The Metropolitan Museum of Art for their support and suggestions and Yana Van Dyke, Associate Conservator, Paper Conservation, The Metropolitan Museum of Art for her help with adopting the gel poultice to textile application.

SOURCES OF MATERIALS

Methyl Cellulose, viscosity 1900-2200 cps.
Talas
330 Morgan Ave
Brooklyn, NY 11211
http://www.talasonline.com

Sodium Hydroxide pellets (NaOH)
Fisher Scientific
http://www.fishersci.com

MAYA NAUNTON is a Textile Conservator in private practice. She was an Assistant Conservator at the Metropolitan Museum of Art from 2004 to 2009. Prior to that she attended New York University, Institute of Fine Arts, Conservation Center. Address: 235 W. 76th Street, #5B, New York, NY 10023. 212-721-1328. Email: maya.naunton@gmail.com.

AQUAZOL AS A HEAT SET ADHESIVE FOR TEXTILE CONSERVATION TREATMENTS

KATHERINE LECHUGA

THIS INFORMATION WAS PRESENTED IN THE POSTER SESSION
OF THE 2009 AIC ANNUAL MEETING

Consolidating shattered silk has been a long standing difficulty in textile conservation due to the fact that most embrittled silk cannot withstand the stress of mechanical consolidation achieved through hand-stitching. The most traditional option has been using an adhesive treatment, which can be problematic since the drape of the textile is almost certainly affected.

A search of the conservation literature on adhesive treatments for textiles showed that many adhesive treatments could adversely affect the drape of cloth and some required the use of organic solvents to reverse their application. Aquazol, Poly(2-ethyl-2-oxazoline), a synthetic water soluble adhesive, often used in painting conservation, was chosen for experiments due to its physical properties of easy reversibility, water solubility, thermoplasticity, and retention of flexibility. Aquazol is available in four molecular weights: Aquazol 5 (MW 5,000), Aquazol 50 (MW 50,000), Aquazol 200 (MW 200,000) and Aquazol 500 (MW 500,000).

In this study only Aquazol 50, 200, and 500 were tested. The viscosity and adhesion strength increases with the molecular weight, which can be advantageous depending on the adhesion strength required for a given treatment. Aqueous solutions of all three molecular weights were mixed and varying concentrations were tested to determine which would provide sufficient adhesion strength while retaining maximum flexibility. The support fabrics used were silk habutai, silk crepeline, and nylon net. Treatment was carried out on a teal green silk chiffon, beaded dress from the 1920's. The dress exhibited severe areas of loss and shattering at the upper bodice area.

Aquazol was easily reactivated with low temperatures and provided sufficient bond strength to consolidate the shattered silk. In addition, it is extremely easy to reverse and cleared using water, so mends could be removed with very minimal risk to this textile artifact. However, it was also discovered that during exposure in high humidity situations (approximately 75% RH), Aquazol did stain and penetrate fabrics.

The poster (figs. 1-12) illustrates the experimental procedures and materials used in fabricating Aquazol coated consolidation fabrics. The sample treatment is illustrated, demonstrating the versatility and potential usefulness of Aquazol as a consolidant for shattered silk.

FURTHER READING

Arslanoglu, Julie. *Aquazol as Used in Conservation Practice.* WAAC Newsletter, 26 no. 1 (January 2004).

Arslanoglu, Julie and Carolyn Tallent. *Evaluation of the Use of Aquazol as an Adhesive in Paintings Conservation.* WAAC Newsletter 25 no. 2 (May 2003).

Wolbers, Richard C., M. McGinn, and D. Duerbeck. "Poly2-Ethyl-2-Oxazoline: A New Conservation Consolidant" in *Painted Wood: History and Conservation.* Ed. V. Dorge and F. C. Howlett. Los Angeles: Getty Conservation Institute: 514-527.

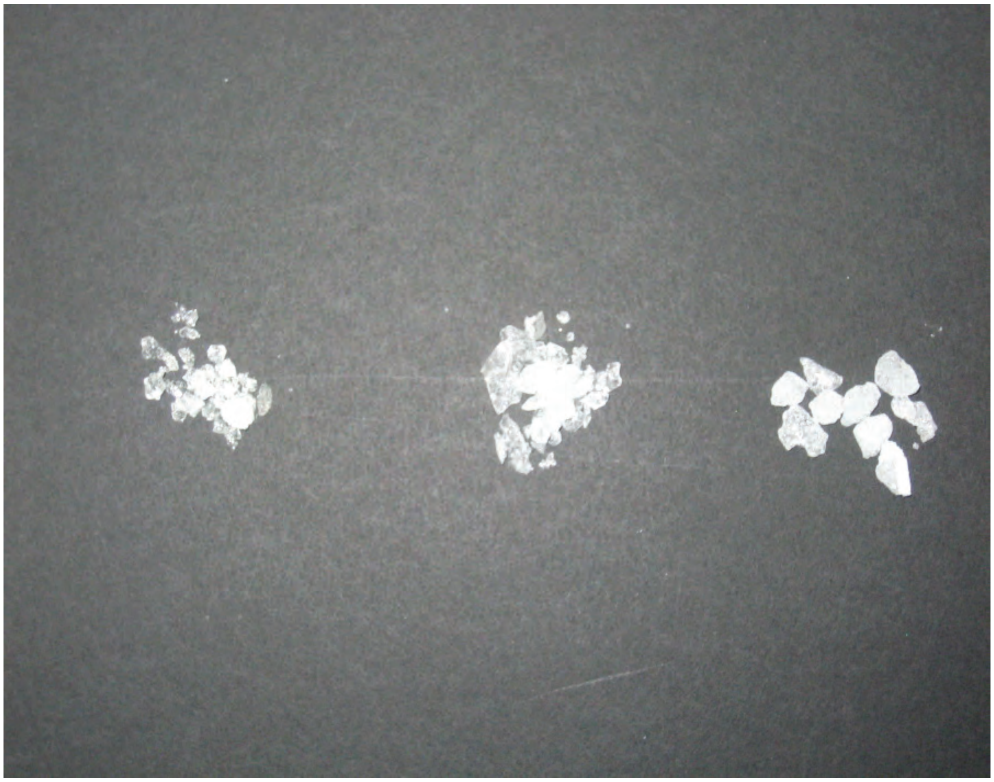
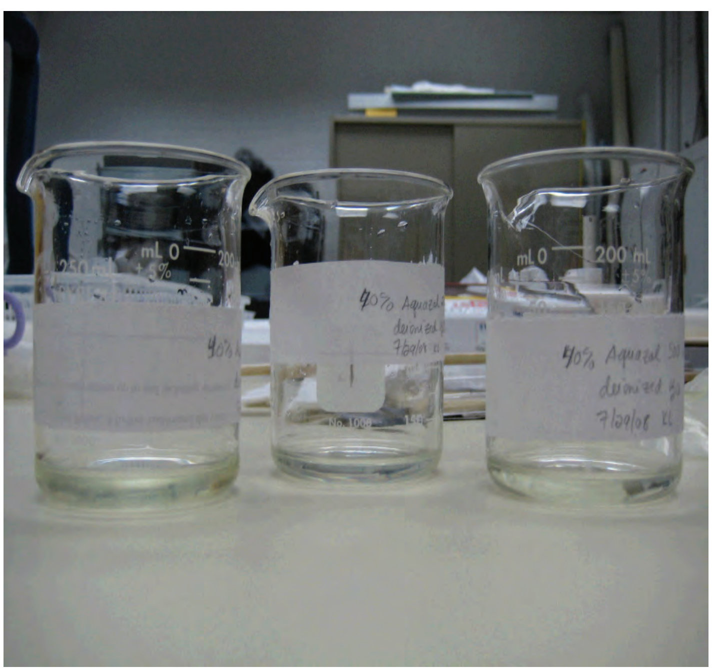


Figure 1. Aquazol can be characterized as Poly(2-ethyl-2-oxazoline). Its uses have been previously explored in painting conservation. Three molecular weights of Aquazol (from left to right): Aquazol 50, Aquazol 200, & Aquazol 500. Adhesion strength and viscosity increases with the increase in molecular weight.



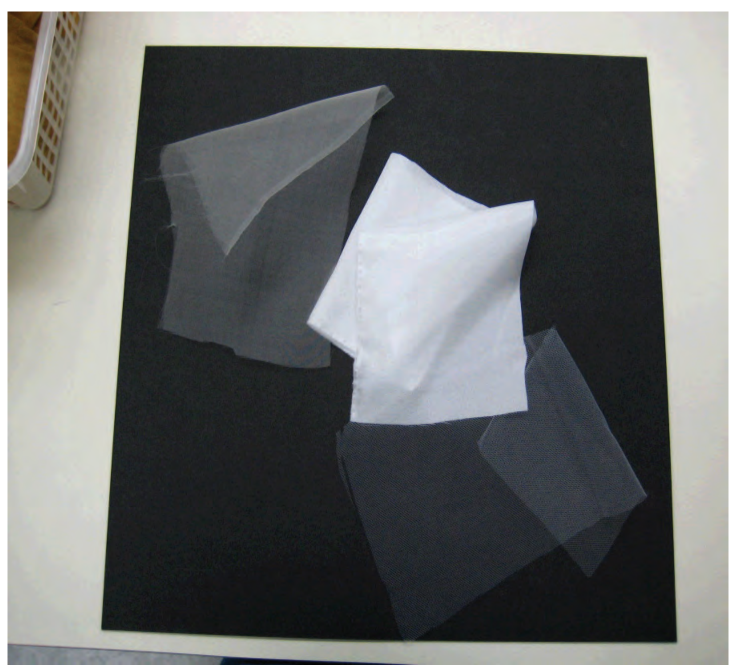


Figure 2. 40% stock solutions of all three molecular weights were prepared using deionized water (on left).
Figure 3. Silk crepeline, silk habutae, and Dukeries monofilament nylon net were used as carrier fabrics (on right).

Figure 4. Case study, a 1920's beaded silk dress. The dress demonstrated typical condition problems associated with shattered silk.

Figure 5. Detail of detached beaded fringe.

Figure 6. Detail of shattered silk in the bodice area and along the neckline.

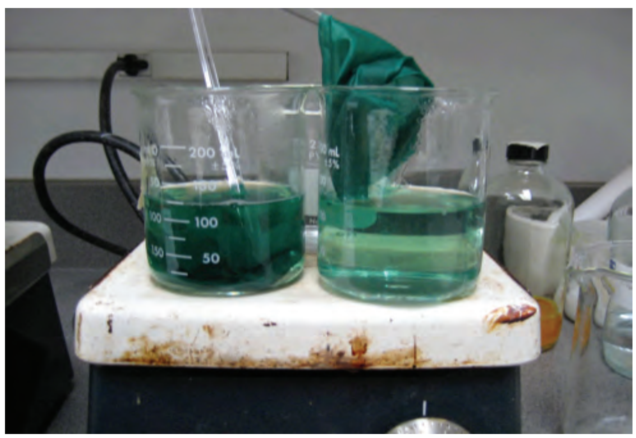


Figure 7. Nylon net and silk habutae were custom dyed to match
the original fabric color using Lanaset dyes.

Figure 8. The net was coated with a 15% solution of Aquazol 50.
Light heat and pressure were used to consolidate the shattered silk.

Figure 9. The Aquazol net securely consolidated the shattered silk and provided support even when placed on a form.

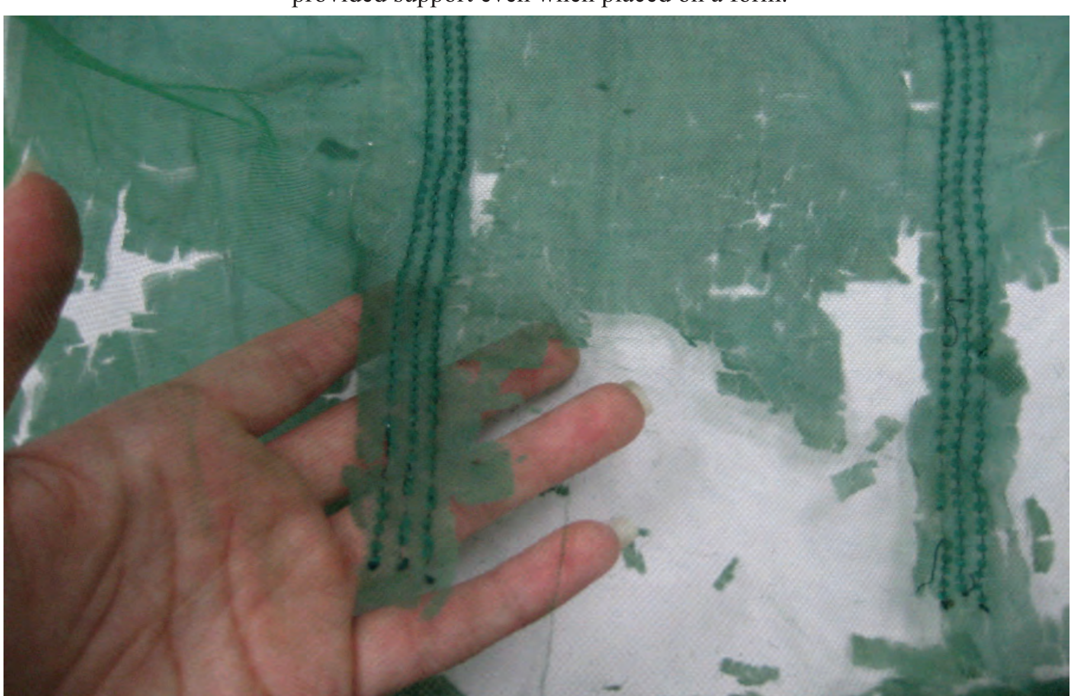


Figure 10. Detail of the consolidated silk.

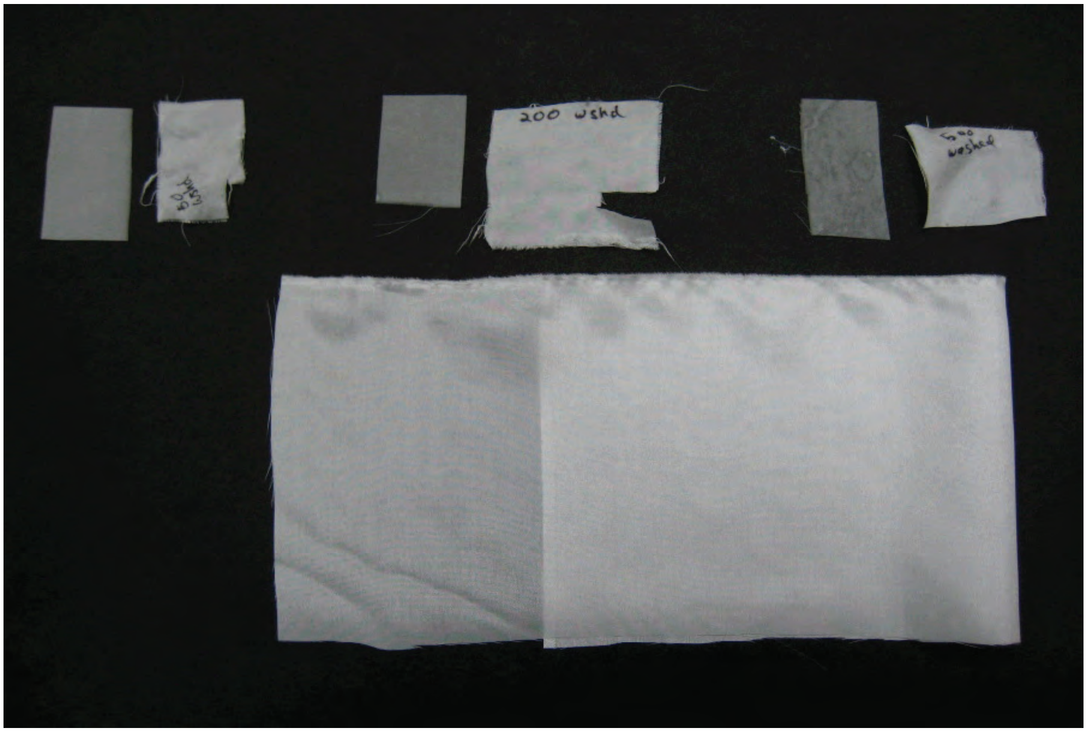


Figure 11. Preliminary aqueous reversibility testing demonstrated that Aquazol was very easily removed from the fabrics, restoring the original refractive index and hand.

Figure 12. Samples were placed in a humidity chamber buffered to a RH of approximately 70-75%. After prolonged exposure, the adhesive was observed to penetrate and stain the silk habutae.

ACKNOWLEDGEMENTS

I would like to express my sincere thanks to The Indianapolis Museum of Art and the following individuals for providing me with the opportunity, means, and guidance to conduct this research: Kathleen Kiefer, Senior Textile Conservator, Christina Milton O'Connell, Painting conservator, Helene Gillette-Woodard, Object conservator and Richard McCoy, Object conservator.

KATHERINE LECHUGA received her MSIS and will receive her CAS in Conservation in May 2010 from the University of Texas at Austin School of Information, Kilgarlin Center for Preservation of the Cultural Record. Address: PO Box 105, Otterbein, IN 47970. Email: klechuga@gmail.com.

VACUUMING TEXTILES: A NEW KIND OF COST BENEFIT ANALYSIS

ELIZABETH SHUSTER

THIS INFORMATION WAS PRESENTED IN THE POSTER SESSION
OF THE 2009 AIC ANNUAL MEETING

Vacuuming is a method of mechanical cleaning, not unlike using a scalpel to remove accretions of dirt from an object. When a textile is vacuumed, a current of air (rather than a blade) is employed to apply enough force to overcome the physical and chemical forces acting between the dirt and the textile. With inexpensive instruments, the forces acting on textiles during vacuuming can be measured and ultimately this data can be used to establish more standardized methods of gentle and effective vacuuming. This procedure will be illustrated with figures 1-10.

Normal (perpendicular) forces acting on a textile during vacuuming can be measured directly with a manometer. A manometer (a.k.a. a water lift gage) measures how many inches of water the vacuum can pull into a tube. These measurements can be converted to the SI derived unit for pressure/stress, the pascal (Pa), or pounds per square inch (psi). Shear (parallel or tangential) forces acting on a textile during vacuuming can be measured indirectly with an anemometer. An anemometer measures the volume of air pulled through a tube or opening during a given period of time. These measurements can be converted to miles per hour.

The more efficient a conservator is while vacuuming, the less gentle he/she will be and vice versa. The standard practice of noting the vacuum setting is grossly insufficient to gage either. The technique of the individual will play the crucial role in determining how gentle and efficient a vacuuming campaign will be, and this *can* be measured. With continued testing, it may be possible to extrapolate the aggregate data to establish general and/or treatment specific protocols for more efficient and gentler vacuuming techniques.

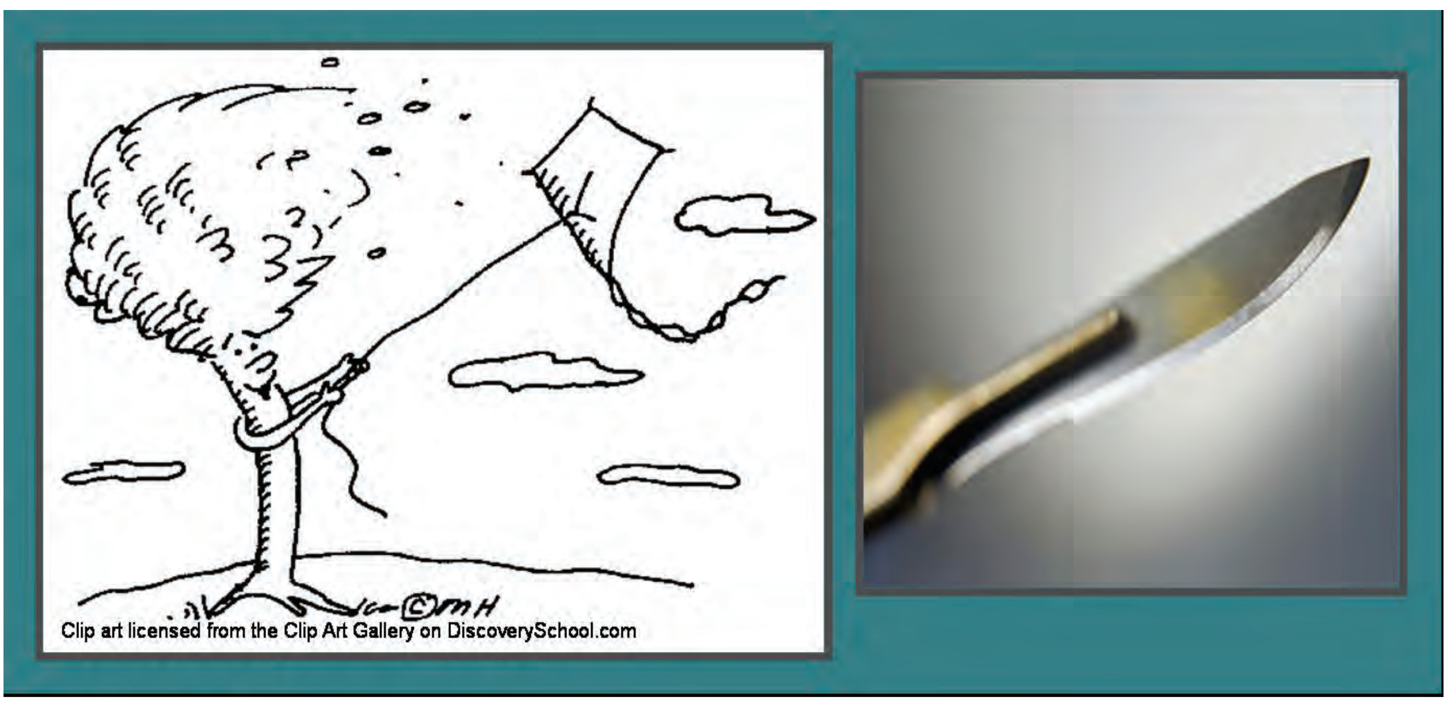


Figure 1. In this cartoon, the tree represents a textile and the kite represents dirt. The string of the kite represents the forces acting to keep them together, and the wind is working to separate them and carry the kite (dirt) away. A scalpel blade can sever the string, and facilitate the separation of the kite from the tree.

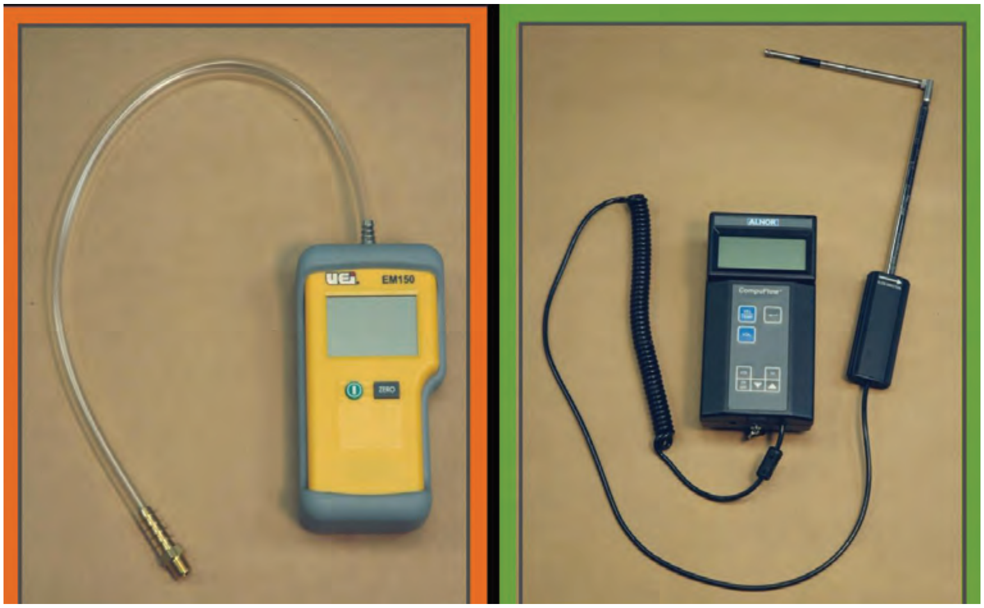


Figure 2. Left: Manometer, Right: Anemometer.

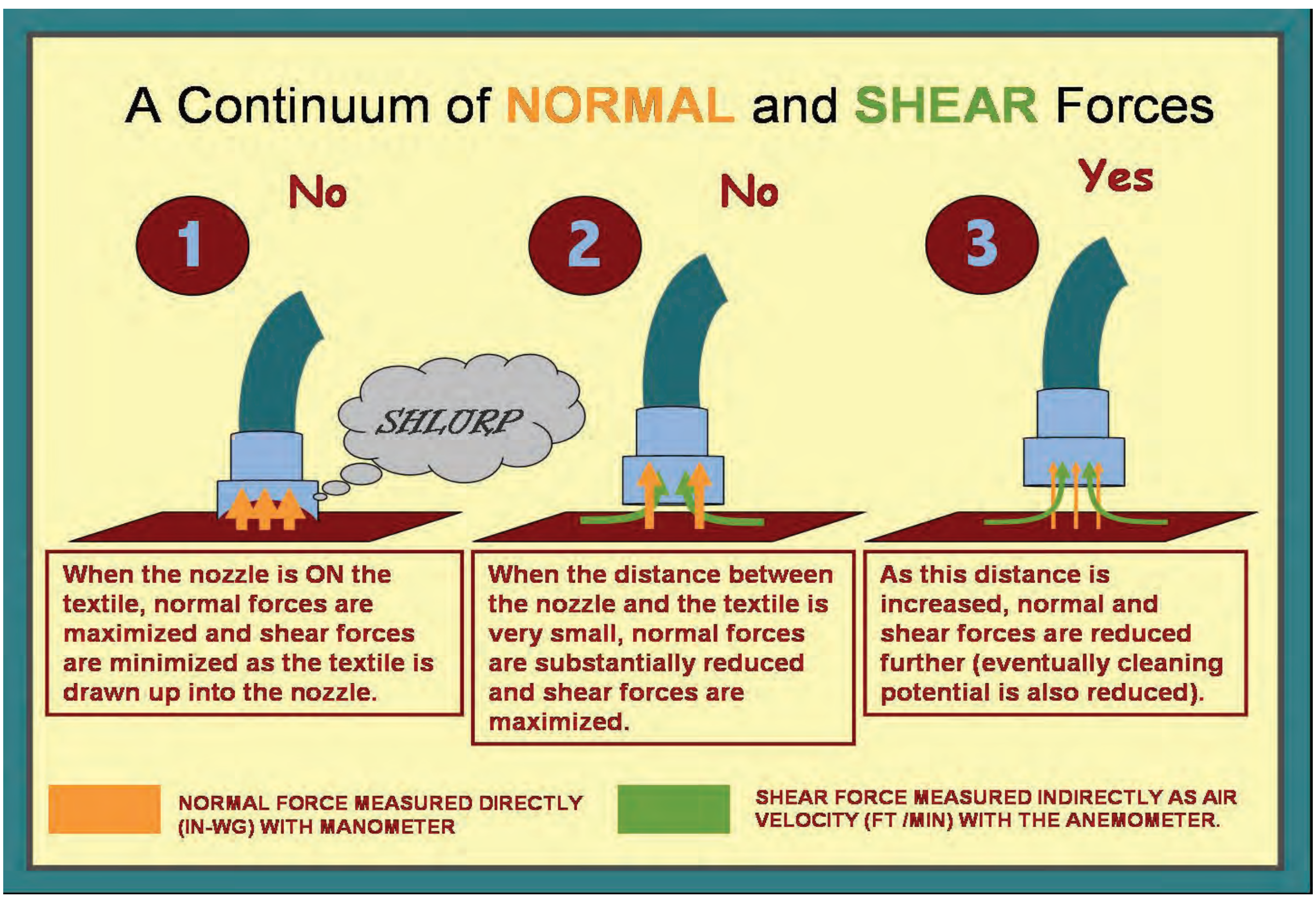


Figure 3. A continuum of normal and shear forces.

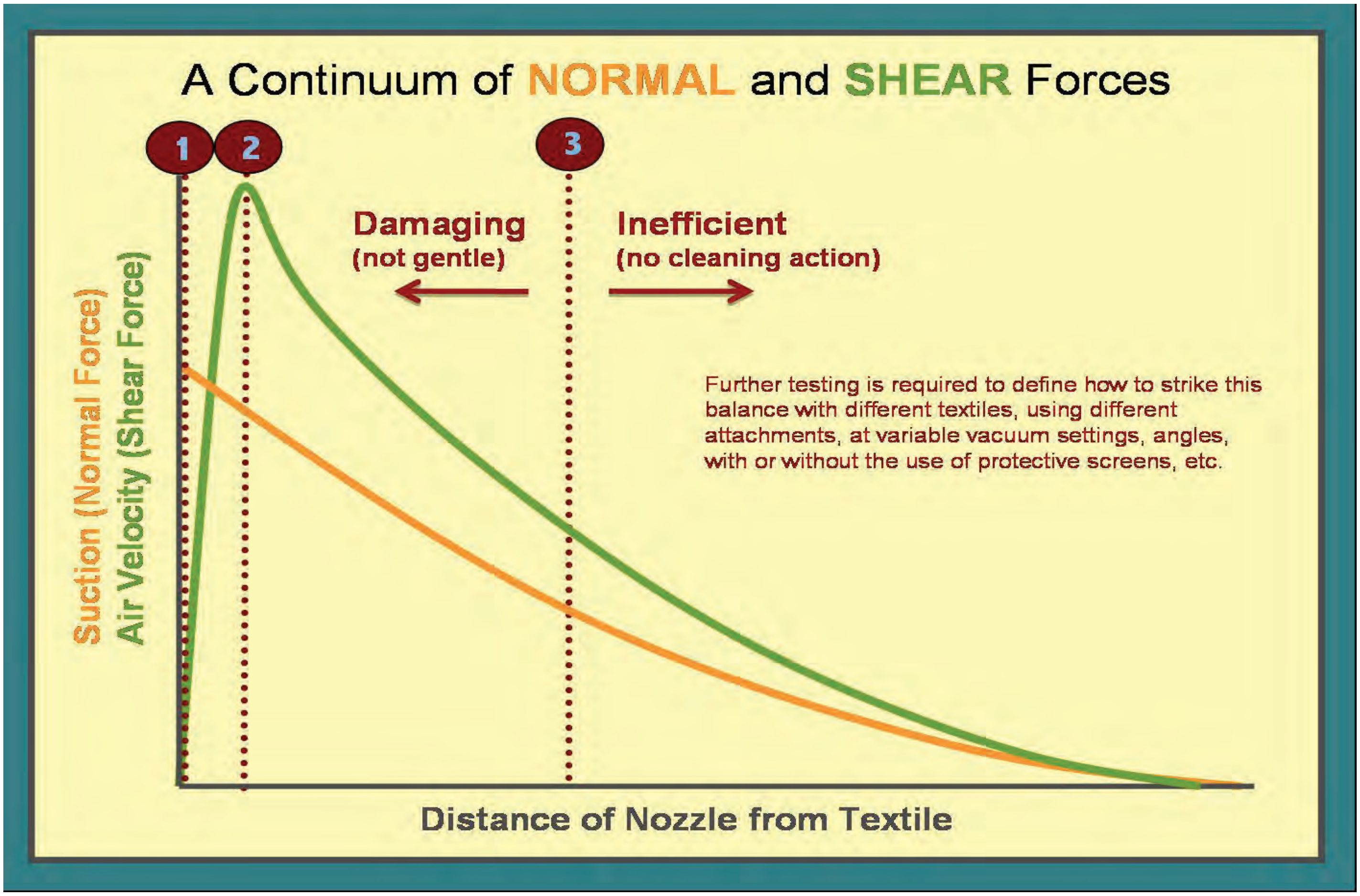


Figure 4. Graphing the continuum of normal and shear forces.

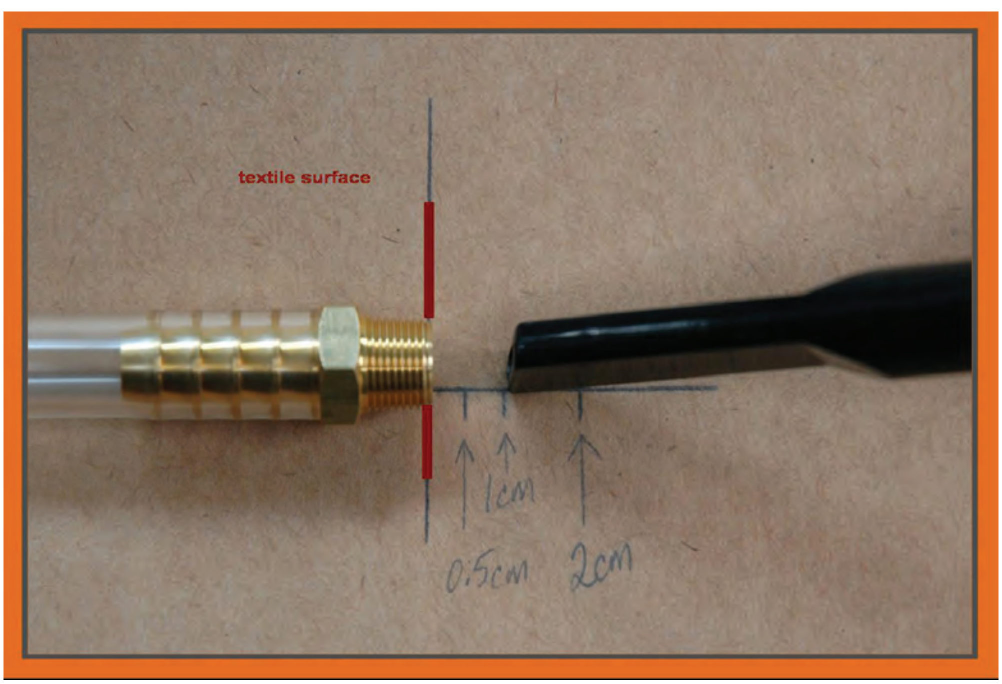


Figure 5. Setup 1 – Measuring normal (perpendicular) forces (i.e. suction) using the manometer. Measurements were taken for several vacuum attachments, including the detailer, seen here.

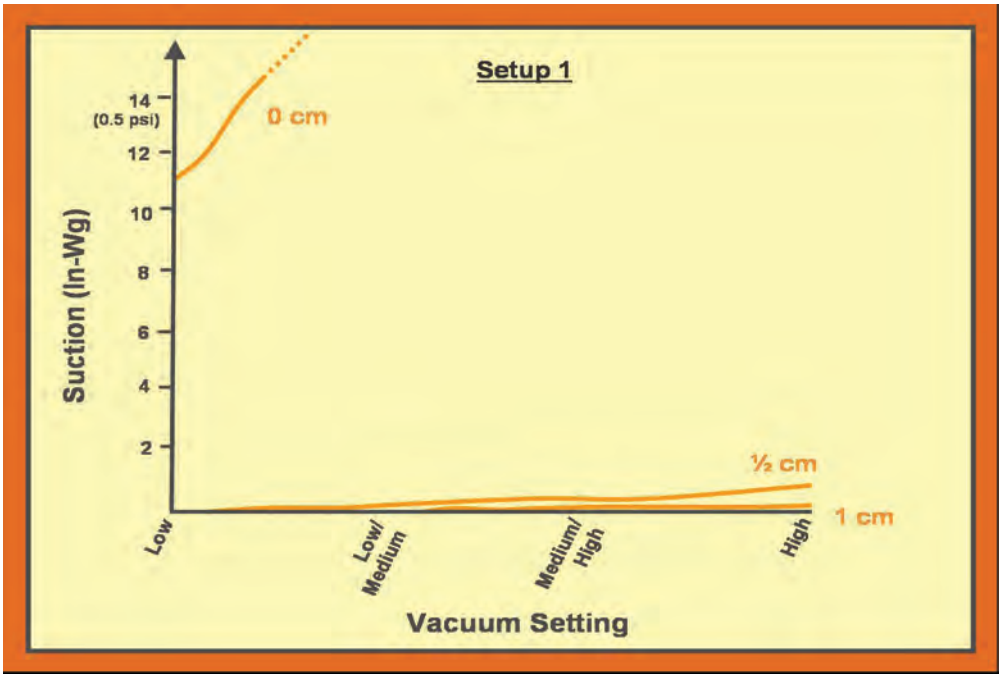


Figure 6. For Setup 1, note the dramatic drop in the magnitude of normal force (suction) with the detailer if the nozzle is kept just ½ cm off the surface of the textile. The decrease in magnitude of normal force is marginal at greater distances, but the risk of SHLURP is also considerably less at greater distances.

Figure 7. Here the most vulnerable areas of the textile are illustrated.

Figure 8. Setup 2 – Measuring shear (parallel or tangential) forces (i.e. air flow) using the anemometer. Measurements were taken using several vacuum attachments, including the upholstery brush, seen here.

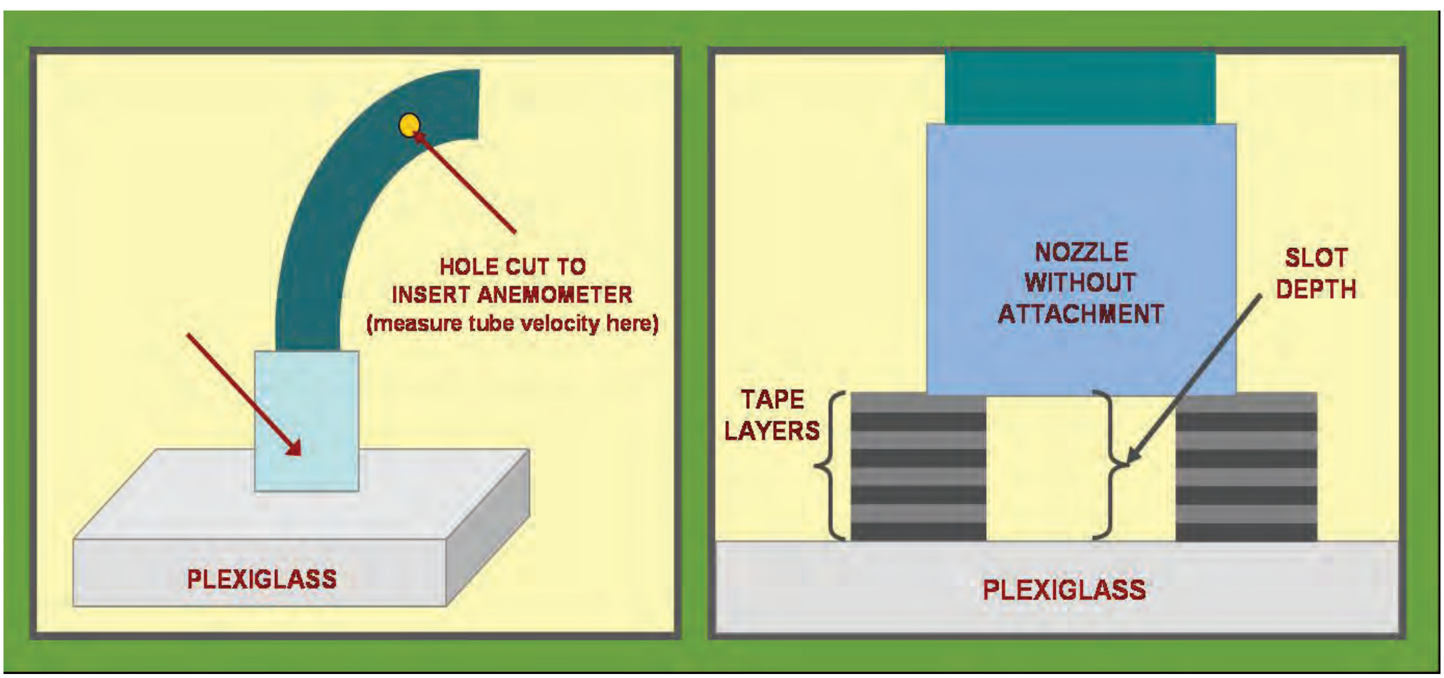


Figure 9. Setup 3 – Another way to measure airflow with the anemometer. This setup measures the flow of air through the tube of the vacuum rather than at the textile surface, and provides the most stable and consistent readings with the anemometer.

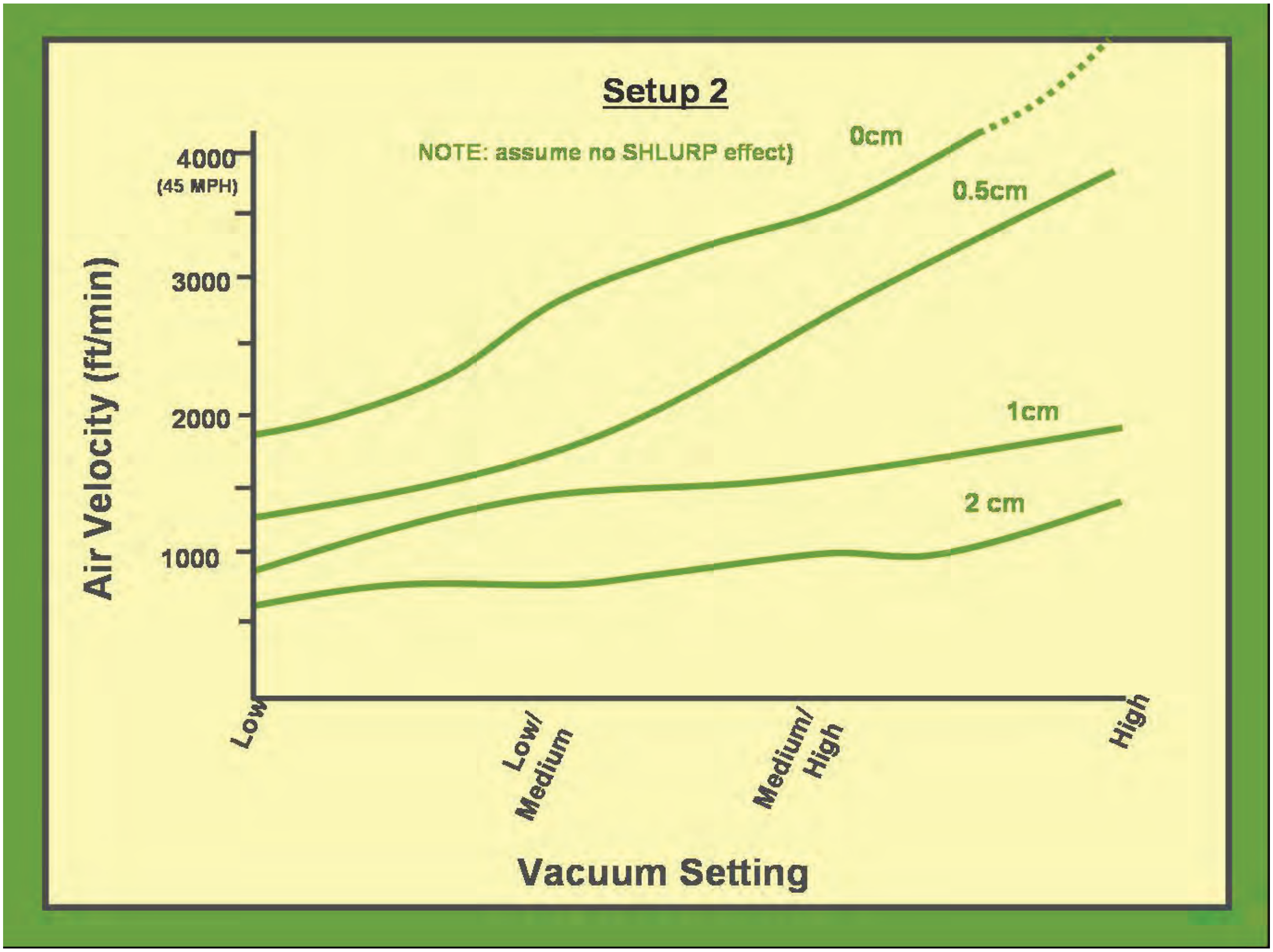


Figure 10. Shear force (i.e. friction, measured indirectly as air flow) drops off more gradually than normal force (suction). The suction of the vacuum creates air flow, which moves the dirt off of the textiles. The amount of air flow that exerts too much force on the textile or not enough force on the dirt will vary according to the makeup and condition of the textile, the vacuum setting, attachment, and technique used by the individual operator (distance, angle, use of a screen, etc.).

Setup 2 measures air flow at the textile surface. These readings are highly variable. This chart represents the average of six runs of the same setup. The standard deviation for these data ranged from 15-87, indicating their questionable accuracy due to the lack of precision in these setups. Still, there are undeniable trends in the data. One way to improve the data would be to reproduce these setups using an ammeter to quantify the output of the vacuum at various settings.

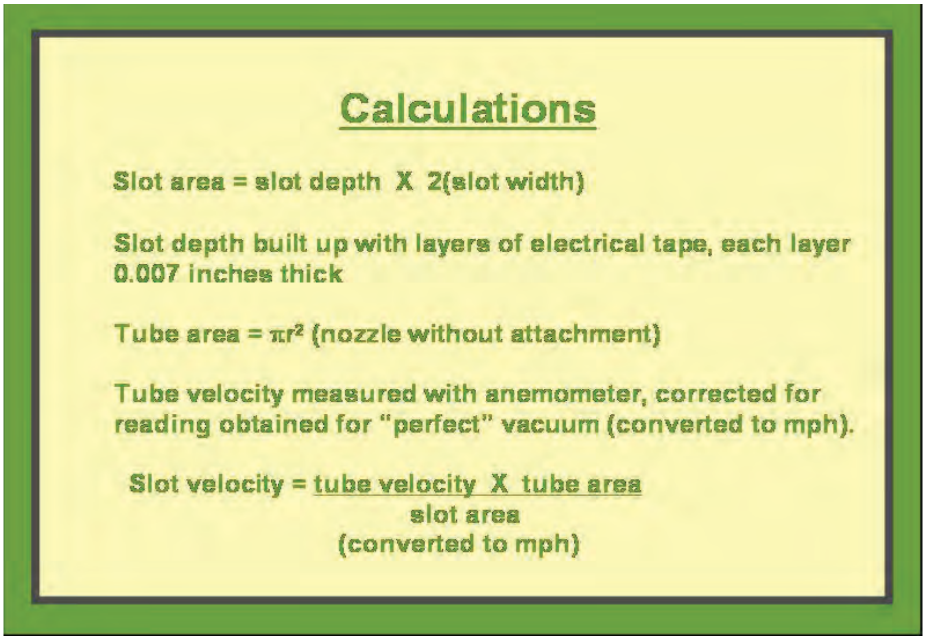


Figure 11. Calculations for the second setup with the anemometer.

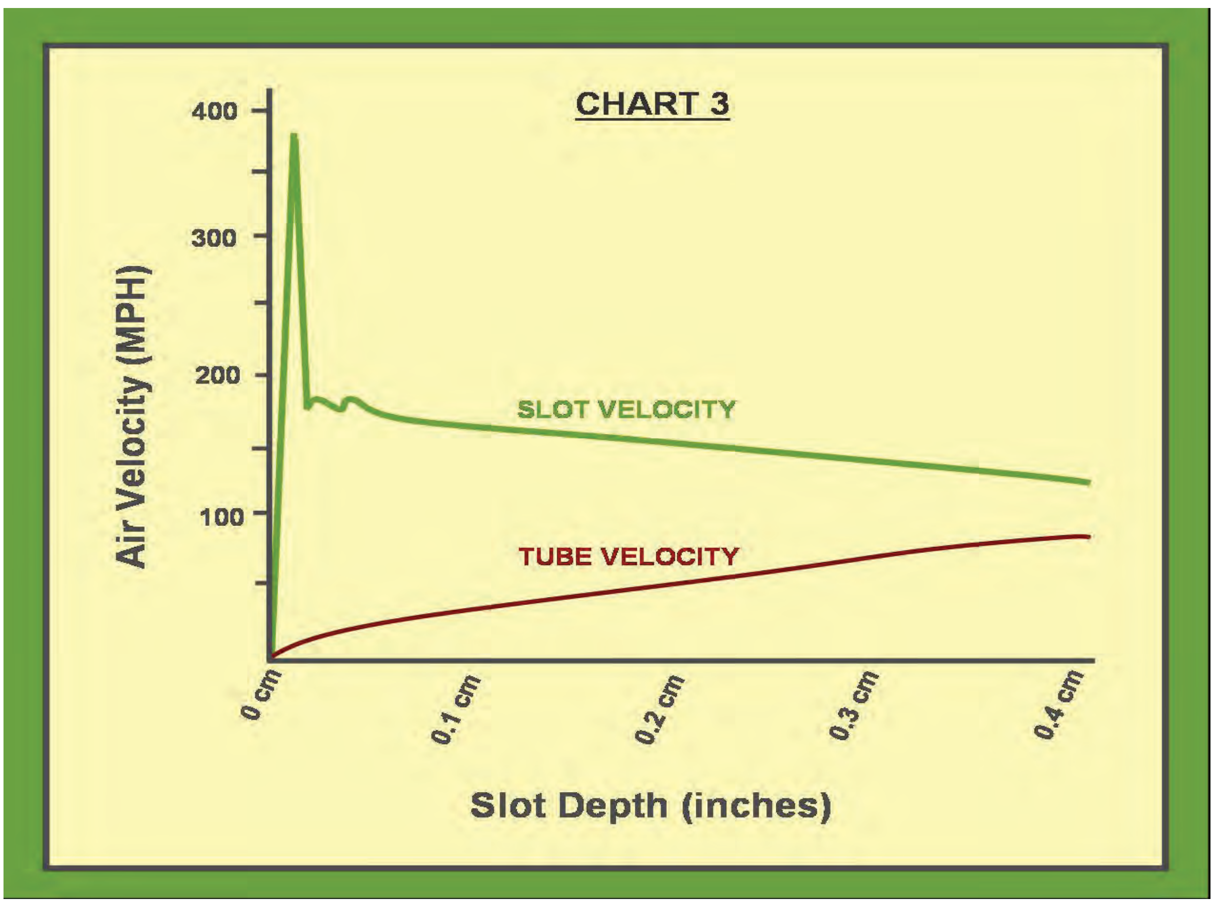


Figure 12. The data represented in this chart were recorded with no vacuum attachment at the highest vacuum setting, but the magnitude of shear force (i.e. friction, measured indirectly as air flow) was alarmingly high even at lower vacuum settings. For example, the slot velocity calculations for the upholstery brush attachment at the low/medium vacuum setting, and more than 1 inch off the textile surface, were still more than 60 MPH!

ELIZABETH SHUSTER

ELIZABETH SHUSTER graduated from the Winterthur/University of Delaware MS program in Art Conservation in 2010. The research presented in this poster was carried out as part of a third-year internship under the tutelage of Mary Ballard, Textile Conservator at the Smithsonian Institution Museum Conservation Institute in Suitland, Maryland. Elizabeth currently resides in Portsmouth, RI. Address: 74 Sherwood Terrace, Portsouth, RI 02871, Email: echambers63@hotmail.com.