THE TEXTILE SPECIALTY GROUP POSTPRINTS

PAPERS DELIVERED AT THE TEXTILE SUBGROUP SESSION

American Institute for Conservation
of Historic & Artistic Works
42nd Annual Meeting
San Francisco, California
May 2014

Edited by

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VOLUME TWENTY-FOUR

AIC
AMERICAN INSTITUTE FOR CONSERVATION OF HISTORIC AND ARTISTIC WORKS

POSTPRINTS of the Textile Specialty Group, Volume Twenty-Four, 2014, is published by the Textile Specialty Group of the American Institute for Conservation of Historic & Artistic Works. 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.

Volume 24

The Textile Specialty Group of the American Institute for Conservation of Historic & Artistic Works
ISSN 2169-1363

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PREFACE

The twenty-fourth volume of POSTPRINTS contains papers presented at the Textile Specialty Group (TSG) session of the American Institute for Conservation of Historic & Artistic Works (AIC), in San Francisco, California from May 28–31, 2014.

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, Lauren Chang, Textile Specialty Group Vice Chair for 2013–2014, are published as submitted by the authors. Editing of papers was done according to the *Journal of the American Institute for Conservation's* "Guidelines for Authors" and the "Best Practices for Online PDF Publication: AIC Specialty Group Annuals & Postprints", 2014 version. 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. Thanks are also extended to Translation Cloud for translating the abstracts into Spanish, and Aptara Inc. for copyediting and layout.

SUSTAINING TACIT AND EMBEDDED KNOWLEDGE IN TEXTILE CONSERVATION AND TEXTILE AND DRESS COLLECTIONS

MARY M. BROOKS

ABSTRACT—This article explores the current paradoxical position of textile and dress collections and textile conservation in museums from an English perspective. Textile and dress exhibitions have become increasingly high profile, and conservators are being energized by an expanded vision for communicating the activity of heritage conservation, engaging with the public in different and exciting ways and making this often hidden process accessible. Nevertheless, despite many exciting initiatives, the underlying trend in the United Kingdom indicates a creeping loss of specialist textile curatorial and conservation posts. The article explores the implications of these losses on tacit and embedded knowledge and expertise and the growing threat to the long-term sustainability of textile and dress collections, particularly in the regions. It studies the reasons for these problems and considers in more detail a key issue, that of the loss of teaching needlework skills. The article argues that these issues need to be considered when planning strategies to ensure the sustainable future of textile and dress collections and related curatorial and conservation skills. It includes a case study exploring approaches to embedding sustainable expertise implemented during a Monument Fellowship at York Castle Museum, England.

SOSTENIENDO LOS CONOCIMIENTOS TÁCITOS E INCORPORADOS EN LA CONSERVACIÓN TEXTIL Y EN LAS COLECCIONES DE TELAS Y TRAJES: RESUMEN—Este documento explora la paradójica posición actual de las colecciones de telas y trajes y la conservación textil de los museos desde la perspectiva inglesa. Las exhibiciones de telas y trajes tienen un perfil cada vez más alto y entre los conservadores crece el entusiasmo por expandir la idea de comunicar las actividades que se realizan para conservar la herencia, llegando al público de maneras diferentes y atractivas y facilitándole el acceso a este proceso tradicionalmente oculto. A pesar de las numerosas iniciativas, la tendencia imperante en el Reino Unido muestra una creciente escasez de publicaciones de curadores y conservadores especializados en telas. El documento explora las implicancias de estas pérdidas sobre la experiencia y los conocimientos tácitos e incorporados, y la creciente amenaza para la sustentabilidad a largo plazo de las colecciones de telas y trajes, especialmente en las regiones. Se analizan las causas de estos problemas y se considera más en detalle un problema clave: la pérdida de enseñanza del arte de la costurería. El documento sostiene que estos temas deben ser tenidos en cuenta a la hora de planificar estrategias que garanticen el futuro sustentable de las colecciones de telas y trajes y del arte de la conservación y el curado de las telas. El escrito incluye el estudio de un caso que explora métodos para la incorporación de experiencia sustentable implementados durante una beca de estudios de monumentos en el Museo del Castillo de York, Inglaterra.

1. INTRODUCTION

This article explores some of the complex issues challenging the conservation profession in general and textile conservators in particular in terms of the sustainability of our expertise. It is, hopefully, a realistic but not too pessimistic contribution to the discussion and necessarily reflects an English perspective. It therefore focuses on the various threats to the long-term sustainability of textile and dress collections in the United Kingdom and the actual or future risks of losing both tacit and embedded knowledge for specialist curating and conserving of textiles and dress. Tacit knowledge is generally considered to be the formal and informal knowledge embodied by individuals working for organized networks or institutions; that is, their specialist knowledge, understanding and skills whereas embedded knowledge is sustained by the processes, routines, and structures of an organization (Horvath 2000; Gamble and Blackwell 2001). Together, tacit and embedded knowledge contribute to the professional culture of an organization and play an important part in establishing and sustaining its corporate memory (Françoise et al. 2000). Erosion of such knowledge risks undermining established practices and standards. In the case of museums and conservation, the loss of curatorial and conservation expertise means that effective and appropriate interpretation, curation, collection development, preventive care, and conservation interventions cannot be sustained. The public's engagement with evocative and informative textile and dress collections for increased learning, knowledge, and enjoyment will, potentially, be lessened.

This article argues that these complex issues need to be addressed to sustain embedded expertise and influence decision making. It aims to unpack some of the issues involved by exploring pressures within the UK sector and focusing on three aspects of sustainability. These are (1) the economic threats to the museum and conservation sector with the associated risk of loss of curatorial and conservation knowledge and expertise, (2) the long-term sustainability of textile and dress collections and (3) the erosion of needlework skills in future generations. The article concludes with a case study of a Monument Fellowship that had the explicit aim of capturing and transferring embodied and embedded specialist knowledge.

2. WIDER VISIONS

Textile and dress collections and conservation would seem to have had much cause for celebration during the early years of the 21st century. In London, the British Museum's World Conservation and Exhibition Centre, funded by Britain's Heritage Lottery, opened in 2014 (British Museum n.d.). The Victoria & Albert Museum's new Centre for Textiles, Fashion Study and Conservation was launched in 2013 and funded by a charitable trust with its roots in a medieval textile guild (V&A n.d.). In Bangkok, the Queen Sirikit Museum of Textiles, supported by royal philanthropy and including Thailand's first textile conservation studio, opened its doors in 2003 (Brennan et al., n.d.). All have enhanced facilities and public access. Hugely popular exhibitions such as the Costume Institute's *Dangerous Liaisons* (Metropolitan Museum 2004) and the V&A's *Hollywood Costume* (V&A 2013) have been pushing display boundaries in innovative ways (Gatley and Morris 2015).

Conservators have also been energized by an expanded vision for the role for heritage conservation, using their technical expertise and knowledge to preserve collections, enhance understanding, and engage the public in this previously hidden process. Many projects have sought to aim to embed a wider social goal of individual and community well-being within conservation activities (Eastop 2006). The award-winning Volunteer Inclusion Project at London Archaeological Archive & Research Centre, Museum of London, is just one example of a project that engaged with the social benefits of conservation as well as actively caring for the museum's collection (Museum of London 2012).

Other projects have amply demonstrated conservators' ability to look beyond the individual object, collection, and institution and work together to analyze conservation problems on a major scale. *A Public Trust at Risk: The Heritage Health Index Report on the State of America's Collections* reported on 35,000 collecting institutions, establishing that immediate conservation action was needed to prevent the loss of 1290 million artifacts (Heritage Preservation 2005); a follow-up survey *Heritage Health Information* was undertaken in 2014, which again reviewed the position of collections and explored changes in preservation practices since the 2005 report (Heritage Preservation [2015]). Internationally, the ICCROM/UNESCO storage survey received responses from conservators and others from 1490 museums worldwide. In consequence of the universal problems recorded, they developed their Storage Reorganization Methodology as a tool for improving access and conservation (ICCROM/UNESCO 2013). The UK's *Mind the Gap* project explored approaches for developing more rigorous collaborative interdisciplinary research approaches for improved understanding of both our material heritage and public impact (Dillon et al. 2014). Interestingly, Nancy Bell, head of collection care at The National Archives, UK, and principal investigator for the project, noted the importance of embodied knowledge, observing that although "technology is making collaboration easier, people remain central" for effective research (The National Archive 2014, n. p.). There have been powerful advocacy activities and publications such as *It's a Material World: Caring For the Public Realm* (Jones and Holden 2008), sponsored by the Textile Conservation Centre, and the Salzburg Declaration on the Conservation and Preservation of Cultural Heritage (Salzburg Global Seminar 2009).

The importance of communicating conservation has long been understood and is increasingly seen as a core activity, demonstrating conservators' contribution to interpretation, access, learning, and enjoyment in the museum as well as advocacy for the profession, a lever for funding, and, critically, a way of alerting and engaging potential future conservators (Pye 2001; Jones 2002; Brooks 2008; Gill 2012). New and old media are being used to reach new audiences. Kath Whittam, ICON's professional development support officer, noted that the BBC 1's television series *Fake or Fortune?*, which involves conservators in assessing the authenticity of paintings, "could do for conservation what *Time Team* did for archaeology" (Whittam 2014, n.p.). On site, conservators at Hampton Court Palace are wearing "Ask the Conservators" badges to encourage visitors to ask questions about the conservation work they see being carried out in the Palace (Frame 2008). Real and virtual exhibitions are being used to communicate the complexity of conservation decision making and practice. For example, the exhibition *Time Will Tell: Ethics and Choices in Conservation* at Yale focused on exploring conservation decision making (Yale University Art Gallery 2009). The conservation of William Etty's 1837 painting *The Sirens and Ulysses* was carried out in the galleries at Manchester Art Gallery to enable public involvement. An online legacy memorializes the challenging treatment (Manchester Art Gallery n.d.). AIC hosts a Wiki, an outcome of the outreach session "Exhibiting Ourselves" at the 2012 Meeting, which acts as a resource for conservators planning outreach activities. It includes a database of exhibitions engaging with conservation, conservation science, or technical art history (AIC 2013).

3. RAISING THE PROFILE

It appears that the profession is doing all it should be doing—developing the public profile, explaining the discipline in creative and engaging ways, working with communities as well as collections and individuals as well as artifacts, and justifiably celebrating some remarkable projects. Such activity and achievement do not seem to be translating into a confident profession. Instead, there seems to be a somewhat paradoxical sense of slippage in the status of conservation and of increasing threats to its future, despite the new understanding of an expanded role for heritage conservation in enriching people's lives and experiences. As Elizabeth Pye and Dean Sully of the Institute of Archaeology, London, put it: "conservators may suffer from a crisis of confidence: they may feel the traditional skills that define the identity of conservators are not valued by institutional managers or funding managers, or are no longer relevant" (Pye and Sully 2007, 19).

These are complex shifts that are not always comfortable. There are many implications for how conservators regard themselves, how conservators are regarded, the often-problematic reality of institutional experience, recognition, and funding as well as for the education and training of the next generation of conservators.

4. AT THE TIPPING POINT?

Since 2009, England has been experiencing deep and lasting year-on-year cuts with local authority budgets reduced by 7.1% each year over four years (Museums Association 2014). Overall, cuts have resulted in a £4-million reduction in museum funding, which has in turn resulted in reduced core and grant funding for national and regional museums. Museums are closing, and budget cuts are reducing staffing levels. Conservation courses have closed, the rising costs of completing a professional conservation qualification are sadly accompanied by increasing difficulty in finding permanent positions, and those jobs that do exist are often temporary contracts. Despite the investment, even the future of the building housing the V&A Clothworker's Centre is now "being assessed by the Department for Culture, Media and Sport (DCMS) as part of a wider government drive to get value for money from its estate" (Stephens 2014a). The UK's Museums Association (MA) has been tracking the impact of the cuts. Between 2005 and 2014, 85% of the respondents reported staff cuts (Newman and Tourle 2011). Specialist curatorial posts, including textile curators, are being lost as are conservation posts although these are only included in the MA's survey under the category "other" (fig. 1); however, Prospect, which represents over 6,000 heritage professionals, noted that the sector is near "the tipping point" and notes that conservation posts are under particular threat (Stephens 2014b; Prospect 2014). Without combined curatorial and conservation expertise, effective planning and interventions for collection development and preventive care cannot be sustained.

We run the risk of moving toward a contract culture where conservators are brought in for specific tasks rather than being an essential part of the museum process. The underlying implication that conservation is seen as a technical fix needs to be examined. In some institutions, conservation seems neither to be valued for being a process that involves skill, long-term embedded knowledge, and expertise about the collection and the building nor for contributing to the museum's curatorial, educational and social goals. Furthermore, despite some shining exceptions, conservators are not necessarily perceived as being "management material." To be fair, many may not have this as a goal, preferring (legitimately) to concentrate on objects and collections. In 2001, Tim Shadla Hall, reader in public archaeology, University College London, voiced concerns about "the

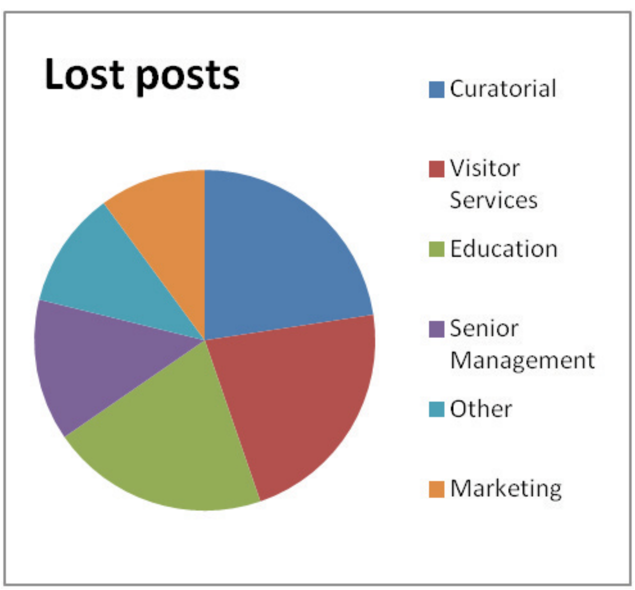

Figure 1: Museums reporting on areas of expertise affected by decreases in staffing since April 2010 (140 respondents); based on Newman and Tourle, *The Impact of Cuts on UK Museums*, 2011.

relatively low esteem in which conservation is held" (cited by Jones 2002). This view persists: "Conservation, though… once you've established the protocol, it's just glorified housework" (Jamie 2012). But this is a salutary insight into perceptions of the profession and its contribution.

The 2012–2013 ICON *Conservation Labour Market Survey* showed there were 3,175 professional conservators in the UK plus 2,500 support staff and volunteers but also revealed shortages of specialist conservation skills and significant gaps in transferable skills like leadership, business, project management, and IT (ICON 2013). It also demonstrated how lack of recognition flows into salary structures. The median wage for the conservation workforce is lower than for comparable professional occupations (£26,000 compared to £36,359), and the cuts have also been having an effect here. One fifth of respondents reported that salaries had fallen by 10% since January 2012, whereas a further 44% noted that salaries had remained unchanged—a fall in real terms.

5. SUSTAINING TEXTILES AND DRESS COLLECTIONS AND CONSERVATION

National and regional textile and dress collections and conservation facilities, despite some notable exceptions, are being adversely affected by reductions in central and local government funding with resulting closures and relocations (table 1).

Table 1: Closures and relocations of UK textile and dress collections and conservation organizations, 2009–2013

Organization	Date of closure
Textile Conservation Centre	Closed December 2009 (textile conservation course now at University of Glasgow)
National Conservation Centre, Liverpool (included textile conservation)	Closed December 2010
Silk Mill Museum	Closed June 2011
Carrow Hall Costume and Textile Study Centre	Closed July 2011
Women's Library, London (Suffragette banner collection)	Closed October 2012 (Collections moved to London School of Economics)
National Museum of Costume, Scotland	Closed April 2013

Underlying these decisions made by directors and trustee boards is the significance and value placed on textiles and textile conservation as an integral part of institutions and the commitment to long-term collection preservation, interpretation, and communication. Even when posts were more secure, few textile specialists, either curators or conservators, became higher level managers so decision-making about collections and recruitment could be made by those without insight into the potential of textiles and dress for telling stories through objects and engaging different publics interested in history, science, trade, and politics. It is all too easy for collections requiring specific specialist display and storage strategies and investment to slip off the priorities list when museums are under pressure. Paradoxically, textile conservation may still be perceived as either domestic "housekeeping," requiring no specialist knowledge beyond the ability to launder, or an expensive and highly technical block to access. The issue of training the next generation also needs to be considered. New opportunities are opening up, such as the *Skills for Future* program at The Bowes Museum, but entry to conservation programs remains competitive despite a shrinking job market (Bowes Museum 2014).

6. GENDER, TEXTILES, AND NEEDLEWORK SKILLS

Although men have long been involved in the textile and garment industries, in Western cultures needlework skills are particularly associated with girls and women. This is a heritage to be proud of, but it is also a limitation. Their very ubiquity and anonymity has contributed to their low ranking in the fine and decorative art hierarchy. Despite enormous shifts in attitudes, the study of textiles and dress is still not regarded by all as a serious discipline, and, although hard to quantify, a gendered view of textiles, dress and their audiences persists.

The account of the visit made by children from Ropley Church of England School to Guildford Museum's Victorian Schoolroom is revealing. Transplanted into the lives of 19th century schoolchildren, their teacher reported that:

> "… girls and boys were once more separated; us females plodding down the stairs… to see Emily awaiting. She explained to us how valuable it was to know how to sew in the nineteenth century. Apparently, it was a useful skill as you could derive much profit from it (either by sewing clothes, darning, etc,) … For that day though, we just had a shot at cross stitch which proved to be a challenge" (Lloyd 2013).

As these 20th century girls–significantly only girls–discovered, needlework skills could be a domestic and financial benefit. What is equally revealing is the girls' (and, incidentally, their teacher's) lack of familiarity with basic stitches. It is possible to track the changes in the UK National Curriculum and see needlework being steadily removed (National STEM Centre n.d.). This has an impact on textile conservation programs as, although they may have much to offer in other areas, fewer students are likely to arrive with high levels of needlework skills. Television programs such as *The Great British Sewing Bee* certainly demonstrate that people lack sewing skills but also show positive engagement with needlework (BBC2 2013). Activities such as the Embroiders Guild's *The Big Stitch* celebrating 'all things embroidered ...' are hugely successful (Ashmolean Museum 2012). The 2012 and 2014 events at the Ashmolean Museum were besieged by enthusiastic stitchers, exploring historical embroidery, adding stitches to the world's longest embroidery, attending demonstrations, and working on their own projects.

7. MONUMENT FELLOWSHIP

In 2010–11, I held a Monument Fellowship at York Castle Museum (YCM) where I had previously worked as assistant keeper of textiles & dress (conservation). The vision behind these Fellowships, administered by the Museum Association and funded by the Monument Trust, a Sainsbury Family Charitable Trust, is to ensure sustainability of embodied and embedded knowledge by enabling transfer of knowledge from previous to current staff (Museums Association n.d.). YCM no longer has conservators on staff, and the specially constructed laboratories are no longer dedicated to conservation. The specialist textiles and dress curatorial post no longer exists.

The "Talking Textiles" project focused on working with colleagues who had not previously been engaged with the YCM textile and dress collections or had worked with conservators. It aimed to develop their understanding of these collections with the broader aim of enhancing public understanding and enjoyment of the textiles and dress collections, thus demonstrating their value to the museum and the benefits of specialist conservation knowledge. I ran workshops on fibers and fashion, created resource packs that integrated evidence from my previous conservation treatments into the curatorial record, and we made videos and podcasts discussing parts of the textiles and dress collection. The idea was to encourage curators and museum educators to see conservation as a valid way of understanding objects and make connections across collections using textiles and dress as a jumping-off point. It is important to recognize that boundaries of professional expertise still remained, reflecting the nature of specific disciplines, the tasks involved, and the requirements of professional standards so decisions are made by those with the appropriate qualifications and expertise.

8. SUMMARY

Conservators have to draw strength from our unique engagement with objects and the power this gives us to engage with the public that "has increasingly become an essential partner in safeguarding our shared cultural heritage" (ICOM-CC 2008 n.p.). This enables us to demonstrate the multiple values of conservation in preserving and interpreting cultural heritage—and show others that it is intriguing and fascinating. It is vital to demonstrate that we are part of an enabling discipline and a culturally meaningful activity that adds to the pleasure and understanding of museum visitors and enhances knowledge for researchers. This will create a virtuous circle, attracting high calibre entrants who need to be offered well-funded programs and be assured of appropriate prospects and rewards including meaningful professional development and research opportunities.

In organizational terms, enhancing conservators' potential for leadership and management is vital. We need to continue our efforts to build a creative, constructive conservation profession capable of convincing colleagues, politicians, and policymakers of our value. The example of ecological conservators may be helpful here: think global, act local. Identify one thing—large or small or a step toward a bigger project—which you or your department can do over the course of a year and build it onto the program. Make sure people know what you are doing and why, and what you have achieved. And, throughout all this, we have to collaborate and communicate with bodies outside the conservation profession, including key decision-makers and influencers. None of this is new thinking, but the current crisis makes it more urgent. To sustain embedded expertise and influence decision-making, it is important to build on our many achievements, think big, challenge preconceptions about the intellectual, historical, and emotional appeal of textiles and dress, and find new collaborators and innovative approaches to demonstrate our unique contribution.

ACKNOWLEDGMENTS

Simon Cane, Birmingham Museums and Art Gallery; Dr. Dinah Eastop, consultant, conservation and heritage studies; Dr. Chris Caple, Durham University; Ann French, Whitworth Art Gallery; Frances Lennard, University of Glasgow.

REFERENCES

AIC. 2013. *PR and Outreach-Exhibiting Conservation Wiki*. Accessed April 11, 2014. http://www.conservation-wiki.com/wiki/PR_and_Outreach-Exhibiting_Conservation.

Ashmolean Museum. 2012. *The Big Stitch*. Accessed April 11, 2014. http://www.ashmolean.org/exhibitions/threads/events/stitch/.

BBC2. 2013. *The Great British Sewing Bee*. Accessed April 11, 2014. http://www.bbc.co.uk/programmes/p0165nj8/.

Bowes Museum. 2014. *Skills for the Future*. Accessed August 12, 2014. http://thebowesmuseum.wordpress.com/2014/07/19/skills-for-the-future/.

Brennan, J. M., Pochoom, P., and Saengsirikulchai, P. n.d. *The Queen Sirikit Museum of Textiles: Establishing a Preservation and Conservation Framework*. Accessed May 9, 2015. http://www.qsmtthailand.org/conservation_detail/81/

British Museum. n.d. *World Conservation and Exhibitions Centre*. Accessed April 11, 2014. http://www.britishmuseum.org/about_us/the_museums_story/new_centre.aspx.

Brooks, M. M. 2008. "Talking to Ourselves." *Preprints of the 15*th *Triennial Meeting, New Delhi, 22–26 September 2008.* New Delhi: Allied Publishers. 1135–1140.

Dillon, C., N. Bell, K. Fouseki, P. Laurenson, A. Thompson, A. and M. Strlic. 2014. "Mind the Gap: rigour and Relevance in Collaborative Heritage Science Research." *Heritage Science* 2 (11): 1–22.

Eastop, D. 2006. "Conservation as a Democratising Practice: Learning from Latin America. A Report from ICOM-CC, Rio de Janeiro, Brazil, 22–27 September 2002." *ICOM UK News* 63 (December): 22–24.

Frame, K. 2008. "Communicating Conservation at the Historic Royal Palaces." *Preprints of the 15*th *Triennial Meeting, New Delhi, 22-26 September 2008*. New Delhi: Allied Publishers. 1141–1146.

Françoise, S., C. Brault, and M. M. Brooks. 2000. "Mémoire Corporative: Strategies in Creating a Theatrical Costume Collection while Performing Art. In *Conservation Combinations: Preprints of a Conference. NATCC*, edited by A. Battram, et al., 92–99. Asheville, NC: Biltmore House.

Gamble, P. R., and J. Blackwell. 2001. *Knowledge Management*. London: Kogan Page.

Gatley, S., and M. Morris. 2015. "Striking a Pose: The Display of Hollywood Costume." *Costume* 49 (1): 75–90.

Gill, K. 2012. "Images Can Speak Louder Than Words: Communicating Conservation Effectively." *Studies in Conservation* 57 (S1): 114–121.

Heritage Preservation. 2005. *Public Trust at Risk: The Heritage Health Index Report on the State of America's Collections* Washington DC: Heritage Preservation.

Heritage Preservation. [due 2015]. *Heritage Health Information 2014*.Washington DC: Heritage Preservation.

Horvath, J. A. 2000. "Working with Tacit Knowledge." In *The Knowledge Management Yearbook 2000–2001*, edited by J. A. Woods and J. Cortada, 34–51. London: Routledge.

ICOM-CC 15th Triennial Conference. 2008. "Terminology to Characterise the Conservation of Tangible Cultural Heritage." Resolution adopted by the ICOM-CC membership at the 15th Triennial Conference, New Delhi, 22–26 September 2008. Accessed January 30, 2015. http://ceroart.revues.org/2794?file=1.

ICCROM/UNESCO. 2013. *Re-Org*. Accessed May 2, 2014. http://re-org.info/en and www.iccrom.org/eng/news_en/2011_en/various_en/10_21StorageSurveyResults_en.pdf.

ICON. 2013. *Conservation Labour Market Survey 2012–13*. London: ICON.

Jamie, K. 2012. "Bergen's Whale Hall: Graveyard of Giants." *The Observer*, April 8. Accessed May 2, 2014. http://www.theguardian.com/environment/2012/apr/08/Bergen-whales-museum-kathleen-jamie.

Jones, H. 2002. "The Importance of Being Less Earnest: Communicating Conservation." *V&A Conservation Journal*, 41. Accessed April 16, 2014. http://www.vam.ac.uk/content/journals/conservation-journal/issue-41/the-importance-of-being-earnest-communicating-conservation/.

Jones, S., and J. Holden. 2008. *It's a Material World*. London: DEMOS.

Lloyd, A. 2013. "Victorian Schooling Experience." Accessed April 11, 2014. http://www.myropley.org.uk/2013/07/14/victorian-schooling-experience.

Manchester Art Gallery. n.d. *Salvaged*. Accessed April 16, 2014. http://www.manchestergalleries.org/salvaged/the-project/.

Metropolitan Museum. 2004. *Dangerous Liaisons*. Accessed April 11, 2014. http://www.metmuseum.org/exhibitions/listings/2004/dangerous-liaisons.

Museum of London. 2012.*Volunteering at the LAARC*. Accessed April 16, 2014. http://www.museumoflondon.org.uk/collections-research/laarc/volunteers-students/.

Museums Association. 2014. *Campaigns: Cuts Timeline*. Accessed May 18, 2014. http://www.museumsassoica-tion.org/campaigns/funding-cuts/19122012-cuts-timetline.

Museums Association. n.d. *Monument Fellowships*. Accessed May 18, 2014. http://www.museumsassociation.org/collections/about-monument-fellowships.

National STEM Centre. n.d. *National Curriculum: Design and Technology*. Accessed April 11, 2014. http://www.nationalstemcentre.org.uk/elibrary/collection/645/national-curriculum-design-and-technology/.

Newman, K., and P. Tourle. 2011. *The Impact of Cuts on UK Museums*. London: Museums Association.

The National Archive. 2014. "'Mind the Gap' Research Study: Project Report Published." Accessed May 18, 2014. http://www.nationalarchives.gov.uk/news/906.htm.

Prospect. 2014. *Heritage in a Cold Climate*. London: Prospect.

Pye, E. 2001. "Communicating Conservation." In *Caring for the Past: Issues in Conservation for Archaeology and Museums*, authored by E. Pye, 183–199. London: James & James.

Pye, E., and D. Sully. 2007. "Evolving Challenges, Developing Skills." *The Conservator* 30:19–38.

Salzburg Global Seminar. 2009. *Declaration on the Conservation and Preservation of Cultural Heritage*. Accessed April 11, 2014. http://www.salzburgglobal.org/calendar/2000-2009/2009/session-466.html.

Stephens, S. 2014a. "DCMS Looking at the Future of Blyth House." *MA News*. Accessed August 12, 2014. http://www.museumsassociation.org/museums-journal/news/29012014-dcms-looking-at-future-of-blythe-house?csort=like.

Stephens, S. 2014b. "Union Highlights Devastating Cuts." *MA News*. Accessed May 18, 2014. http://www.museumsassociation.org/museums/.../07052014-heritage-sector-at-tippingpoint/.

V&A. 2013. *Hollywood Costume*. Accessed April 11, 2014. http://www.vam.ac.uk/content/exhibitions/exhibition-hollywood-costume/about-the-exhibition/.

V&A. n.d. *About the Clothworkers' Centre for the Study and Conservation of Textiles and Fashion*. Accessed April 11, 2014. http://www.vam.ac.uk/content/articles/a/about-the-clothworkers-centre-for-textiles-and-fashion-study-and-conservation/.

Whittam, K. 2014. *Fake or Fortune?* Accessed April 16, 2014. http://www.linkedin.com/groups/Fake-Fortune-3918511.S.5831777869222670338.

Yale University Art Gallery. 2009. *Time Will Tell: Ethics and Choices in Conservation*. Accessed April 16, 2014. http://artgallery.yale.edu/exhibitions/exhibition/time-will-tell-ethics-and-choices-conservation.

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BLOWN UP: COLLABORATIVE CONSERVATION AND SUSTAINABLE TREATMENT FOR AN INFLATABLE DRESS

CHANDRA OBIE

ABSTRACT—This paper discusses the collaborative process that drew on contributors inside and outside the museum bubble to produce a unique treatment for a pneumatic dress by Issey Miyake. The dress was not yet a museum object, which necessitated a treatment that preserved the function of the dress as a wearable object as well as addressed its major condition problem: The inflatable sleeves no longer held air due to the failure of the adhesive holding the inflation valves in place. A treatment plan was developed after discussion with the owner and professionals from a variety of fields, and testing. The sleeves were filled with polystyrene beads inside a Stabiltex liner to recreate a "blown-up" appearance without the need for inflation by air.

CONSERVACIÓN COLABORATIVA Y TRATAMIENTO SUSTENTABLE PARA UN TRAJE INFLABLE: RESUMEN—Este documento trata sobre el proceso colaborativo impulsado por colaboradores de dentro y fuera del museo para producir un tratamiento único para un traje neumático creado por Issey Miyake. El traje no era una pieza de museo aún, pero necesitaba un tratamiento que preservara su función de traje, como objeto utilizable, y solucionara su principal problema: las mangas inflables ya no tenían aire por una falla en el pegamento que sostenía a las válvulas. Después de una charla con el dueño del traje y con profesionales de diferentes áreas, se desarrolló un plan de tratamiento y pruebas. Las mangas se rellenaron con perlas de poliestireno forradas con Stabiltex para que parezcan "infladas" sin necesidad de utilizar aire.

1. INTRODUCTION

Much of modern conservation takes place in the bubble of the conservation lab, but the conservation project discussed here provided an opportunity to expand that closed environment and to work *on* a bubbleor more specifically, two bubbles, which form the sleeves of a "pneumatic dress" designed for the 2000–2001 fall/winter line of Issey Miyake. The object's transformation from flat back to blown up provided an opportunity to practice collaborative conservation by expanding the team to draw on the skills and knowledge of contributors inside and outside of the conservation lab. Their involvement was key to preserving the object's meaning and role as well as its physical form. That collaboration ultimately produced an effective and sustainable approach to satisfy the unique demands of the treatment and the object's role.

The pneumatic dress came to the textile conservation lab of the Cincinnati Art Museum under unique circumstances: It was not a museum object, yet. Its role as an "outside" object necessitated the close involvement of collaborators outside the typical museum conservation sphere, beginning with its owner. The dress belongs to the private collection of Mary Baskett, an important donor to the Cincinnati Art Museum's Fashion Arts and Textiles Collection, former curator, and wearer of contemporary Japanese fashion design. The Cincinnati Art Museum hopes to acquire Baskett's collection one day and routinely consults with her on its care. Baskett has loaned many pieces from her extensive closet, which is stocked with pieces by Issey Miyake, Yohji Yamamoto, and Rei Kawakubo. Baskett's collection has been the basis for several exhibitions including *Contemporary Japanese Fashion: The Mary Baskett Collection* at The Textile Museum, Washington DC in 2009 and *Where Would You Wear That? The Mary Baskett Collection* at the Cincinnati Art Museum in 2007. Her collection includes other important pieces such as one of her favorite pieces to wear, Miyake's iconic layered "bounce dress," and the

1996/1997 Pleats Please collaborative piece with Yasumasa Morimura, *Guest Artist Series #1*. Other examples of *Guest Artist Series #1* are already part of several important art collections including those at the Museum at FIT, Los Angeles County Museum of Art (LACMA), and the Rhode Island School of Design.

2. BACKGROUND

Issey Miyake's innovative designs have made him a voice in the fashion and art worlds since the 1970s. Miyake rose to prominence when he opened the Miyake Design Studio in Tokyo in 1970. In the 1980s he innovated new methods of pleating, creating the Pleats Please line. Miyake retired from designing men's and women's wear in 1994 and 1999, respectively. This piece was created by Miyake's chief designer in 2000, Naoko Takizawa. Takizawa later went on to become Creative Director for Helmut Lang's men's line and is currently Design Director at Uniqlo. At the time he designed the pneumatic dress, Takizawa was experimenting with unusual shapes and volumes. For the 2000–2001 fall/winter show, he designed this inflatable sleeve cap, which was also available on a long-sleeved blouse or in a pointed, hornlike shape.

The dress is part of the evolving tradition of inflatable artworks that challenge conservators to find ways to keep them blown up as intended, but in ways that are sustainable for the future of the work. Inflatables have been entering collections in a number of forms (Topham, 2002), including Panamarenko's *Aeromodeller* (1969–1971) at the City Museum for Contemporary Art, Ghent Belgium, which was the topic of Huys and van Oosten's 2005 ICOM paper in which they describe the daunting task of caring for its 88.25 sq. ft. of PVC foil on a painted cane structure, assembled with synthetic glue. Air inflation may be almost impossible for an artwork to sustain as even the most sensitive inflation results in stress on the object and inevitable air leakage, necessitating repeated inflations. A set of four inflatable clothing items by Michiko Koshino have never been on display (as of 2011) at the National Gallery of Australia because of the difficulty of finding a safe way to blow them up and keep them looking that way for the period of display. The challenge of inflatables means a host of inflatable artwork either lingers unseen in storage or is blown up—safely or otherwise.

The pneumatic dress had met a similar fate, stored away in a closet. It currently remains part of Baskett's life, and she hopes to continue wearing it before donating it to the museum; therefore, the role of this particular art object encompassed not only exhibition in the museum, but also an active "life" outside the museum bubble, an aspect that was as important to conserve as the material of the object. Baskett fondly remembers wearing it to a dinner party at her home when the dress was new in December 2000 and she last wore it at her 70th birthday party in 2011. By 2011, however, she was already disappointed that the dress could not maintain a blown up shape and she unhappily "retired" it until it came to the conservation lab at the Cincinnati Art Museum in its deflated condition.

3. CONDITION

Upon arrival, the dress had minor condition problems, mostly related to Baskett wearing it. Condition diagrams recorded the locations of pulled threads, brownish tidelines, marks (pen? makeup?), and yellowed, crusty adhesive around the inflation valves. The one glaring and major conservation problem was the fact that the sleeves no longer held air. For this object, the artist's intent was blown up by the object's inability to blow up.

It was clear that the yellowed, crusty adhesive was probably the culprit of the loss of airtightness. Although the seams appeared sound and airtight (glued wrong sides together with seam allowances to the exterior), there was evidence of several campaigns of gluing and regluing the inflation valves (fig. 1). Baskett reported

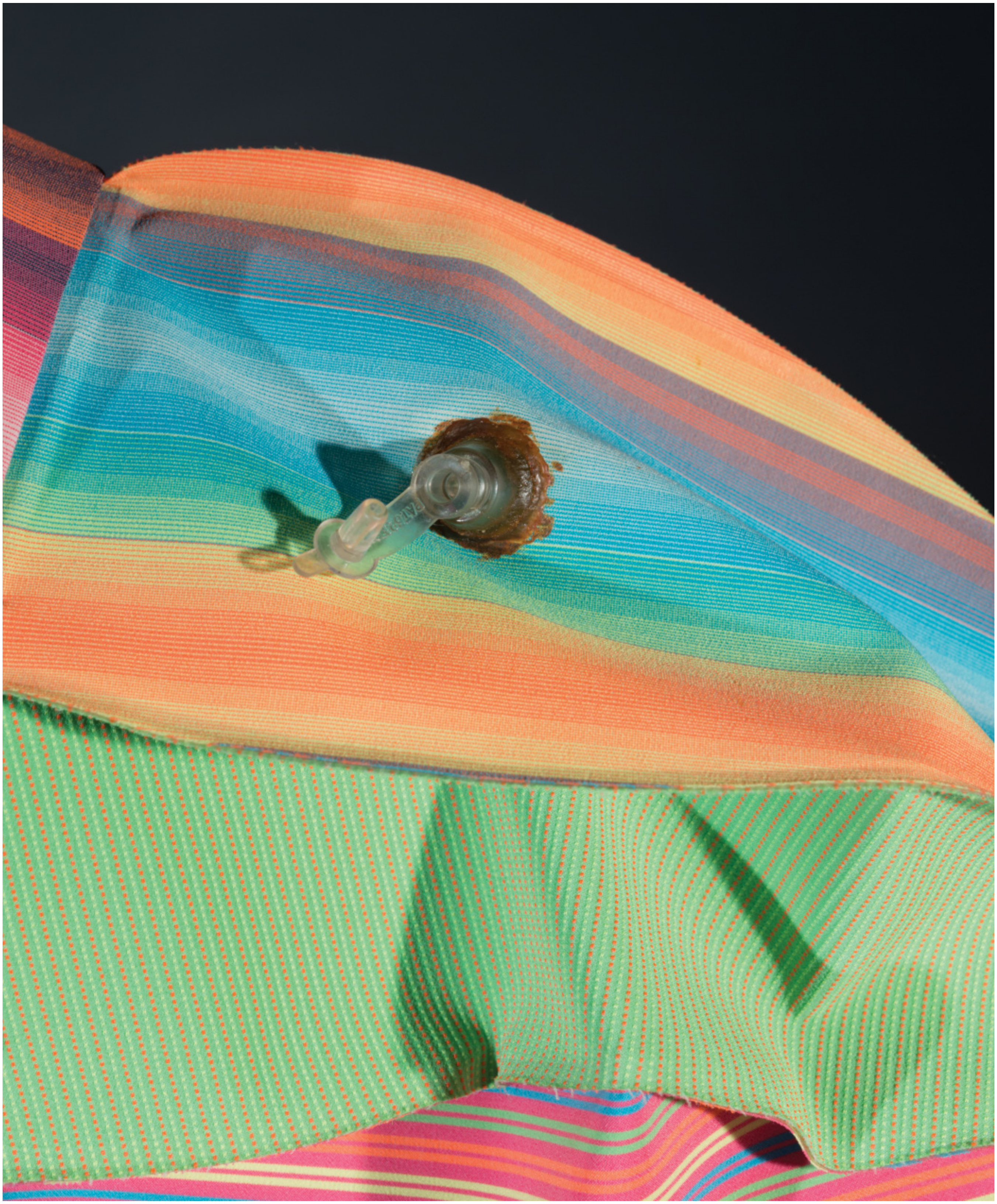

Figure 1: Thick, discolored adhesive around the inflation valve before treatment failed to make the valves airtight and was unsightly.

that when the problem first appeared, she returned it to the Miyake studio for repair. There, it appears additional adhesive was added, but the problem recurred. Just a little mechanical manipulation was enough to completely free one valve during inspection and the buildup of glue was easily removed with tweezers and a small amount of deionized water to soften what remained. Research suggested that the problem was not unique to Baskett's dress. A listing for a 2007 auction by Kerry Taylor Auctions, London, offered a nearly identical dress; the description noted that the "inflation tubes and stoppers" were missing (Kerry Taylor Auctions 2008). An acquaintance of Baskett's owned the blouse version, but she told Baskett she had only worn it a few times before it stopped holding air properly.

The answer to why the inflation valves were prone to coming unstuck was listed on the dress' content and care label: Contents include 42% nylon, 40% polyester, 18% polyurethane with parts 100% polyurethane. Polyurethane was immediately the prime suspect. Glues used for polymers usually weld pieces together chemically and slight tackiness on the base of the vinyl inflation valves might be from chemical welding or from plasticizer migration in the valves themselves. Either way, glues tend to have poor aging properties with polyurethane and vinyl, undergoing mechanical failure and discoloration (Klein-Juneau 2014).

Best-known as foam for padding and insulation, polyurethane is used in a wide range of applications from footwear to fake leather coating, similar to the polyurethane coating inside the inflatable sleeve caps. Despite its many useful applications, polyurethane also comes with some important drawbacks: It is susceptible to chemical degradation by oxidation, which causes yellowing and eventually mechanical failure (Quye and Williamson 1999). Impurities in the chemical chain form sites of potential photo-oxidation reactions, which ultimately result in the kind of degradation familiar to conservators who have worked with these materials: crumbling, discoloration, and peeling and cracked coatings. Polyurethane foams (PUR) degrade more rapidly because of greater surface area, as much as 3% solid material to 97% air by volume (van Oosten, Lorne, and Béringuer 2009). The sleeve interiors' polyurethane laminate (PUL) has been largely protected from heat, light, and moisture and no peeling or cracking was apparent yet, but is expected in the future. The bond of the polyurethane coating to the fabric of the dress was also found to be fragile with mild cleavage observed around the valve hole after cleaning and manipulating this area.

3. COLLABORATING TO DEVELOP A TREATMENT PLAN

A full understanding of the problem drew on an expanding team of collaborators both inside and outside the museum bubble. The collaborative team included the owner and wearer Mary Baskett, the artists Issey Miyake and Naoki Takazawa, colleagues who offered insights and suggestions via the Conservation Dist List, experts on polyurethane and plastics such as Thea van Oosten, the co-author of *PUR Facts* and a co-author of the 2005 paper for ICOM about the conservation of the Aeromodeller, and chemist Dr. Lauren Ashley-Juneau. Closer home at the Cincinnati Art Museum, Curator of Fashion Arts and Textiles Cynthia Amnéus, Chief Conservator Serena Urry, and Objects Conservator Megan Emery all contributed to the evolving treatment strategy.

A number of possible interventions proposed in the course of collaboration were considered. Among the possible approaches was inserting a semi-rigid form such as a cage inside the collapsed sleeve. The cage could allow for inflation without relying solely on it, but it might be cumbersome and difficult to put in place besides creating a new set of stress points on the interior. Another idea was to insert a new balloon inside the original, which would allow for inflation and add almost no weight, but finding materials (medical-grade balloon?) would be difficult and recreating the original shape from the inside certainly challenging. Assuming a balloon could be made and inserted, the original problems of failed adhesives and leaking fill points would likely recur in the future, necessitating repeated treatment. Although considered, readhering the inflation valves was considered was ruled out because of the difficulty of holding in place anything safely and reversibly to the polyurethane coating. Chemical welding would be necessary to achieve airtightness, endangering surrounding material.

Finally, a promising idea came via the Conservation Dist List from Tom Braun, objects conservator at the Minnesota Historical Society. Braun shared his experience treating a set of inflatable pool toys by filling them with polystyrene beads intended as filling for beanbag chairs and plush toys (Braun 2012). The beads flow easily, filling any shape with loft that imitates the appearance of inflated objects. They are lightweight, readily available, and inexpensive.

The idea came with some drawbacks, however. Polystyrene does suffer from photo-oxidation, which causes yellowing, and is too rigid and not considered stable enough in solution for use as a consolidant or adhesive on objects (Horie 1987, 114). In the protected, closed environment of the sleeve interior, the beads would have extremely little exposure to light or air, thus retarding their oxidation. As they were to be used in their solid form, their rigidity was not a concern. The opacity of the sleeve also meant that yellowing was not an aesthetic concern, but that mechanical failure—the ultimate fate of crumbling foams—may occur eventually. Although the beads appeared to be a promising solution, it was important that the treatment be completely reversible given the uncertain future of the polystyrene beads.

The next challenge was to find a means to get the static-prone beads into the sleeves while ensuring they could eventually be gotten back out again. Although the pool toys had large holes through which fill material could be introduced, access was extremely limited for the pneumatic sleeves, which have airtight seams but a failed fill point. The access point was an approximately 1 cm-diameter hole on the top of each sleeve where the inflation valves had been removed. To safely and reversibly fill the sleeves, it would be necessary to create liners, which could be inserted in the sleeves first and then filled with beads. In the future, the treatment could be reversed or the beads merely replaced by pouring the beads out and pulling the liner out with any remaining beads. The treatment would maintain the dress' shape and wearability, and preclude retreatment or additional attention, making it a sustainable choice.

Before undertaking treatment, tests to perfect the liner and fill were carried out. Small square forms of Stabiltex were sewn and filled. For the first test, the Stabiltex form was filled with Ethafoam grated with a cheese grater. Ethafoam fill avoided concerns about the long-term stability of polystyrene, but the results were too lumpy and heavy. The second test form was filled with polystyrene beads, but the beads were so fine and prone to static electricity that they would shift or fly out, which resulted in a form that never looked completely full. The third test was filled with polystyrene beads and then topped off with a "plug" of grated Ethafoam. The heavier plug material prevented the fill from shifting away from the fill point and produced a fuller look (fig. 2).

4. TREATMENT

With testing complete and a plan in place that seemed to satisfy all the unique needs of this treatment, execution commenced. The minor aesthetic issues including spot cleaning for the tide lines and small stains were addressed. Both inflation valves were removed and cleaned. Clumps of old adhesive were removed mechanically

Figure 2: After the polystyrene filling was in place, the sleeves appeared "blown up" again. This shot, during treatment, shows the filled sleeve with the access point visible before the valve was tacked in place to cover it.

with tweezers, and the valves received a swab with deionized water and ethanol. Next was treatment of the deflated sleeves.

The linings were made by creating a precise 10-piece pattern of the sleeves and reconstructing them with double layers of Stabiltex. A rub-off pattern-making technique was used, facilitated by the sleeves' external seam allowances. The linings were made with double layers of Stabiltex to tolerate the stress of the seam line and the pressure that would be created by filling them. The pattern pieces were "cut" from white Stabiltex using a soldering iron to melt the edges, limiting raveling. Eight pieces form the outer "beach ball" shape and two form the interior sleeve cap, which accommodate the wearer's upper arm inside the inflated sleeve. Constructing a pattern allowed a close understanding of the mechanics of the inflatable sleeve: While it "hugs" the shoulder inside with the shaped interior pieces, the front and back are identical. The turning point (for turning right sides out after seaming) was a short seam in the armpit that was adhered and stitched closed. The pattern was adapted slightly to add a fill tube to extend up through the inflation valve holes, which would be used for filling after the linings were in place.

These linings were inserted through the valve hole using a glass stirring rod to help guide them into position inside the sleeves. At the bottom of the sleeve, the turning point's seam prevents the lining from passing

Figure 3: After treatment, the sleeve appears fully inflated, complete with inflation valve.

completely under the arm, so it was necessary to guide the bottom edges of the lining into position and hold them there with silicone-tipped clamps during filling. The sleeves were filled with polystyrene beads through an aluminum funnel, which produced less static electricity than a plastic one (fig. 4). Gentle jostling encouraged the polystyrene beads to settle and completely fill the sleeves. A heaping tablespoon of grated Ethafoam topped off the fill for each sleeve, preventing escaping beads and helping create a more "full" appearance and produced a firmer base to support the nonfunctional inflation valves. The filling tube was sewn closed and tucked inside the sleeve. The bases of the inflation valves were inserted through the holes and tacked in place with a few stitches of Skala polyester thread, which passed through the thin vinyl ring at the base of the valves, completing the blown-up look without any actual inflation.

Figure 4: Textile conservator Chandra Obie filling a sleeve with polystyrene beads using an aluminum funnel.

The final step of treatment was novel for a textile conservation lab: a fitting on a live wearer. Baskett visited the museum to try on the finished dress. She found the dress wearable and was excited that it appeared inflated again. The sleeve caps hug the shoulder quite snuggly inside, but this may help hold them up given the slight addition in weight from the bead filling. If they are not positioned quite right, the sleeves can look twisted or pull across the chest, but some attention to their position remedies this. Baskett says it gets easier every time she wears the dress as she gets used to the adjustment and the dress, in turn, settles around its wearer. The dress can now be seen on Mary Baskett on the streets of Cincinnati.

Figure 5: The fully "inflated" dress after treatment

5. CONCLUSIONS

The “reinflation” of the pneumatic dress using polystyrene beads was considered a success and the dress was able to recommence its role as both a wearable piece of fashion art and an exhibition-ready one. By working with a team of collaborators to access the range of specialist knowledge necessary, it was possible to find and adapt a treatment plan that satisfied all the unique needs of the object in its various roles, now and into the future. The long-term stability of the polystyrene beads requires monitoring—especially if their use as a treatment material is to be expanded and used elsewhere—but the risk was considered acceptable given their success and the fact that the treatment could easily be reversed. The use of polystyrene beads may present a viable solution to the problem of inflatable artworks that are required to appear to be under the strain of full inflation, but could actually be only blown up like the pneumatic dress.

ACKNOWLEDGMENTS

Mary Baskett, Cincinnati Art Museum, CAM Conservation staff, Serena Urry, Cecile Mear, Kelly Schulze, Wendy Crawford, Megan Emery, Cynthia Amnéus, Julia Gardner, Dr. Lauren Klein-Juneau, Jennifer Hardin, Tim Bechthold, Tom Braun, Conservation Dist. List, Textile Specialty Group, Objects Specialty Group, AIC.

REFERENCES

Braun, T. 2012 *ConservationDistList* instance 26:15, distributed September 2, 2012.

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

Huys, F. and T. B. van Oosten. 2005. “The ‘Aeromodeller OO-PL’: The Conservation of a PVC Balloon.” *ICOM Committee for Conservation preprints*. *14th Triennial Meeting, Hague*. Paris: ICOM. 1: 335–342.

Kerry Taylor Auctions. 2008. *Lot 1284: An Issey Miyake Pneumatic Dress, Circa 2000*. Accessed September 10, 2013. http://www.liveauctioneers.com.

Klein-Juneau, L. 2014, pers. Comm. Doctor of Chemistry, Rutgers University, Piscataway, New Jersey.

Quye, A. and C. Williamson, eds. 1999. *Plastics: Collecting and Conserving*. Edinburgh: NMS Publishing Ltd.

Topham, S. 2002. *Blow Up: Inflatable Art, Architecture, and Design*. New York City: Prestel Publications.

van Oosten, T. and A. Lorne and O. Béringuer. 2009. *PUR Facts: Conservation of Polyurethane Foam in Art and Design.* Amsterdam: Amsterdam University Press.

SOURCES OF MATERIALS

Polystyrene beads
    amazon.com
    Tel: 1-888-280-3321

Stabiltex fabric

Plastok
79 Market Street
Birkenhead
Merseyside
CH41 6AN
Tel: +44 (0) 151 647 4579
Fax: +44 (0) 151 647 3641
www.plastok.co.uk

Storage materials

University Products
517 Main Street
Holyoke, MA 01040
Tel: 1-800-628-1912
Fax: 1-800-532-9281
www.univsersityproducts.com

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A CASE STUDY USING MULTIBAND AND HYPERSPECTRAL IMAGING FOR THE IDENTIFICATION AND CHARACTERIZATION OF MATERIALS ON ARCHAEOLOGICAL ANDEAN PAINTED TEXTILES

E. KEATS WEBB, REBECCA SUMMEROUR, JENNIFER GIACCAI

ABSTRACT—Spectral imaging techniques, including infrared reflectography and ultraviolet-induced visible fluorescence, have been used by conservators since the 1930s. These techniques are relatively accessible and have become routine in research and conservation. Institutions with imaging, color science staff, and high-end spectral imaging equipment can create and process large spectral data cubes that provide information for the identification of materials. Combining a low-resolution hyperspectral camera with a high-resolution digital camera modified for multiband imaging may present an alternative imaging option to aid identification and characterization of materials in cultural heritage objects. This paper presents a case study of the combined use of multiband and hyperspectral imaging to investigate the materials of four archaeological Andean painted textiles from the collection of the National Museum of the American Indian. The goals of this project are to explore various spectral imaging options, present a technique that can be used on a variety of cultural heritage objects, and offer new insights that previous routine imaging could not provide.

ESTUDIO DE UN CASO EN EL QUE SE UTILIZARON IMÁGENES MULTIBANDA E HIPERESPECTRALES PARA LA IDENTIFICACIÓN Y CARACTERIZACIÓN DE MATERIALES EN TELAS ARQUEOLÓGICAS ANDINAS PINTADAS: RESUMEN—Desde 1930, los conservadores han estado utilizando técnicas de imágenes espectrales que incluyen la reflectografía infrarroja y la fluorescencia ultravioleta visible. Estas técnicas son relativamente accesibles y se han convertido en prácticas de rutina en el campo de la investigación y conservación. Las instituciones que cuentan con equipos de imágenes, personal especializado en la ciencia de los colores y equipos de imágenes espectrales, pueden crear y procesar grandes cubos de datos espectrales que proporcionen información para la identificación de los materiales. La combinación de una cámara hiperespectral de baja resolución con una cámara digital de alta resolución modificada para imágenes multibanda, podría ser una opción alternativa para identificar y caracterizar materiales en objetos de herencia cultural. Este escrito presenta el estudio de un caso en el que se utilizó una combinación de imágenes multibanda e hiperespectrales para investigar los materiales de cuatro telas arqueológicas andinas pintadas, de la colección del Museo Nacional Indoamericano. Los objetivos de este proyecto son explorar varias opciones de imágenes espectrales, presentar una técnica que puede ser utilizada en una gran variedad de objetos de herencia cultural y aportar nuevos conocimientos que las imágenes de rutina no ofrecen.

1. INTRODUCTION

Spectral imaging techniques, specifically infrared reflectography and UV-induced visible fluorescence, have been used by conservators since the 1930s (Warda et al. 2011). These nondestructive and noninvasive techniques have become routine for material characterization and differentiation, as they are relatively accessible in terms of cost and ease of use. Hyperspectral and multispectral imaging have been more recently incorporated into cultural heritage conservation and research for material identification through the creation and processing of spectral data cubes. These instruments, however, are expensive for many institutions and conservators in private practice and can involve complex processing. This project explores a lower-cost imaging option that combines a high-resolution digital camera, modified for multiband imaging, with a low-resolution hyperspectral camera to aid in the identification and characterization of materials in cultural heritage objects. These techniques were applied to four archaeological painted Andean textiles from the collection of the National Museum of the American Indian, Smithsonian Institution (NMAI).

The techniques used for this project are multiband and hyperspectral imaging, which can carry a range of definitions depending on the project and application. These techniques, along with reflectance imaging spectroscopy and multispectral imaging, are defined here to clarify the differences between them. Multispectral and hyperspectral imaging are both types of reflectance imaging spectroscopy, which Ricciardi et al. (2013, 13) define as the "collection of images at many different wavelengths to obtain reflectance spectra over a large spatial area." Reflectance refers to the light reflected or scattered by a material relative to the incident light, and reflectance spectra is a curve illustrating the amount of reflectance at each wavelength over a defined spectral range (Fischer and Kakoulli 2006). Ricciardi et al. (2013) define multispectral imaging in the context of reflectance imaging spectroscopy as the acquisition of calibrated images with bandwidths of tens to hundreds of nanometers and hyperspectral as the collection of images with bandwidths of a few nanometers or less. Multiband imaging is similar to these techniques; however, it refers to the acquisition of uncalibrated images with bandwidths of hundreds of nanometers that are captured using a modified digital SLR camera and bandpass filters. Similar to hyperspectral and multispectral imaging, multiband imaging captures characteristic spectral information about objects; however, the uncalibrated image sets cannot produce reflectance spectra.

2. OBJECTS

A sample set of four archaeological painted Andean textiles (fig. 1) was selected to investigate the materials and manufacturing techniques used in their creation. The textiles are in the collection of the NMAI. They are attributed to Peru but beyond that have minimal provenience. Research and consultations with Andean textile scholars helped identify the cultural attributions of three of the textiles as Chancay style fragments (23/9073, 22/0497, 23/9038) and one as a Middle Horizon textile (23/9040). The four painted textiles are a subset of a larger project investigating the materials and techniques used to create 21 archaeological Andean painted textiles in the NMAI's collection. The larger project included other noninvasive analytical techniques, such as XRF and FORS, as well as invasive techniques such as FTIR, XRD, and LC-diode array detector-MS (Summerour et al. n.d.).

All four textiles are plain-woven cotton fabrics with colorants applied to one side (fig. 2). The colorants are referred to as paints because they appear to have been selectively applied in a paste or semi-liquid form, which distinguishes them from immersion dyes. They are embedded in the fibers on one side of the fabrics. Most appear matte, suggesting they contain minimal or no organic binder. Some of the browns, however, appear thick and shiny in select areas as if they do contain an organic binder. These thicker brown colors are most prominent on the three Chancay-style fragments where brown outlines separate colored shapes. Overall, the linear designs on the Chancay style fragments are carefully applied in regular repeating patterns, while colors on the Middle Horizon textile are more freely applied in a looser style.

2.1 PREVIOUS WORK ON SIMILAR PAINTED TEXTILES

Few studies have been published on the materials and techniques used to create painted archaeological Andean textiles. The present work builds on three of the previous studies, published by Saltzman, Keay and Christensen (1963), Smith (1986), and Boucherie (2009). Saltzman, Keay and Christensen used a spectrophotometer to identify shellfish purple dye in Paracas and Ocucaje painted textiles. Smith used XRF and polarizing light microscopy to identify iron-based pigments, carbon black, and lead-based pigments on Late Intermediate

Figure 1: Visible light images of the four archaeological painted Andean textiles selected for this project. (top left): NMAI 22/0497, Chancay style fragment; (top right): NMAI 23/9073, Chancay style fragment; (bottom left): NMAI 23/9040, Middle Horizon textile; (bottom right): NMAI 23/9038, Chancay style fragment

Figure 2: Reverse of a Chancay style fragment showing how the colorants, applied to the opposite side, partially bled through to the reverse. National Museum of the American Indian, Smithsonian Institution (22/0497).

Period textiles that are probably from the central coast of Peru. Boucherie used optical microscopy, Raman spectrometry, SEM-EDS, FTIR, and HPLC to analyze colorants in Nasca painted textiles and identified carbon black, iron oxides, calcium sulphate, indigo, a copper-containing blue mineral (possibly azurite), and cinnabar.

2.2 POTENTIAL COLORANTS

A literature review of Peruvian colorants revealed a group of materials that might be present on these textiles. This group included cochineal dye, *Relbunium* species dyes, mineral red pigments, carbon black pigment, and indigo (Smith 1986; Roquero 2002; Cardon 2007; Roquero 2008; Boucherie 2009; Phipps 2010). Initial work with FORS and XRF identified iron-rich mineral reds, an insect-based pink,[1] and indigo on the textiles. Plant-based reds, such as *Relbunium* species dyes, and heavy-metal red pigments, such as cinnabar and red lead, did not appear to be present.

3. METHODOLOGY

The methodology used at the Smithsonian Museum Conservation Institute (MCI) for the imaging and analysis of the Peruvian archaeological textiles included (1) multiband imaging to explore the various bandwidths and responses for the materials and (2) hyperspectral imaging to acquire reflectance spectra for regions of interest. Reflectance spectra from individual points were also acquired using fiber optics with a visible-near infrared spectrometer (vis-NIR) for comparison with the hyperspectral reflectance spectra.

3.1 MULTIBAND IMAGING

A modified Canon 5D Mark II was used for multiband imaging with a Coastal Optics 60mm UV-VIS-IR APO lens and a set of MidOpt bandpass filters with bandwidths in the hundreds of nanometers. Modifications to the camera included removal of the IR-cut filter from the sensor and the removal of the color filter array (CFA), which were done by MaxMax. After modification, the camera acquires monochrome images and has a maximum potential sensitivity between 350 and 1200 nm (MaxMax). The textiles were illuminated with two Lowel Pro lights with Impact halogen lamps (125W 3200K). The camera was mounted on a studio stand and the filters were changed manually, without changing the focus or position of the camera. Movement of the camera or focus while changing the filters manually could affect the alignment of the images. A filter wheel could be useful to avoid these small shifts; however, this increases setup costs, and manual changing was adequate for this project.

Nine filters were used, producing nine monochrome images for each textile in addition to a visible light image for reference. The transmission curve for the filters can be seen in figure 3. Each monochrome image recorded the interaction of light (reflection and absorption) with the material of the textile and pigment at the specific bandwidth of the filter. The variation of the interaction of the light with the different bandwidths can reveal and distinguish materials. Image subtraction with image processing software such as Adobe Photoshop or ImageJ can be used to process images to better reveal some of the pigments used. Image subtraction is a simple, powerful process that can be applied for visualizing the difference or changes between two images (Jain 1986). The pixel values of two images are subtracted resulting in an image that reveals the differences between the pixel values of two images.

3.2 HYPERSPECTRAL IMAGING

Hyperspectal imaging was carried out using the Surface Optics Corp. 710 (SOC710) with a CCD sensor and spectral sensitivity from 400 to 1000 nm. The SOC710 acquires 128 images between 400 and 1000 nm

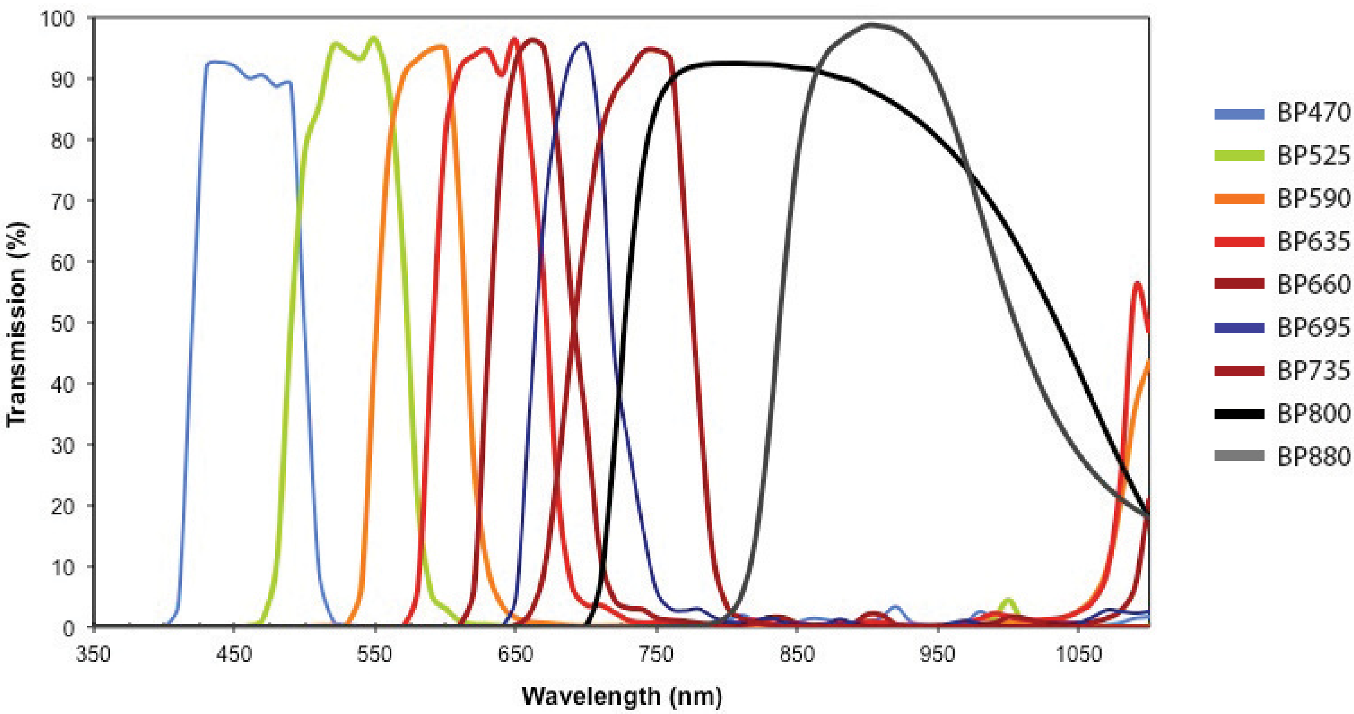

Figure 3: Transmission curves of MidOpt Bandpass filter kit used for multiband imaging. Graph from MidOpt website

creating a data cube that can provide reflectance spectra for pixels or areas of interest, as well as images of the area analyzed at a particular wavelength. The sensor captures images of 696 x 520 pixels. The textiles were illuminated with two Lowel Pro lights with Impact halogen lamps (125W 3200K).

3.3 FIBER OPTIC REFLECTANCE SPECTROSCOPY (FORS)

Point reflectance spectra were acquired using an ASD FieldSpec Hi-Res near infrared spectrometer with Indico Pro software. Spectra were collected from 375 to 2500 nm adding 50 scans at 1 nm resolution. The light source was a 70W 3100K halogen bulb. Spectra were acquired with either (1) direct halogen lighting and the instrument's original fiber optics to capture the reflected light from an approximately 1cm spot size or (2) a microfiber optic attachment in which both the source and reflected light were carried through fiber optics and there is a 1–2-mm spot size. In both cases, spot size is determined by the distance of the fiber optics from the sample. Jumps in the spectra at 1000 and 1800 nm are present due to the change in detector between the three regions of the spectra. Two spectra were taken from each spot and background spectra were acquired using a Spectralon 99% white reference and unpainted areas of textiles.

4. RESULTS AND DISCUSSIONS

4.1 BLUE PIGMENT

The signature reflectance spectrum for indigo includes a strong absorbance around 660 nm and a high reflectance just under 800 nm (Leona and Winter 2001). This drastic difference in absorbance can be captured with an image subtraction using the 735 nm bandpass filter and the 660 nm bandpass filter (fig. 4). The resulting image highlights the blue regions (figs. 5, 6). This result was supported by point reflectance spectra (fig. 7), which indicated that blue pigments in textiles 22/0497 and 23/9038 were indigo.

Figure 4: NMAI 23/9038 660 nm bandpass image (left) and 735 nm bandpass image (right)

Figure 5: NMAI 23/9038 visible light image (left) and image subtraction of the 735 nm bandpass image and the 660 nm bandpass image emphasizing the areas of indigo in resulting image (right)

Figure 6: Detail of NMAI 22/0497 visible light image (left) and image subtraction of the 735 nm bandpass image and the 660 nm bandpass image emphasizing the areas of indigo in resulting image (right)

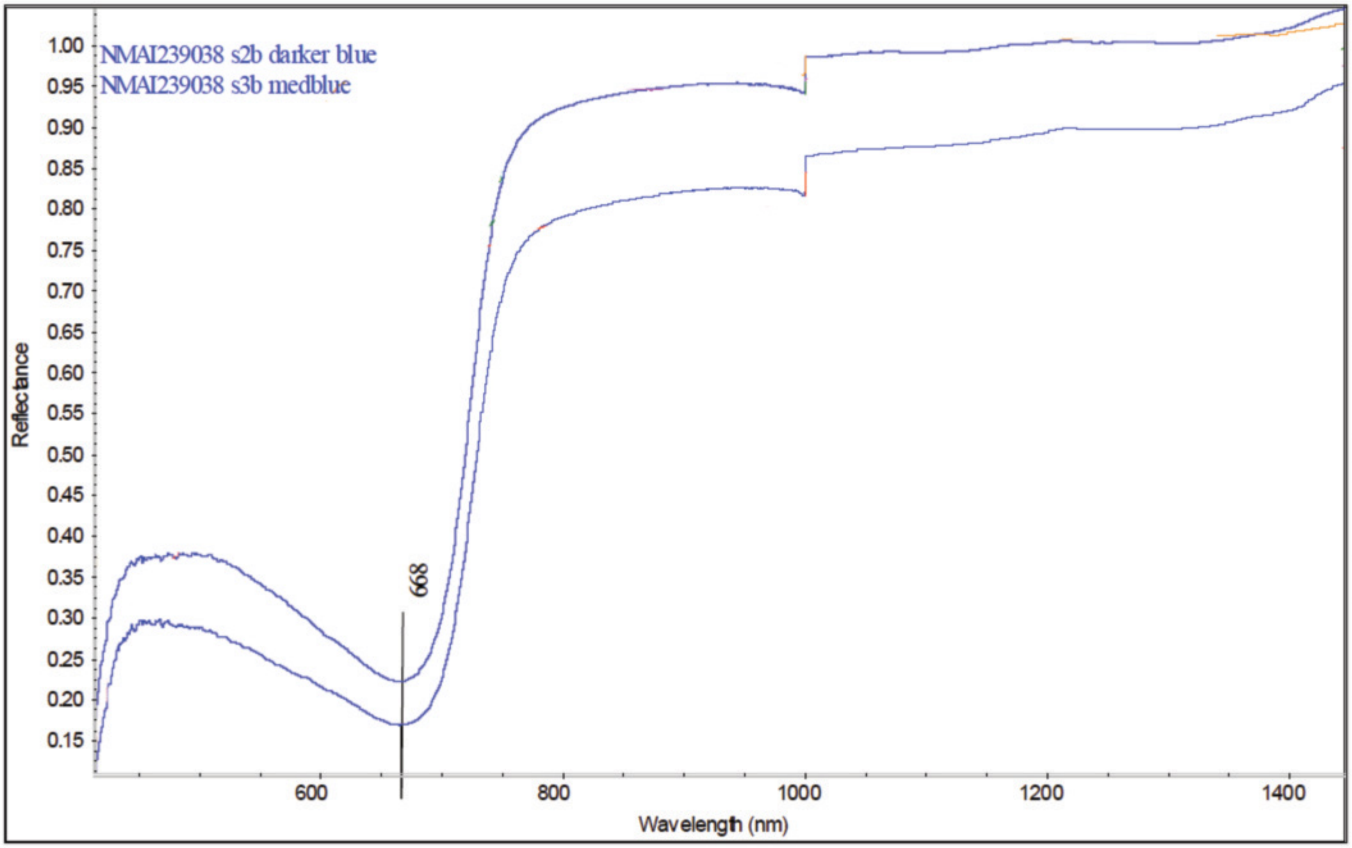

Figure 7: NMAI 23/9038 FORS spectra of blue pigment showing the signature spectra for indigo.

Image subtraction using the 735 nm and 660 nm bandpass filter images was also performed for the Middle Horizon textile (NMAI 23/9040) even though there was no indication that indigo would be present. The results suggested that the black pigment included indigo (fig. 8), which was supported by the reflectance spectra from FORS and the hyperspectral camera (fig. 9).

Figure 8: Visible light image of NMAI 23/9040 (left image) and the results of image subtraction of the 735 nm bandpass image and the 660 nm bandpass image (right image)

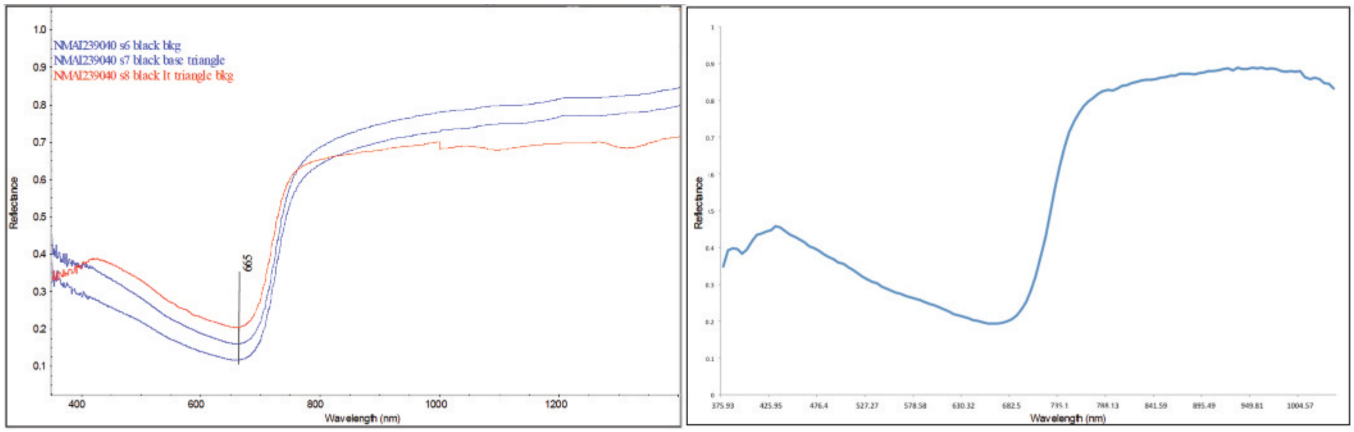

Figure 9: FORS spectra of black pigment (left) in the Middle Horizon textile (NMAI 23/9040) and hyperspectral spectrum of black pigment (right) confirming that the black pigment includes indigo.

4.2 RED PIGMENTS

4.2.1 Mineral Reds

The FORS spectra of mineral reds show a sharp incline starting just before 600 nm and an absorption valley around 880 nm (fig. 10), which is characteristic of iron oxides (Cornell and Schwertmann 2006). This incline and absorption valley can be seen in the hyperspectral spectra, but image subtraction was not successful in differentiating mineral reds from the insect-based red colorant. The 880 nm bandpass filter passes 840–1010 nm and does not appear to be narrow enough to show the difference between the reflectance recorded with the filtered images, and therefore is unable to characterize the mineral reds.

4.2.2 Insect-based Reds

The spectrum for cochineal has a signature double peak around 525 nm and 565 nm, which is seen in the FORS spectrum for NMAI 23/9038 in figure 11 (Winter, Giaccai, and Leona 2003). This double peak for the insect-based colorant can sometimes be difficult to see in the hypersepctral spectrum but is visible in figure 11. There is no significant change in the spectrum that might be useful for an image subtraction using multiband imaging to characterize insect-based colorant.

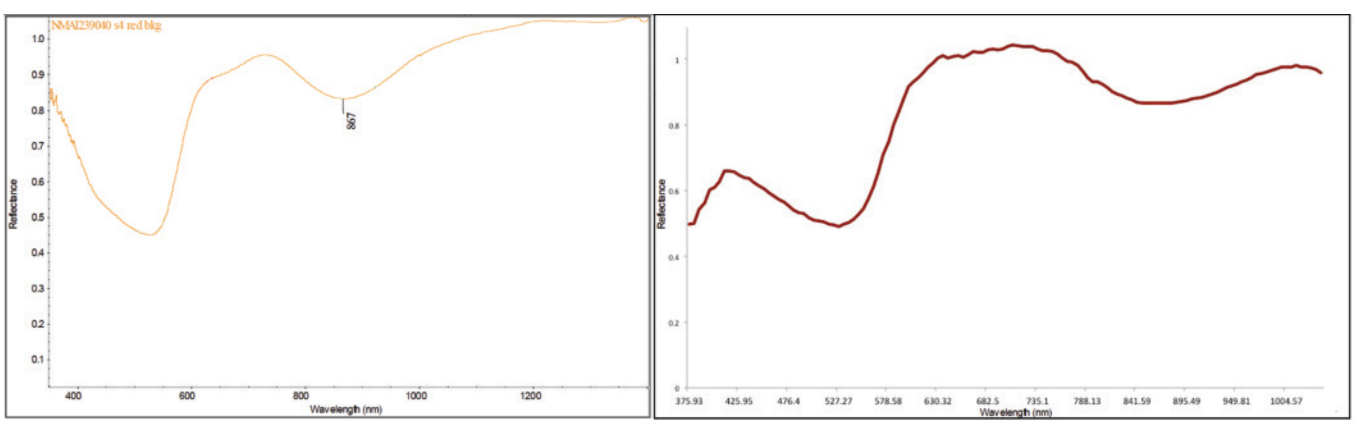

Figure 10: FORS spectrum for mineral red (left) in textile NMAI 23/9040 and hyperspectral spectrum of mineral red (right)

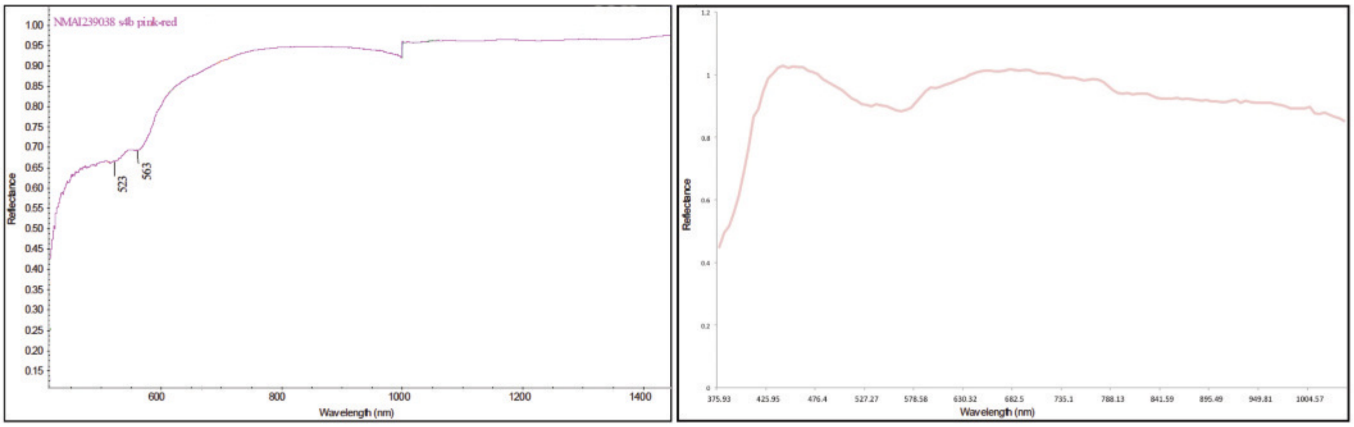

Figure 11: FORS spectrum for cochineal (left) in textile NMAI 23/9038 and hyperspectral spectrum (right)

4.3 BROWN PIGMENTS

Multiband and hyperspectral imaging were not helpful in distinguishing between different types of brown colorants. Analytical techniques such as XRF and HPLC were found to be more informative in characterizing the mineral and plant-based brown colors. Preliminary analysis suggests that a combination of earth pigments and tannin-based dyes are present, but additional analysis is underway.

4.4 CALIBRATION, LIGHTING, AND FUTURE WORK

As mentioned earlier, the multiband imaging in this project did not use calibrated images. A few steps added to the image acquisition process allow calibration of the images, changing the technique from multiband to multispectral imaging. These steps would include correction for each image using flat fielding and reflectance standards (Ricciardi et al. 2009). The resulting data produces quantitative information and not just visualization of spectral differences.

After executing the research and imaging for this project, we realized that the light source being used in multiband and hyperspectral imaging did not provide even light around 400–500 nm. Author Webb is in the process of creating a new lighting setup with light sources that are stronger in these wavelengths, for a wider and better spectral distribution for future imaging.

5. CONCLUSIONS

The investigations presented in this paper illustrate how multiband and hyperspectral imaging can be useful for nondestructive identification and differentiation between pigments and materials in textiles. Multiband imaging proved useful for characterizing select materials, especially when used in combination with hyperspectral imaging or fiber optic reflectance spectroscopy. Multiband imaging was useful for highlighting the consistency of materials throughout each textile because each image can encompass the entire textile, rather than small select areas.

Indigo was successfully characterized with both multiband and hyperspectral imaging. The image subtraction with multiband imaging accurately mapped the location of indigo over an entire textile. The image subtraction alerted researchers that the black colorant in the Middle Horizon textile included indigo, which was supported by the hyperspectral imaging and FORS spectra. This technique using image subtraction with multiband images is likely to be useful for characterizing indigo on other types of objects, such as ceramics or paintings.

This project did not provide conclusive information for the identification of red or brown colorants. On the basis of the characteristic reflectance spectra of cochineal and mineral red pigments that can be acquired with FORS, it seems likely that these materials could be characterized using modified versions of the multiband and hyperspectral imaging setups applied in this project. Additional work remains to be done for imaging analysis of the red colorants found in these textiles. The similarity between all brown reflectance spectra, for both organic and inorganic colorants, suggests that these imaging techniques will not be useful for characterizing browns.

The multiband and hyperspectral imaging worked well as a means of characterization and identification for the painted Andean textiles because the textiles contained a limited palate that did not include complex mixtures. For example, had ultramarine been present, the image subtraction processing would not have been successful because ultramarine reacts very similarly to indigo. This reminds us how vital our understanding of the historical and cultural context of the object is to our interpretation of image analysis. Multiband and hyperspectral imaging are important tools that offer a nondestructive option for material characterization within the context of the entire object.

ACKNOWLEDGMENTS

Grateful thanks to Emily Kaplan, Susan Heald, and Marian Kaminitz at the NMAI and Blythe McCarthy at the Freer|Sackler, for their support and guidance, as well as to Ann Rowe, Mary Frame, and Rommel Angeles Falcón for offering their knowledge about the attributions of the textiles in this study. The Andrew W. Mellon Foundation supported this project. The authors acknowledge the work of Melvin J. Wachowiak, Jr., and his contributions to scientific and computational imaging of cultural heritage material.

NOTES

1. This insect-based colorant is presumed to be cochineal based on the established use of cochineal in the Andes (Phipps 2010). FORS does not distinguish between different types of insect-based dyes.

REFERENCES

BK100-xx Filter KitBandpass Filters. MidOpt Filter Kit. Accessed July 6, 2014. http://machinevisionfilters.com/kit_bk100.html.

Boucherie, N. 2009. "Telas Pintadas Nasca, Pigmentos yTécnica Pictural:Primeros Resultados." *Actas IV Jornadas Internacionales sobre Textiles Precolombinos*. 79–92.

Cardon, D. 2007. *Natural Dyes: Sources, Tradition, Technology and Science*. London: Archetype.

Cornell, R. M. and U. Schwertmann. 2006. *The Iron Oxides: Structure, Properties, Reactions, Occurrences and Uses*. Weinheim, Germany: Wiley & Sons.

Delaney, J. K., E. Walmsley, B. H. Berrie, and C. F. Fletcher. 2005. "Multispectral Imaging of Paintings in the Infrared to Detect and Map Blue Pigments." In *Proceedings of the National Academy of Sciences Scientific Examination of Art: Modern Techniques in Conservation and Analysis*. Washington, DC, March 2003. 120–136.

Dyer, J., G. Verri, and J. Cupitt. 2013. "Multispectral Imaging in Reflectance and Photo-induced Luminescence modes: A User Manual Version 1.0." The British Museum. Accessed July 14, 2014. http://www.britishmuseum.org/pdf/charisma-multispectral-imaging-manual-2013.pdf.

Fischer, C., and I. Kakoulli. 2006. "Multispectral and Hyperspectral Imaging Technologies in Conservation: Current Research and Potential Applications. *Reviews in Conservation* 7 (2006): 3–16.

Jain, A. K. 1986. *Fundamentals of Digital Image Processing.* Edgewood Cliffs, NJ: Prentice Hall.

Leona, M. and J. Winter. 2001. "Fiber Optics Reflectance Spectroscopy: A Unique Tool for the Investigation of Japanese Painting." *Studies in Conservation.* 46 (3): 153–162.

MaxMax Camera Conversions and Service. Digital Still Cameras. Accessed August 4, 2014. https://www.maxmax.com/digital_still_cameras.htm.

Phipps, E. 2010. *Cochineal Red: The Art History of a Color*. New York: Metropolitan Museum of Art.

Ricciardi, P., J.K. Delaney, M. Facini, and L. Glinsman. 2013. "Use of Imaging Spectroscopy and In Situ Analytical Methods for the Characterization of the Materials and Techniques of 15th Century Illuminated Manuscripts." *Journal of the American Institute for Conservation* 52 (1): 13–29.

Ricciardi, P., J.K. Delaney, L. Glinsman, M. Thoury, M. Facini, and E.R. de la Rie. 2009. "Use of Visible and Infrared Reflectance and Luminescence Imaging Spectroscopy to Study Illuminated Manuscripts: Pigment Identification and Visualization of Underdrawings." In *Proceedings of O3A: Optics for Arts, Architecture, and Archaeology II*: 7391 (July 2, 2009): 739106–1–12.

Roquero, A. 2002. *Tintes y tintoreros de América: Catálogo de materias primas y registro ethnográfico de México, Centro América, Andes Centrales y Selva Amazónica*. Madrid: Ministerio de Cultura, Dirección General de Bellas Artes y Bienes Culturales, Subdirección General del Instituto del Patrimonio Histórico Español: Instituto del Patrimonio Histórico Español.

Roquero, A. 2008. "Identification of Red Dyes in Textiles from the Andean Region." In *Proceedings from the 11*th *Biennial Symposium of the Textile Society of America, Textiles and Cultural Expressions.* Honolulu, Hawai'i, September 4-7, 2008. DigitalCommons@University of Nebraska – Lincoln. Accessed May 4, 2015. http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1129&context=tsaconf.

Saltzman, M., A. M. Keay, and J. Christensen. 1963. "The Identification of Colorants in Ancient Textiles." *Dyestuffs*. 44 (8): 241–251.

Smith, L. M. 1986. "When Textiles Are Paintings." In *Proceedings of Symposium 86: The Care and Preservation of Ethnological Materials* edited by R. Barclay et al. Ottawa: Canadian Conservation Institute. 200–206.

Summerour, R. J. Giaccai, K. Webb, C. Mori, N. Little. n.d. The Technical Analysis of Four Archaeological Andean Painted Textiles. *Nuevo Mundo: Mundos Nuevos*. Online publication in process.

Warda, J., F. Frey, D. Heller, D. Kushel, T. Vitale, and G. Weaver. 2011. *The AIC Guide to Digital Photography and Conservation Documentation, 2nd Ed.* Washington, DC: American Institute for Conservation of Historic and Artistic Works (AIC).

Winter, J., J. Giaccai, and M. Leona. 2003. "East Asian Painting Pigments: Recent Progress and Remaining Problems." In *Scientific Research in the Field of Asian Art: Proceedings of the First Forbes Symposium at the Freer Gallery of Art,* ed. P. Jett, J. G. Douglas, B. McCarthy, J. Winter. London: Archetype. 157–163.

SOURCES OF MATERIALS

Azurite, "Gunjyoo No. 9" purchased at Kukodo, Kyoto 1986;
Red lead, F. Weber Co.
Freer and Sackler pigment reference collection
1050 Independence Ave SW
Washington DC 20560

Black Walnut Whole Fruits Harvested autumn 2010Buffalo, NY

Bone Black, French Yellow Ochre Deep, Lamp Black, Prussian Blue
Conservation Materials Ltd. (out of business)
240 Freeport Blvd, Box 2884
Sparks, NV 89431
Tel: 702-331-0582

Burnt Sienna, Burnt Umber, Indian Red, Raw Umber
Conservation Materials (out of business)
1165 Marietta Way
Sparks, NV 89431
no number

Vermilion (HgS), Winsor & Newton
Museum Conservation Institute pigment reference collection
4210 Silver Hill Road
Suitland, MD 20746-2863

Cochineal
Kremer Pigments
247 W 29th StNew York, NY 10001
Tel: (212) 219-2394
Fax: (212) 219-2395
http://www.kremerpigments.com/

Ferrous sulphate
Fisher Scientific
Tel: (800) 766-7000
https://www.fishersci.com/

Indigo, Madder Root
Earth Guild
33 Haywood St
Asheville, NC 28801
http://www.earthguild.com/

Jagua (Genipa Americana)
Ink Gel Tattoo
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FROM NORTH TO SOUTH: THE CONSERVATION OF CIVIL WAR COSTUME FROM THE TENNESSEE STATE MUSEUM

HOWARD SUTCLIFFE

ABSTRACT—In 2013 and 2014, Tennessee commemorates the 150th anniversary of the death of two important figures in both the Civil War and state history; General Patrick Cleburne and Sam Davis "the boy hero of the Confederacy." The Tennessee State Museum holds the kepi that General Cleburne was wearing when he was killed in the Battle of Franklin and the greatcoat worn by Davis, a Confederate courier, who was caught and executed by Federal Troops.

The conservation of the artifacts was supported by the Tennessee Chapter of the Sons of Confederate Veterans for events taking place at the Museum and off site. The two objects were both in very fragile condition and their conservation was considered an act of commemoration by the Sons of Confederate Veterans. This paper details the conservation and analysis work undertaken and the management of a project that had to balance many stakeholders and interested parties.

DE NORTE A SUR: LA CONSERVACIÓN DE UN TRAJE DE LA GUERRA CIVIL DEL MUSEO ESTATAL DE TENNESSEE: RESUMEN—En 2013 y 2014, Tennessee conmemoró el 150° aniversario de la muerte de dos importantes figuras tanto de la Guerra Civil como de la historia del estado: el General Patrick Cleburne y Sam Davis, "el niño héroe de la Confederación". El Museo de Tennessee conserva el kepi que llevaba puesto el General Cleburne cuando lo mataron en la Batalla de Franklin, y el abrigo que usaba Sam Davis, un mensajero de la Confederación capturado y ejecutado por las Tropas Federales.

La Delegación de Tennessee de la organización Hijos de Confederados Veteranos (SVC, por sus siglas en inglés) colaboró con la conservación de las piezas para los eventos que se realizaron dentro y fuera del museo. Los dos objetos se encontraban en muy mal estado y la SVC consideró que su conservación sería un acto conmemorativo. Este documento detalla los trabajos de conservación y análisis realizados y la gestión de un proyecto que tuvo que equilibrar los intereses de las diferentes partes involucradas.

1. INTRODUCTION

On November 30, 1864, the Confederate army of Tennessee stepped forward, some 20,000 strong, for their ill-fated charge into Franklin. Riding near the center of their line was General Patrick R. Cleburne. Leading his Confederate division on that day, the man known as "The Stonewall of the West" moved forward into what would prove to be his final battle.

On a mare borrowed from one of his officers, General Cleburne advanced toward the enemy, then had his horse killed beneath him as he came within about 80 yd. of the Federal works. A replacement horse was offered, but it was shot dead before he could place himself in the saddle. Undaunted, Cleburne pressed forward toward the Union earthworks on foot, sword in hand, and waving his kepi.

The next morning the dead were strewn across the battlefield of Franklin. Word had come that Cleburne was killed, and he was discovered lying on the field, with his kepi partially over his eyes, everything else of value had been stripped from his body.

Today, the kepi is in the Tennessee Historical Society Collection and housed at the Tennessee State Museum in downtown Nashville. It is a keystone object in the museum and is on permanent display.

Another equally important object in the museum's collection is the greatcoat worn by Sam Davis who was a member of Coleman's Scouts, a Confederate unit gathering information on Union operations in Middle Tennessee.

November 2013 marked the sesquicentennial of his capture carrying vital military information to Confederate headquarters in Chattanooga. He was sentenced to hang for being a spy, but he refused repeated Union entreaties to save his own life in exchange for identifying his comrades. His youth, dramatic mission, and nobility while facing death place him high in the pantheon of Southern heroes.

The two objects were both in very fragile condition, and their conservation was supported by the Tennessee Chapter of the Sons of Confederate Veterans (SCV) for events taking place in 2013 and 2014 at the museum, the State Capitol Building, the Davis House, and Franklin Battlefield.

2. THE STAKEHOLDERS

Candace Adelson, the curator of costume and textiles at Tennessee State Museum, contacted me in July 2013 to examine the kepi and write a proposal. She has been very successful in using situations like historical anniversaries or loans as opportunities to acquire funding for the conservation of objects that is not ordinarily available within the state system.

The numerous chapters of the SCV throughout the South are well known for their support of conservation—in particular, the conservation of flags. Money for conservation is raised through donations and through the sale of specialty license plates. The Tennessee Division has been able to donate thousands of dollars toward the conservation and preservation of historic flags and now, at the 150th anniversary of the war, their fundraising efforts have increased exponentially.

The conservation of the kepi was chosen as an additional project not only because of the 150th anniversary of Cleburne's death but also because 2014 marks the retirement of Douglas Henry, a state senator for Tennessee since 1954, a board member of the TN State Museum Foundation, and the man behind the Douglas Henry State Museum Commission. The commission was created with the primary function to oversee the operations of the State Museum. The conservation of the kepi—one of his favorite objects, was a surprise to be revealed to him at the end of 2014 at the first of many events to mark the beginning of his retirement.

Once the treatment proposal was approved, the call to arms to SCV members was put out via various media outlets including Facebook. Members were asked to donate $5 each, and within a week, the funds had been raised, within two, they had enough of a surplus to call me back to the museum to look at Sam Davis' coat.

3. CONSIDERATIONS FOR CONSERVATION

The kepi was the first object to be worked on. Following examination on site, in-depth discussion of the treatment protocol with Candace, we ensued to assess the long-term consequences of treatment. The curator was very concerned that conservation should be minimal, enough to aid future preservation but not change the character of the object, and be sustainable in terms of the longevity of the materials being used, thereby reducing the need for and indeed cost of future interventions. Preventive conservation was of course a critical aspect of the project, as a new mount was required to fully support the kepi on permanent display and also allow easier handling and travel when necessary.

3.1 THE KEPI

A kepi is a cap with a flat circular top and visor. In Europe, it was most commonly associated with French military and police uniforms. In North America, it is readily identified with the Civil War as it was worn by soldiers on both sides.

General Cleburne's (fig. 1), made from dark blue/black fulled wool and was heavily decorated with applied silver gilt braid stitched in place using fine cotton thread. A much thicker band of silver gilt braid directly

Figure 1: The Kepi before treatment

above the visor had small brass buttons stitched at either end. The visor itself had a squared-off profile and was made from a thick piece of leather stitched to the cap rim using a thick cotton thread.

The interior was missing its original lining, but there was a replacement made from plain weave cotton, a leather crown insert, cotton canvas sweatband (with an unknown waterproof coating), and paper stiffener. A flat red wool cord ran through the sweatband.

The kepi was in fair-to-poor condition overall. It was very fragile and difficult to handle safely. It had extensive particulate surface soiling throughout and had a crushed appearance with numerous creases and distortions. There were also isolated areas of damage caused by insect grazing, and the stitching that secures the braid had broken in several areas causing the braid to come loose.

The leather visor, which warps upwards slightly, had abrasions to the surface and in areas, it exhibited signs of red rot.

On closer inspection, I found that some repair work had been done in the past—no museum records were found for it, so it was possibly done in the late 1970s or early 1980s. A piece of black warp-faced silk had been inserted into the damaged area at the front left of the kepi. It had been secured using spots of a shiny adhesive (possibly B-72) that has now failed. The replacement cotton lining is also probably of the same vintage. In areas where there were holes, the cotton had been painted black.

3.1.1 Conserving the Kepi

One of the curator's requests was that I vacuum-sample the kepi while surface cleaning it. To facilitate this, a regular Nilfisk vacuum bag was cut down to create a filter on which the dirt was collected. It is hoped that the soil will be analyzed at a later date. Identification of particulates such as clay soils and pollen can sometimes help identify geographical areas that objects were made or used in.

The cap was carefully humidified using a preservation pencil in conjunction with an ultrasonic humidifier to help remove some of the creases and distortions. This allowed the areas of structural damage to be brought back into alignment before being supported using small stitched patches of black plain weave Kona cotton. Each patch was inserted between the damaged wool layer and the cotton interlining and secured using threads drawn from black Tetex. Areas of loose braid were stitched back in position using running stitch worked in Brown Pearsall's silk thread.

The break in the leather visor was repaired; the break edges were consolidated using 100% Cellugel, which is hydroxypropylcellulose in isopropanol; and the small piece was glued back into position using a small dab of neat Lascaux 498HV adhesive on either side.

The most involved part of the project was making the new mount (fig. 2) that incorporates a handling edge. The mount board was made from Corex covered with a layer (on the top side only) of polyester needle punch felt. A layer of gray Unisono III Creation Baumann cotton was used as the exhibition fabric and to cover both sides of the board.

A form to support the kepi was made from a carved Ethafoam core that was padded out using polyester batting and a thin layer of polyester needle-punch felt. The form was covered with washed Tyvek (shiny side out), and the base of the form was covered with a band of the gray Unisono cotton to match the board. The form was positioned on the board and stitched in place.

A small polyester needle-punch felt ring (fig. 3) was made to pad out the front of the kepi and the crown ring. It, too, was covered with washed Tyvek (matte side out). The ring was placed inside the kepi before it was slid into position on the mount (fig. 4).

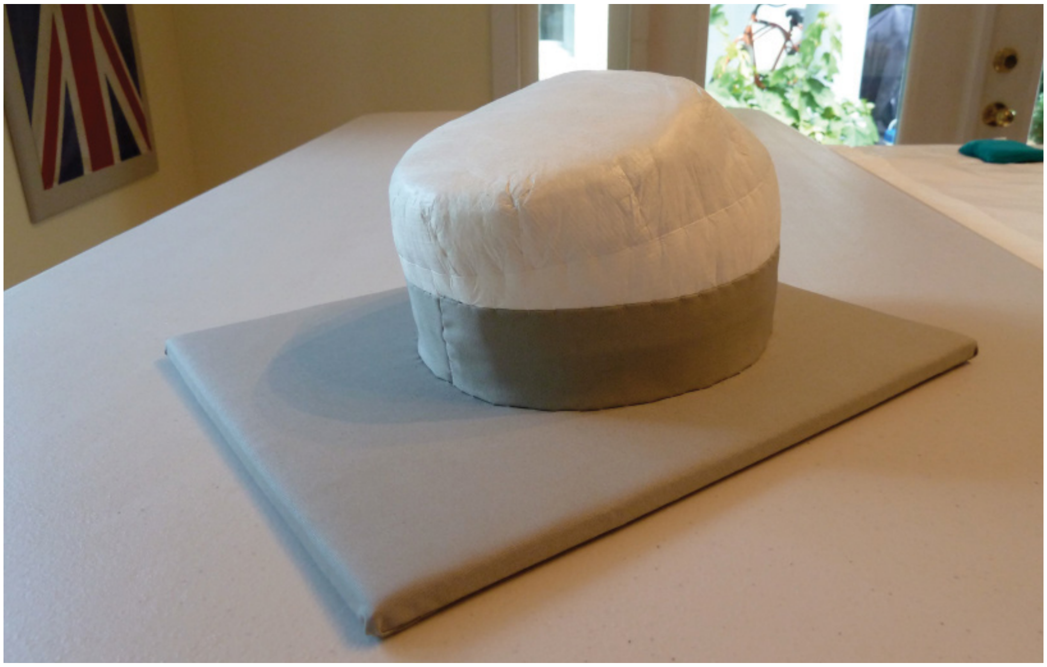

Figure 2: The Kepi mount

Figure 3: The crown ring

Figure 4: The Kepi after treatment

3.2 THE SAM DAVIS COAT

A short walk from the display on General Cleburne (fig. 5) is the case housing artifacts associated with Sam Davis—a pocket knife, a boot and his greatcoat (fig. 6).

In 1863, Union troops held Nashville, and the Confederate army of Tennessee was desperate for information concerning the plans of the Union forces in the state. Captain Coleman and his scouts, including Davis, had a very well-developed intelligence network in the area and were a great source of information for their generals.

Late that year, Coleman and a number of his men were spying out the Union forces in the Nashville area. When they had gathered sufficient information, several men were dispatched to carry the reports to Confederate General Braxton Bragg. They never made it. When Davis was captured, some very detailed maps of the fortifications and defenses of Nashville, and an in-depth report concerning the Union Army in Tennessee were found hidden in his saddle. More troubling for Davis, however, was the sealed letter they found in his boot. It was a letter from the infamous Coleman to General Bragg's command.

The same day, in a separate incident, Coleman was captured in disguise as an unkempt and grizzled old man in civilian clothes and was held in the same jail cell along with Davis. Despite repeated appeals to give up

Figure 5: The Kepi back on display after treatment

Figure 6: The Sam Davis greatcoat before treatment

the names and locations of his superiors, Davis knew that Coleman, a much more valuable asset to the Confederate cause, would have hung in his place had he done so.

According to the testimony of Union soldiers, given in evidence at the court martial that tried Davis, the courier was wearing a regular Confederate uniform and a Union-issue greatcoat that had been dyed black and from which the military buttons had been removed. He insisted he wasn't a spy because he was wearing a Confederate uniform, but his defense was tenuous at best given the documents found in his possession, and it was further undermined by the fact that he was wearing a Union-issue coat, which at that point in the war was considered an act of espionage in itself by Union forces.

3.2.1 Uniform Confusion

Throughout the war, there was a huge variety in uniforms because of reasons such as location, limitations on the supply of cloth and other materials, state regulations different from the standard regulations, and the cost of materials, etc.

At the start, there was very little difference between the "official" uniforms of both sides, which according to Myers Brown, archivist at the TN State Archives, lead to many instances of friendly fire. Myers is also a reenactor and made the important point that after a couple of days of trudging through mud and standing around pine-burning camp fires, all uniforms ended up the same color of mud mixed with soot.[1]

Toward the end of the war, confusion was further compounded when supply routes to the South had been cut off. Faced with shortages, Confederate troops took to wearing Union uniforms—sometimes modified, sometimes not. They were often taken from the dead on the battlefield or stolen from Union shipments headed south.

3.2.1 The Dye Question

Family lore had always asserted that Davis' mother had overdyed what was originally a sky blue cavalry greatcoat to make it appear more "Confederate," obviously in an effort to try and protect her son. We do not know where she got the coat, but during its examination at the museum, the initials MS (or SW) were found (presumably from the original owner) stitched into the sleeve lining.

Analysis of the dyes using direct analysis in real time–time of flight mass spectrometry (a newly developed method for identifying organic dye chromophores in natural fiber textiles) at Eastern Michigan University showed that the indigo-dyed coat had indeed been overdyed with butternut or walnut. When dyes became scarce, Confederate manufacturers resorted to using a dye made of copperas (iron sulfate) and walnut hulls, which produced the color known as "butternut" that was a light brown. In fact, the terms "butternuts" or "butternut rebels" were sometimes used to refer to Confederate soldiers.[2]

My understanding of the situation is that there have always been questions as to whether the object was a very dirty overdyed Union coat or just a very dirty Confederate coat. It was nice to provide an answer to this 150-year-old question in time for the anniversary commemorations held at the State Capital in Nashville and the Davis House in Smyrna.

3.3.3 Conserving the Coat

In very poor condition, dirty, structurally unsound and having been "souvenired" in places, consultation took place to determine what condition issues should be treated and what important information (e.g., mud accretions and old repairs) should be left in place. As was the case with the kepi, there was a desire to minimize interventions and apply only long-lasting materials for the conservation and new mount.

The coat was surface-cleaned using low-powered vacuum suction and again the soils removed were collected for future analysis. These included identifiable things such as grass seeds, clay, and sand deposits.

At some point, the fragmentary lining had been stitched to the coat itself to stop the pieces from moving around or getting lost. Those stitches were cut and removed to enable a more accurate repositioning of the lining. Humidification was carried out using an ultrasonic humidifier and dampened Gore-Tex sheeting to help remove some of the creases and distortions.

The areas of structural damage in the outer wool layer were secured using small stitched patch supports. Plain weave cotton broadcloth was dyed to match. Each patch was applied to the reverse and secured with stitches using threads drawn from black Tetex.

Open seams were stitched closed using Gutterman polyester thread. Old repairs were left in place. If extra support was needed in an area that had been repaired previously, a cotton patch was applied on top of the existing repair. Loose threads associated with the old repairs were tacked down.

The lining was given an overlay support of fine nylon net dyed to match. The net was pinned in place and then lightly stitched to secure, working from the outside edges, where connection with the coat was most extant, in toward the center back of the coat. The net was folded, cut, and stitched as needed to fit around each armseye. Stitching was carried out using a combination of Stabiltex and Gutterman polyester threads.

The open seams in the sleeve linings were stitched back together as far as access would allow. The loose areas around the armseye were restitched to secure, and these were further supported and protected using the lining net overlay. The cuffs were supported using a doubled-up layer of nylon net to cover the damage. Holes and structural damage in the pockets were supported using net overlays lightly tacked in place.

A new custom-made mount was made (fig. 7). A double rod painted metal plate stand held the Ethafoam body form. The Ethafoam core was carved to shape and padded to fit the coat using polyester batting. It was covered in a layer of black cotton jersey. The arms were made from black cotton broadcloth and padded using polyester fill stuffing. The proper right arm was stitched to the body, whereas the proper left arm was left detachable using Velcro to facilitate dressing. Rare earth magnets, covered in Japanese tissue and toned to match, were used at the collar to aid closure at the neck (figs. 8, 9).

4. CONCLUSIONS

When people first started to learn that I was planning to open a private practice in Alabama, I heard a lot of "well….prepare yourself for the civil war stuff." I was a little trepidatious, to say the least. The conservation of Civil War materials that are considered by many to be relics can be challenging; preserving the material while respecting the history they represent can be a difficult balance to achieve. The conservation of these two iconic objects was, however, a very gratifying experience and one that was reinforced by the positive reaction of the many stakeholders involved. The careful consideration of the techniques and materials used will hopefully see that these two objects are around to take part in the bicentennial commemorations in another 50 years' time.

Figure 7: The new body form for the Sam Davis greatcoat

Figure 8: The Sam Davis greatcoat after treatment

Figure 9: The Sam Davis greatcoat back on display after treatment

ACKNOWLEDGMENTS

I would like to thank Candace Adelson, curator of costume and textiles at the Tennessee State Museum and Myers Brown, archivist, Tennessee State Library and Archives. Ryan Blocker, assistant curator at the Alabama State Archives, and Dr. Cathy Selvius DeRoo, conservation scientist at the Detroit Institute of Arts.

NOTES

1. Personal communication with author, August 2013.
2. Personal communication with Myers Brown, August 2013.

FURTHER READING

Clemmer, G. S. 1996. *Valor in Gray: The Recipients of the Confederate Medal of Honor*. Stanton, VA: Hearthside Publishing.

The Encyclopedia of Arkansas History & Culture. s. vv. "Patrick Ronayne Cleburne (1828–1864). Last updated September 4, 2014. Accessed May 2, 2014. http://www.encyclopediaofarkansas.net/encyclopedia/entry-detail.aspx?entryID=339.

Hamil, H. M. 2014. *Sam Davis: A True Story of a Young Confederate Soldier*. Griffin, GA: J F Thomspon Publishing.

Save Our Flags. s.vv. "General Patrick Cleburne's Kepi." Accessed May 2, 2014. http://saveourflags.org/index.php/home/34-flgastosave/46-14tnflag.

Walker, G. C., Sam Davis, Boy Hero of the Confederacy. Create Space Independent Publishing Platform. 2012.

Wikipedia. s.vv. "Patrick Cleburne." Last modified May 4, 2015. Accessed May 2, 2014. http://en.wikipedia.org/wiki/Patrick_Cleburne.

Wikipedia. s.vv. "Sam Davis." Last modified May 4, 2015. Accessed May 2, 2014. http://en.wikipedia.org/wiki/Sam_Davis.

SOURCE OF MATERIALS

Cellugel, Ethafoam, polyester needle punch felt, polyester fill, Tyvek, Velcro

University Products
517 Main St
Holyoke, MA 01040
800-628-1912
info@universityproducts.com

Correx
Sabic Polymershapes
411 37th St. North
Birmingham, AL 35222
205-595-0033

Cotton Jersey
Testfabrics
415 Delaware Avenue
PO Box 26
West Pittson, PA 18643
570-603-0432
www.testfabrics.com

Kona Cotton
www.fatquartershop.com

Pearsall's Gossamer Silk Thread
www.jsflyfishing.com

Tetex
No current suppliers

Unisono III cotton
Creation Baumann Fabrics
979 3rd Ave. Suite 1522
New York City, NY 10022
212-906-0106

AUTHOR BIOGRAPHY

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RELYING ON THE KINDNESS OF STRANGERS: GATHERING INFORMATION FOR THE TREATMENT OF A SUIT OF JAPANESE SAMURAI ARMOR

ANNE BATTRAM

ABSTRACT—George W. Vanderbilt travelled to Japan in September 1892 when he received a special invitation to attend birthday celebrations for the emperor. Among his many souvenirs was a suit of samurai armor that needed to be treated for inclusion in an exhibition entitled, *The Vanderbilts at Home and Abroad*. The exhibition opened in the spring of 2012 and highlights the many objects that Vanderbilt and his family acquired during their years of travel.

As a conservator who specializes in upholstery, this author typically relies on each piece of furniture to provide most of the relevant information concerning its treatment needs. My lack of familiarity with samurai armor and the culture from which it came required me to go outside of the normal sources of information to identify the materials, the various components of the armor, and their relationship to each other. This paper briefly discusses how information was gathered and what basic treatment steps were taken that enabled this object to be brought to display condition.

CONFIANDO EN LA BONDAD DE LOS EXTRAÑOS: RECOLECCIÓN DE INFORMACIÓN PARA EL TRATAMIENTO DE UNA ARMADURA SAMURÁI JAPONESA: RESUMEN—George W. Vanderbilt viajó a Japón en septiembre de 1892, cuando recibió una invitación especial para asistir a los festejos del cumpleaños del emperador. Entre los tantos *souvenirs* que trajo de su viaje, se encontraba una armadura samurái que debió ser tratada para ser incluida en una exhibición llamada *The Vanderbilts at Home and Abroad*. La exhibición se inauguró en la primavera de 2012 y expone los numerosos objetos que Vanderbilt y su familia adquirieron durante sus viajes.

Como conservador especializado en tapicería, este autor estudia cada pieza para obtener información relevante sobre el tratamiento que necesita. La falta de familiaridad con la armadura samurái y la cultura de la que proviene, exige realizar una investigación más exhaustiva, fuera de las fuentes habituales, para identificar los materiales, los diferentes componentes de la armadura y su relación entre sí. En este documento, hablaremos sobre la forma en que se obtuvo la información y sobre los pasos de tratamiento básico que permitieron preparar este objeto para su exhibición.

1. INTRODUCTION

When George W. Vanderbilt, owner of the Biltmore Estate, received an invitation to go to Japan for the Emperor's birthday celebrations in 1892, he went to that exotic country for 10 weeks, purchasing 32 crates of souvenirs ranging in value from fine Satsumi porcelains to 1000 paper lanterns. Among his prizes was a suit of samurai armor, an object that quickly became a favorite item for American collectors. The popularity of this subject matter has come full circle again as witnessed by the success of the exhibition mounted by the Metropolitan Museum of Art, entitled "Art of the Samurai: Japanese Arms and Armor, 1156–1868," which was on view at the museum in New York from October 2009 to January 2010. The beautiful catalogue that accompanied the show was a major source of information and inspiration for our project. This exhibition and the more recent one of last summer at the Boston Museum of Fine Art clearly illustrate the renewed interest in this topic today.

Those who are familiar with Japanese armor know that it is as varied and intricate as the history, politics, and wars that created the need for it. The Metropolitan catalogue says this: "Japanese armor… possesses a refined beauty that is enhanced by its combination of sophisticated techniques and rarified materials that range from wrought iron, leather, lacquer and silk to non-ferrous and precious metals and dyed textiles" (Hiroshi and Ogawa 2009, 37). Sounds like a conservator's dream, or possibly, a nightmare!

Figure 1 shows our samurai in storage, standing with a friend who is dressed in a chain mail suit. The armor had been displayed at various times over the years in Biltmore House but now needed to be brought out of storage and treated. The armor was mounted on a wooden support of unknown origin, and, as it was disassembled to move it to the lab, it became obvious that it had been assembled using some very questionable strategies. Figure 2 illustrates how the thigh protectors had been tied to a crosspiece of the wooden structure under the breastplate. It was quickly realized that there was much to be learned about the various parts of the existing armor, what they were called, how they fit together, and even if all the parts belonged to this suit.

It is difficult, if not impossible, to write a condition report about an object without knowing the names of the parts. For this information, the Metropolitan catalogue was referenced for the proper Japanese terminology. A detailed diagram can be found at the back of the catalogue, which is followed by a glossary of terms that briefly describes each component of the armor. Even though a Japanese soldier put on his armor from the bottom up, the basic parts of the armor, our discoveries and treatments are discussed from the top down.

2. THE HELMET

Helmets consist of two parts—the bowl or *hatchi* and the neck guard, which is called the *shikoro*. The square-shaped element hanging below the neck guard (fig. 3) had been added to the back of the helmet sometime in the past. It was soon recognized as a shoulder guard, which is called a *sode*, and it was removed. Figure 4a is a view of the helmet interior showing the inner lining (*ukebari*) of two layers of indigo-dyed hemp fabric that are joined together with rows of hand stitching in a spiral pattern, a traditional sewing technique known as *momo haiku-ye-zashi,* meaning "many stitches." This and other interesting textile information was found in a White Paper entitled, "Preventative Conservation of Samurai Armor" authored by Camille Myers Breeze, the director of Museum Textile Services in Andover, Massachusetts (Breeze 2008).

No repairs were done to the torn and curled fabric and leather elements, but an Ethafoam mount, covered with black polyester/cotton fabric, was fabricated to fit against only the sides of the inside of the helmet (fig. 4b), leaving the lining to float in the crown of the helmet as originally intended (Breeze 2008). Areas of exposed metal along the edges of the neck guard, due to missing lacquer, were treated with a dilute solution of tannic acid. Tannic acid is a reversible coating used for iron that forms ferric tannate, a protective film that inhibits the metal's reaction with water vapor. Those exposed areas that would be visible to the public were infilled with Japanese paper that had been color-matched with dilute acrylic paints and secured with dots of Acryloid B-72 in xylene.

Starting in the early 15th century, helmet makers usually signed the inside of the back plate (Sinclaire 2008) but markings on the helmet, assumed to be the maker's mark, were found on the outer surface of the helmet near the proper right temple.

Figure 1: Armor in storage

Figure 2: Ties attaching parts of armor to wooden structure in storage.

3. FACE MASK

The style of our face mask, which has a detachable nose, is known as a *mempo* (fig. 5a) because it is a half-mask, covering all the face below the eyes. "Although the mempo may have provided some facial protection, it is considered that the main function was to provide a base for tying off the helmet strings, small protrusions on the cheeks and chin were to facilitate this" (Sinclaire 2008, 3). According to *Wikipedia*, in a Japanese armor, the throat guard that hangs from the front of the mask is called the *yodare-kake*. Treatment included minimal stabilization of lacings with matching DMC embroidery thread and mechanical cleaning of green corrosion products from the teeth. The inside of the mask was often painted red (fig. 5b) that, by reflecting on the wearer's face, was thought to increase his look of fierceness (Sinclaire 2008, 3). The mask provided us with some exciting information. The existence of one solitary blonde hair just to the left of the left nostril tells us that, at one time, this *mempo* had a moustache, which, along with beards, warts, and the red paint, was an attempt to depict the samurai as a demon or evil spirit to scare the enemy (Bedrosov n.d.).

Figure 3: Back side of helmet with *sode*.


Figure 4a (left): Fabric lining of helmet interior Figure 4b (right): Ethafoam mount friction-fitted inside helmet


Figure 5a: Front view of face mask (left). Figure 5b: Back view of face mask (right).

4. CUIRASS

The largest element of the armor is the "cuirass" or *do* (fig. 6). This two-part metal clamshell design hinges from the proper right side under the arm and protects the upper torso. Pendants, which hang from the cuirass from silk lacings, are called the *kusazuri* and protect the lower torso and upper legs. Our cuirass is decorated with a dragon design of inlaid silver that matches the motif on the helmet. The solid construction of our cuirass classifies it is as a full-plate armor whose design was influenced by contact with western armor, especially Spanish and Portuguese (Sinclaire 2008), and, according to *Wikipedia,* made necessary by the introduction of firearms in 1543. It was most popular during the peaceful Edo Period (1603–1868), the time frame from which we believe our armor originates.

Figure 6a (left): Front view of cuirass Figure 6b (right): Back view of cuirass


Figure 7a (left): Damaged edge of leather lining. Figure 7b (right): Interior view of cuirass

Because of the heavy, rigid upper unit and its flexible, weighted lower section, the cuirass was a challenge to maneuver for treatment. So it was mounted on an Ethafoam figure left over from a previous costume project. Some of the silk lacings had become detached and were stitched back into place. The lacings, called *odoshi ito*, looked like shoelaces, so missing sections were replaced with black cotton shoelaces that were color-matched with diluted acrylic paints and sewn in place with DMC embroidery thread.

The interior of the cuirass was very interesting. Figure 7a shows how the leather lining had cracked and curled at the edges from dryness. These areas were humidified and weighted while the torn and loose areas were secured to the metal with Acryloid B-72 in acetone. But the leather was coated with a shiny, auburn-colored material that we did not recognize (fig. 7b). A casual conversation with Heather Allen Hietala, a friend, led to a discussion about this coating. Heather is a mixed media artist in Asheville who specializes in surface decoration, among other things, and who has lived and studied in Japan. She suggested that the coating might be *kakishibu*, a solution made by fermenting unripened green persimmons. In Japan, it is used as a dye, a waterproofing agent, and as a traditional preservative against mold and insects. It would be logical to use such a preservative on an interior surface that would have experienced repeated contamination from perspiration (Hietala pers. comm.).

The cuirass also offered up some historical information as to the rank of the soldier wearing this armor. Figure 8 shows the hardware that was attached to the back of the armor. A square-shaped ring was secured between the shoulder blades (fig. 8a) and a cup was attached to the cuirass at the small of the back (fig. 8b). Research verified that every warring group had flag bearers who carried small flags or banners (*sashimono*) on their backs for identification (Cranbrook Institute of Science n.d.). According to *Wikipedia* ("Japanese armour"), "[i]ts purpose was to identify the wearer as friend or foe which was essential in the chaotic confusion of a pitched battle melee". The *sashimono* was used after 1573 when armies became bigger and communication on the battlefield became more vital. The flag was usually cotton or silk on a wooden or bamboo rod, rising above the bearer's head approximately half a meter.

Figure 8a (left): Upper flag hardware. Figure 8b (right): Lower flag hardware

5. ARM PROTECTORS

Arm protectors (*kote*) have taken many forms over the centuries, originally covering only the left arm to protect it from the bowstring (Bedrosov, n.d.). This form eventually evolved into a pair of glove-like sleeves that extended from the hands to the shoulders (fig. 9a), protecting the soldier's arms against edged weapons. The metal plates (*ikada*) are joined by mail over a padded inner layer of fabric, lacing closed on the underside (fig. 9b). Custom-made padded pillows were added to the *kote* interiors during our treatment to give the arms a greater sense of presence. Originally, the sleeves attached to the shoulder straps of the cuirass with toggles, but the heavy weight of the sleeves causing stress and deformation over a period of time was a concern. So twill tape straps were attached to the metal elements at the top of the sleeves so they could be tied to our new understructure.

6. THIGH PROTECTORS

One of the last elements of Japanese armor to evolve into the form we see today is the *haidate*, the bifurcated thigh protectors that tie with soft cloth around the waist like an apron and attach to itself behind each knee. Figure 10 shows the two *haidate*, which were previously tied to each other in storage. But a samurai only requires one, so the more degraded *haidate* (fig. 10a) was put into storage whereas the other one (fig. 10b) was treated.

The intricacies of this armor, in terms of materials and construction, continued to amaze us throughout the treatment. Figure 11a is a detail of the stenciled trim on the inner edges of the *haidate*, called *e-gawa*, which felt hard and rigid to the touch but is actually doeskin (Soanes 2004). This information was found on a website called katchushi.com, a company that specializes in the restoration and conservation of high quality Japanese arms and armor. Figure 11b is a close-up of the silk damask that covers the main upper areas of the


Figure 9a (left): Top view of arm protectors Figure 9b (right): Underside of arm protectors.


Figure 10a (left): View of degraded thigh protector Figure 10b (right): Thigh protector chosen for treatment

Figure 11a (left): Detail of stenciled leather edging on *haidate* Figure 11b (right): Detail of degraded silk on *haidate*

haidate. Similar to the arm protectors, the lower portion consists of small metal plates joined with mail over the silk fabric. The tactile contrast between the hard and soft materials used in the *haidate*, specifically, and in the suit, in general, speaks to the need for it to be strong enough to protect the soldier's life while flexible enough to allow him to march, fight, and ride a horse.

As silk is wont to do, the navy blue fabric was shattered in places where it existed, and completely missing in most of the upper areas (Fig. 12a). Because of the longevity of the exhibition, it was decided to stabilize the silk in two ways. First, it was backed with BEVA heat-sensitive film and dark blue cotton fabric. Then the areas of silk were held flat to the surface of the *haidate* with a layer of dark blue nylon netting that was handstitched around all the edges through to the cotton lining. The leg band had become distorted from being attached to the other *haidate* (Fig. 12b), so it was flattened with humidification and weights.

7. BOX

As research began for this project, images of samurai armor displayed sitting on a box were seen repeatedly. Innocent at that time to the subject matter, the significance of this display approach was a mystery to us. Enquiries to friends at the Denver Art Museum brought us into contact with Douglas Wagner, curatorial assistant in the Asian Art Department. He explained that each suit of armor existed with its own storage box

Figure 12a (left): Shattered silk overall on *haidate* Figure 12b (right): Distorted strap on *haidate*

to protect this item when not in use (Wagner pers. comm.). The armor—a respected symbol of protection, ceremony, and prestige—was often a valued family heirloom handed down through the generations. Each box, called a *bitsu*, was custom-made to enable all the parts to fit into it efficiently. It was this veneration for the armor that enables examples to survive from as early as the 12th century (Hiroshi and Ogawa 2009).

Our samurai did not have a box so one needed to be made. For possible dimensions and details, Heather Dumka, objects conservator at the Glenbow Museum in Calgary, Alberta, Canada, was consulted. The Glenbow has a large collection of armors, many of them Japanese samurai armors, and Heather was able to provide images and dimensions for a variety of their boxes (Dumka pers. comm.).

The boxes can be black lacquered wood or black lacquered leather over wood. Some are reinforced with metal straps. They are decorated on the sides with gilded motifs (*mon*), which represent the owner's insignia or family crest (Bedrosov 2008). Because our armor would be displayed for an indefinite period of time in a closed Plexiglas vitrine, our box was constructed from birch plywood that was covered with MarvelSeal. To further reduce the effects of off-gassing, the box was then covered with a layer of brown Pacific cloth. No attempt was made to simulate the leather covering to avoid any misinterpretations concerning the originality of the box.

8. MANNEQUIN

Mounting a Japanese samurai armor is a skill onto itself. A birch mannequin was fabricated following the example of an image found on a website called shogunart.com. The site provided images and a detailed description of dressing the samurai, which enabled us to put our pieces together in the traditional form, with the armor in a sitting position, hands on knees, simulating the posture of a samurai sitting on a campstool on campaign (Wagner 2001).

Figure 13a and 13b show the front and back views of our mannequin during a fitting for the arm protectors. The center shaft of wood has holes and a piece of dowel that allows for adjustments in height of the

Figure 13a: Front view of new wooden mannequin (left). Figure 13b: Back view of mannequin (right).

helmet support, which becomes crucial once the parts start to come together. Our mount was attached to a wooden base, which was then screwed to our new box. Pieces of Ethafoam, covered with black polyester/cotton fabric, were hot-melt glued to the base to create areas of support for various parts of the armor. Cup hooks and other hardware were also added in strategic places to secure the various ties. We needed the armor to be very stable and very secure for a very long time.

9. MISSING ELEMENTS

Besides not having its own *bitsu*, our armor was missing a few other traditional elements. One piece of armor we do not own is a pair of shin guards, called *suneate.* The single shoulder guard, which we removed from the back of the helmet, was secured to the right shoulder without having a mate on the left side. It had been decided by our curators that missing parts of the armor would not be replicated unless they were necessary;

Figure 14: Close-up of new tie holding helmet

however, it was believed that the fabric tie that holds the helmet to the face mask was essential to the success of the display. So a new tie was fabricated from navy blue silk crepe and stuffed with polyester batting, imitating those seen in the Metropolitan catalogue (fig. 14).

Another component of the samurai armor lacking from our collection is the decorative piece that attaches to the front of the helmet, the *date*. These elements are very interesting, diverse, and somewhat humorous, and it was a great temptation to fabricate one for our helmet. The original designs ranged from natural and mythological references to Buddhist or Shinto motifs, providing protection for the soldier during battle. They were also thought to be an expression of the warrior's personal identity. This concept of decorative helmets, called *kawari-kabuto*, was a phenomenon that began in the last half of the 16th century (Sinclaire 2008). Our helmet retains the three metal supports that would have held its *date* in place.

Figure 15: Front view of armor before installation

10. CONCLUSIONS

It is always gratifying for a conservator to move an object out of storage and treat it for display. Figure 15 shows our samurai, during its final fitting before being disassembled one more time for the trip to the exhibition building. Learning about the intricacies of this particular object was especially exciting and brought to this author a new respect for the skills needed to create such a beautiful yet functional costume. Reading about the long social and political history that accompanies this item only makes one aware of how much more there is to know.

ACKNOWLEDGMENTS

I want to thank both the flesh-and-blood people and the cyberspace ones who contributed their information to make this project possible. I would like to add a special thanks to our Biltmore team: Nancy Rosebrock, chief conservator, who assisted with all aspects of the treatment from day one; Renee Jolly, objects conservator, for her guidance and work on the metals; and to Leslie Klingner, curator of Interpretation, who is our department Internet diva. Last but not least, I want to thank the people who created the Web and the Internet, for making our lives easier and more complicated all at the same time.

REFERENCES

Bedrosov, B. P. n.d. "The Evolution of Japanese Armour." Accessed May 4, 2014. http://www.myarmoury.comfeature_jpn_armour.html.

Breeze, C. M. 2008. "Preventative Conservation of Samurai Armor." White Paper. Accessed July 28, 2014. http://www.museumtextiles.com/uploads/7/8/9/0/7890082/preventative_conservation_of_samurai_armor.pdf.

Cranbrook Institute of Science. n.d. "The Story of the Samurai Armor." Accessed November 15, 2014. http://science.cranbrook.edu/science-central/research/samurai.

Dumka, H. 2011. Personal communication. Glenbow Museum, Calgary, Alberta, Canada.

Hietala, H. 2011. Personal communication. Asheville, NC.

Hiroshi, I., and M. Ogawa, ed. 2009. "Art of the Samurai: Japanese Arms and Armor, 1156–1868." Exhibition catalogue. New York, N.Y.: Metropolitan Museum of Art.

Sinclaire, C. 2008. "Japanese Armour." Accessed November 15, 2011. http://www.to-ken.com/articles/ArmourMay08 (no longer available).

Soanes, R. n.d. "Restoration." Accessed 29 July, 2014. http://www.katchushi.com/restoration.asp.

Wagner, D. 2011. Personal communication. Asian Art Department, Denver Art Museum, Denver, CO.

Wikipedia s.vv. "Japanese Armour." Last modified April 29, 2015. Accessed July 28, 2014. http://en.wikipedia.org/wiki/Japanese_armour. http://www.shogunart.com. Accessed November 15, 2011.

SOURCES OF MATERIALS

Acryloid B-72 100% solids
Conservation Materials Ltd. (no longer in business)
1165 Marietta Way, PO Box 2884
Sparks, NV 89431
Tel: 702-331-0582
Fax: 702-359-0582

BEVA Heat-Sensitive Film, MarvelSeal 360
Talas 330 Morgan Ave.
Brooklyn, NY 11211
Tel: 212-219-0770
Fax: 212-219-0735
www.talasonline.com

Cotton, Polyester/Cotton and Silk Crepe Fabrics, DMC Embroidery Threads, Pacific Cloth
Local fabric store
Asheville, NC

Ethafoam DOW EF 220 white Plank
Hibco Plastics, Inc.
PO Box 157,
Yadkinville, NC 27055
Tel: 800-849-868; 336-463-5591
Fax: 336-463-5591
www.hibco.com

Japanese tissue
Hiromi Paper, Inc.
Bergamot Station
2525 Michigan Ave., #G9
Santa Monica, CA 90404
Tel: 310-998-0098
Fax: 310-998-0028
http://hiromipaper.com

Polyester padding
B&M Upholstery Supply, LLC
332 Geer Road
Lebanon, CT 06249
Tel: 860-886-1884; 800-223-1298
Fax: 860-886-4209

Tannic acid
Aldrich P.O. Box 2060
Milwaukee, WI 53201
Tel: 800- 558-9160; 414- 273-3850
Fax: 800- 962-9591; 414- 273-4979
www.aldrich.sial.com

Twill Tape

University Products
517 Main Street, PO Box 101
Holyoke, MA 01041-0101
Tel: 800-628-1912; 413-532-3372
Fax: 800-532-9281
www.universityproducts.com

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WORKING WITH LIMITED RESOURCES: IMPROVING STORAGE CONDITIONS FOR ARCHAEOLOGICAL TEXTILES AT UNIVERSITY OF CONCEPCIÓN

FRANCISCA A. LUCERO JUEZ AND FRANCES LENNARD

ABSTRACT—The project focused on planning a conservation strategy for a collection of archaeological textiles at the University of Concepción in Chile. This began as Miss Lucero's dissertation topic for the degree of MPhil Textile Conservation at the University of Glasgow. A funding proposal based on the project was presented to the Cultural Funds 2014 given by the Chilean government, although without success.

The collection comprises 33 undocumented textiles of different characteristics, possibly found in several sites. Their condition is varied but in general homogeneous, as they were stored together for a long period. Most of the damage (insect damage, dust deposition, cobwebs, some mold, and corrosion, different kinds of soil – possibly evidential –, among others) is thought to have occurred due to poor storage conditions.

The project aimed to improve storage conditions of these textiles by creating bespoke boxes for them and implementing an environmental monitoring system and pest control. This task became a complex one due to several issues: low availability of conservation-grade materials in Chile, low resources available from public funding, consideration of alternative, affordable materials available, and managing limited resources as a whole in terms of materials, money, and people working in the field.

TRABAJAR CON RECURSOS LIMITADOS: MEJORES CONDICIONES DE ALMACENAMIENTO PARA TEXTILES ARQUEOLÓGICOS EN LA UNIVERSIDAD DE CONCEPCIÓN: RESUMEN—El proyecto se enfocó en la planificación de una estrategia de conservación para una colección de textiles arqueológicos en la Universidad de Concepción en Chile. Comenzó como el tema de la disertación del autor para obtener el título de Conservación Textil MPhil de la Universidad de Glasgow. Se presentó una propuesta de financiamiento del proyecto a los Fondos Culturales 2014 otorgados por el gobierno chileno, pero sin éxito.

La colección contiene 33 textiles no documentados con diferentes características, posiblemente encontradas en diferentes sitios. Su estado es variado pero, en general, homogéneo ya que estuvieron guardados juntas durante mucho tiempo. Se cree que la mayor parte del daño (provocado por insectos, polvo, telas de araña, algo de moho y corrosión, diferentes tipos de suciedad—posiblemente evidencial—, entre otros) se produjo por malas condiciones de almacenamiento.

El objetivo del proyecto fue mejorar las condiciones de almacenamiento de estos textiles creando cajas especiales e implementando un sistema de monitoreo ambiental y control de plagas. Ésta fue una tarea compleja por varios motivos: la poca disponibilidad de materiales de conservación en Chile, la escasez de fondos públicos disponibles, la consideración de materiales alternativos y accesibles disponibles y la administración de los recursos limitados en general, en términos de materiales, dinero y personas trabajando en el campo.

1. INTRODUCTION

In Chile, textile conservation is a small field. There is little information available regarding current measures to stabilize the condition of textiles by means of preventive conservation, and usually no funding comes to these kinds of projects because they are not fully understood by the people who review them. The project discussed here aims to shed light on the issue of preserving archaeological textiles in Chile, focusing on a collection that was excavated in the 1970s, a rare survival. The collection has not been preserved in any way—as far as we and the people involved are aware—and for most of the past 40 years, it was kept inside a ceramic jar, which presumably was found around the same time. After thorough documentation and surveying the current storage facilities at University of Concepción (*Universidad de Concepción*), where the textiles arrived years ago, a proposal was prepared for public funding for the conservation and storage improvement of the collection. Sadly, funding was not obtained for 2014, but it is hoped to apply once more in the next period and finally improve the collection's condition for the long-term preservation of these valuable objects.

2. ARCHAEOLOGY AND ARCHAEOLOGICAL TEXTILES IN CHILE

The Archaeological Society of Santiago (*Sociedad Arqueológica de Santiago*) was founded in the 19th century, but it was not until the start of the 20th century that a more systematic archaeology discipline began to develop, with much more theoretical depth than before. By the 1990s, Chilean archaeology had become a scientific discipline, occupying an academic, intellectual, and professional place in the country.

Textiles in archaeology are often the most difficult to find among archaeological sites due to their fast deterioration. Organic materials are, generally, the ones that decay most rapidly in burial environments, and toward the central and southern regions of Chile, they are practically nonexistent because of increased moisture and humidity.

The north, however, possesses an exceptionally dry climate which, combined with appropriate soil composition, allows the long-term preservation of organic material, including textiles. This region was once filled with lakes—now evaporated—that have left behind a reserve of salt deposits, immersing the soil with salts, saltpeter, and sometimes metal sulfates and oxides, which cause the dehydration of cadavers before decomposition begins. As a result, textiles in this region are sometimes found intact, covering the dry bodies of their owners. However, passage from burial to the open environment, when excavated, is quite a shock in terms of oxygen intake, increased relative humidity (RH) and temperature, and sudden exposure to light. Textiles may be found in surprisingly good condition, but deteriorate much more rapidly than other textiles after excavation because they have adjusted to the burial environment and cannot acclimatize properly to their new environment—sometimes the deterioration rate is as fast as 30% in less than 50 years, even when in good storage conditions (Kauffmann Doig 1979). Preventive conservation measures should be applied from the moment of excavation, and it would be ideal to have a textile conservator in the field to ensure the well-being of textile artifacts (Cronyn 1995). In general, the conditions that need to be met for the long-term preservation of archaeological textiles are the same as for other historical textiles: ideally low light levels, no UV, medium RH levels, and relatively low temperature (Paine 1992; Bullock 2011; Staniforth 2011).

Textile conservation as a field is very small in Chile, and is even smaller when considering archaeological textiles. The professionals working as textile conservators are often archaeologists, anthropologists, textile designers, or conservators of other materials who have become interested in textiles. Most of them have learned all they know from practice, from working in the field, from attending small workshops and courses and working in museums as volunteers, and there are a select few who have trained specifically in textile conservation. There are large textile collections found in the North of Chile, but other artifacts have been given higher priority in terms of conservation and attention. Several Chilean archaeologists and people who work in the field think this could be due to the lack of expertise by professionals who are unaccustomed to finding organic material. Additionally, textiles are often not considered visually attractive or as robust as other objects and are less likely to be wanted for exhibition.

3. THE TEXTILE COLLECTION AT UNIVERSITY OF CONCEPCIÓN

The University of Concepción has a long, renowned history among Chilean Universities. It is the third oldest university in the country, founded in Concepción in 1919. Although it no longer has a specific Archaeology department, its Anthropology school holds a very large assortment of archaeological objects that has its origins in the old Archaeology Institute that was once part of the university. This was donated in the 1970s, and by 2010 a group of anthropologists from the university made sure that more than 2000 archaeological pieces were catalogued and properly stored in one of the classrooms that the university appointed as a storeroom: Classroom 7 (*Aula 7*). They worked under the supervision of Mr. Pedro Andrade, archaeologist appointed to the care of the archaeological finds.

The textile collection, however, was not part of the initiative, and it was not catalogued or conserved in any way. The anthropologists involved in the project did not have the experience to include textiles in their initiative. As public funds are often very limited, there was likely not enough money to include a textile conservator for the project. Because of this, these textiles remain unstudied and although they are generally quite robust and stable, much remains to be done to improve their storage conditions.

The textiles at the University of Concepción have, sadly, remained shrouded in mystery for many years, but the university is once more focusing its efforts toward the archaeological collection. The textiles, a total of 33 including small fragments, comprise a wide variety of designs, shapes, and sizes. There is one tunic (fig.1), two bags, and all others are subject to interpretation regarding their original shape and use. All are plain weave, warp-faced, and most of them have linear and/or geometrical designs. On the basis of their design and characteristics, it appears that most of them come from the north of Chile, possibly from the Andean and Arica cultures, among others; however, their provenance and age is unknown and nothing can be asserted until further analysis and research is carried out. The fiber content has not been tested as of yet, but in Chile the fibers most used in the north by pre-Columbian cultures are alpaca and llama hair, which is consistent with the visual and tactile characteristics of the fibers present in the textiles. There is only one that presents a much newer look, with brighter color and what is presumed to be wool fiber (fig.2). This could mean it is a southern or central region textile, and possibly nonarchaeological but rather ethnographic, as it does not present any burial-related characteristics or damage. (This is but an assumption, however, and the object is still considered to be part of the archaeological collection.) There is another one presumed to be from the Central region, possibly from the Mapuche culture: a band that presents a different design with silver beads, a characteristic decoration material used by the Mapuches (fig.3).

The collection entered the university in a large ceramic jar, crowded together (fig. 4); when Mr. Andrade found them, he took great care to remove them and place them in slightly better containers. Although they remain in quite precarious storage conditions, their condition is much improved. Because the textiles were kept together in a small confined space for so long, most of the soil and damage found in them is consistent with poor storage and environmental conditions. If this is the case, it could also mean that most of the soiling and damage is rendered "contaminated" and no longer evidential for study purposes, although a more thorough analysis using specialized tools (stereomicroscopy, microscopy, scanning electron microscopy, among others) might reveal otherwise. This "contamination" theory is based on the observation of several types of damage that are found on almost all the textiles of the collection: insect damage, dust deposition, cobwebs, some mold and corrosion, different kinds of soil and dirt—possibly evidential—among others.

Figure 1: General photo of a small, squared tunic: UdeC-MA.04, showing what is believed to be its front side due to the length of the neck opening. Courtesy of Universidad de Concepción ©2013

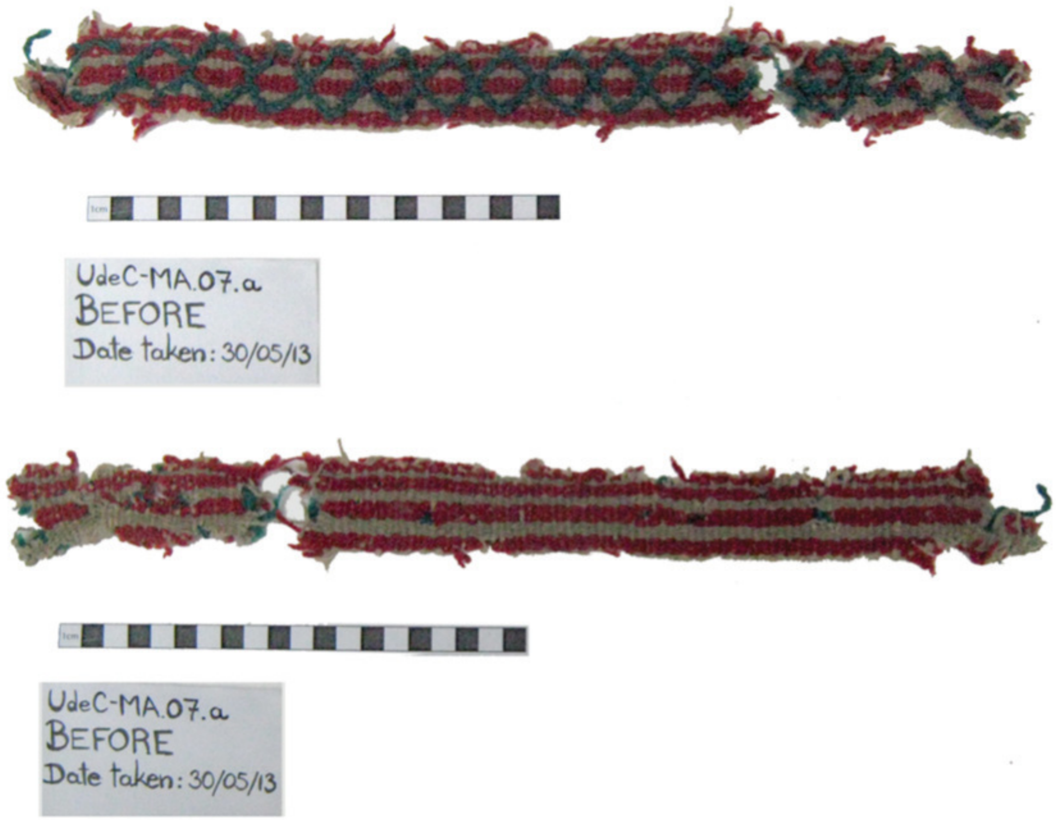

Figure 2: General photo of textile band UdeC-MA.07.a, showing both sides. Colors are bright and different from those used in the majority of the collection. Courtesy of Universidad de Concepción ©2013

Figure 3: General photo of textile band UdeC-MA.07.c, showing both sides. Design comprises black color with silver beading, which leads to the belief that this could belong to the Mapuche culture. Courtesy of Universidad de Concepción ©2013

Figure 4: The large ceramic jar in which the textile collection was once stored. Courtesy of Universidad de Concepción ©2013

This is currently a rare example of poor documentation and storage conditions. Archaeologists in Chile are most methodical and thorough in their classification and documentation of their finds, but the people involved in this project believe archaeologists did not excavate these textiles. Although there is no information regarding their provenance, the different characteristics of each object suggest they most likely come from multiple sites.

What are these textiles and where did they come from? What is their current condition? How can it be improved? What resources are available for their conservation? These were some research questions that led to this project, aiming to learn more about the archaeological textiles and their context in Chile as well as how preventive conservation applies to these particular objects. A close examination of the causes of damage and deterioration, considering the limited tools available at the time, would then lead to a conservation strategy to improve the textiles' storage conditions. Documenting each textile and every stage of the project will prevent unnecessary manipulation of these fragile artifacts.

4. THE PROJECT

In June 2013, new inventory numbers were assigned for each textile object within the collection. Preliminary documentation was carried out; observing as far as possible the details of weave and design, and describing the types and extent of damage. Part of the proposal is to continue the documentation process with historical research, consultation with archaeologists and historians, laboratory analysis (such as carbon dating and fiber ID), and hopefully closer observation using a stereomicroscope, which was not available at the time of the initial registry. This way, historical context can be given to these artifacts to learn from them, sharing this information publicly on the university's database for everybody to access.

The photographic record was also very basic in terms of equipment, as there were no means at the time to hire a photographer. Light in the storeroom was quite dim, so the photos created for this initial registry are low quality and merely serve as a reference for the initial stages of the project. Ideally, when the project receives funding, high-quality photographic records will be carried out following the guidelines provided by the Unified System of Registry and Documentation (*Sistema Unificado de Registro y Documentación*—SURDOC), the administration system of heritage collections created by the Heritage Assets Documentation Centre (*Centro de Documentación de Bienes Patrimoniales*).

During a visit to Concepción, a thorough survey was carried out to examine the suitability of Classroom 7 (figs. 5, 6) to store this collection and to plan the conservation strategy accordingly. Geographically Concepción is in the VIII Region of Chile, south of the capital, with mostly rainy weather, strong winds, and high RH. The university area is prone to flooding when rain is excessive, and there is a risk of the room being flooded as a consequence. So far, flooding has been restricted to the garden areas and the buildings have not been affected, but it would be best if the collection were moved to a safer location. Even without any kind of control, the environment is quite stable thanks to the construction of the building, and although RH is usually high in Concepción, the storeroom itself presents no issues in this aspect, and there have been no problems with insects or pests in the years the collection has been there. The insects found in the textiles appear dead and inactive, and there was no evidence of current pest problems within the room; the infestation possibly occurred before the collection was donated, and it is unknown whether the collection was previously treated for its pest infestation. The implementation of a pest control system and environmental monitoring are of course vital to understanding this space and procuring the best conditions possible for the entire archaeological collection.

Figure 5: General view of the storeroom: Classroom 7, at University of Concepción. Courtesy of Universidad de Concepción ©2013

Figure 6: Closer view at one of the shelves within the storeroom, where some of the textiles are stored covered in Tyvek® sheets. Courtesy of Universidad de Concepción ©2013

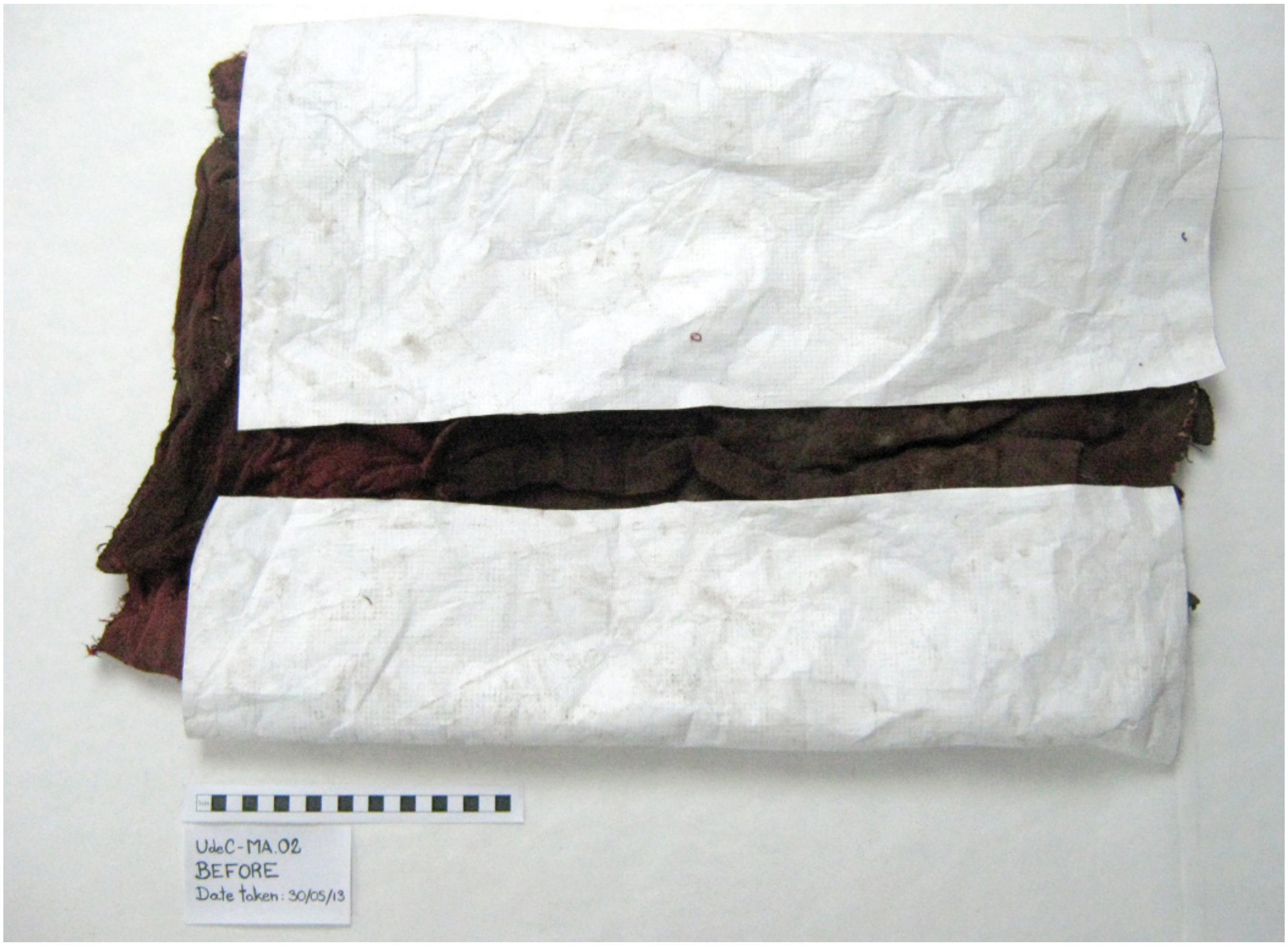

Figure 7: Examples of current materials (small Tyvek® sheet that does not cover the textile entirely) used for the storage of the archaeological textile collection as photographed in June, 2013. Courtesy of Universidad de Concepción ©2013

Currently materials used for storage of textiles include corrugated cardboard (not acid-free), plastic trays, polyethylene plastic bags, and some Tyvek® sheets (figs. 7–10) placed on metallic modular shelves, which are installed on a rail system for easy access. This system is practical but large objects can be difficult to handle because of the narrow space within the shelves; however, the storeroom is adequate to store the entire textile collection comfortably, and the difficulties of manipulation that the narrow aisles present are manageable. As a result of the survey, Classroom 7 was deemed appropriate for the storage of the textile collection, at least until a better, purpose-built storeroom can be constructed for the entire archaeological collection.

In combination with the knowledge acquired through research on preventive conservation measures and that of the analysis of the textiles themselves, a plan of action was devised to improve the textiles' current situation.

5. THE CONSERVATION STRATEGY

The strategy focused on the improvement of storage conditions by creating bespoke boxes for each textile (or group of textiles) using appropriate materials and considering the physical characteristics of the storeroom and its shelving system. Appropriate labeling and photographic reference on the boxes will allow ease of access and

Figure 8: Examples of current materials (plastic tray where the textile lays folded, without any protection or cover) used for the storage of the archaeological textile collection as photographed in June, 2013. Courtesy of Universidad de Concepción ©2013

prevent excessive movement and handling of the textiles, and preventive conservation measures will allow for the monitoring of the storeroom's environment and the prevention of possible pest infestations in the future.

Improving access to the collection without the need to handle the textiles directly by use of digital media and the inclusion of the textile collection in the university's online database was also considered within the strategy, as this will prevent further damage to the textiles by reducing manipulation during removal from their containers. Documentation and assignation of inventory numbers according to the university's system and SURDOC will further aid this point, allowing scholars, students and the general public to access the information available on these textiles and learn from Chilean cultural, artistic and historical heritage.

Since conservation-grade materials are hardly available in Chile and their import from abroad can be very expensive, alternative materials were sought. References were found of paper and photography conservators using papier mâché card (*cartón piedra or cartón Europa*) to make boxes, lining them with acid-free paper. The Andrés Bello Central Archive of the University of Chile (*Archivo Central Andrés Bello de la Universidad de Chile*) and many other smaller studios and archives use this technique to compensate for the lack of acid-free cardboard found on the market. It is believed that, although not acid-free, the card is appropriate for temporary storage, and the acid-free paper lining should work well as a barrier between the box and the objects, perhaps with

Figure 9: Examples of current materials (insufficient Tyvek® and acidic corrugated card) used for the storage of the archaeological textile collection as photographed in June, 2013. Courtesy of Universidad de Concepción ©2013

the addition of a layer of aluminum foil. No bibliographic references regarding the use of papier mâché card in conservation were found; it would be interesting to carry out some tests before and after the manufacture of the boxes. As temporary storage, however, it may be a good compromise in terms of material and costs, even though further testing is needed to confirm the use of this material for long-term preservation of historical textiles.

As part of the environmental monitoring system, the use of dataloggers was suggested in key areas of the storeroom to monitor RH and temperature fluctuations over time and during different times of the year. It was also suggested to place insect traps in the store to identify the type and number of insects present in the area. In this manner, the university staff can identify the storeroom's current environmental parameters that will aid future project proposals regarding upgrades to the storeroom.

6. OBTAINING FUNDING

Miss Lucero's dissertation included interventive conservation measures (such as surface cleaning to remove dead insects, cobwebs and dust), always following the aim of minimally interventive measures for the improvement of the textiles' condition to allow future study and research on their provenance and historical relevance. This part of the project was not included in the proposal presented to Cultural Funds 2014 (*Fondos de Cultura* 2014), as it became too expensive for the Funds' limited budget. It was decided to divide the project and present only the preventive conservation aspect, which has been summarized in this document.

For cultural schemes such as this, the institution appointed to provide funding is the National Council of Culture and Arts (*Consejo Nacional de la Cultura y las Artes—CNCA*). The project was presented to their Cul-

Figure 10: Examples of current materials (plastic tray and polyethylene bags with no labeling) used for the storage of the archaeological textile collection as photographed in June, 2013. Courtesy of Universidad de Concepción ©2013

tural Funds 2014 scheme—public funds that are given every year to a variety of cultural and artistic projects. After obtaining the appropriate permits to work on the collection from the Monuments Council (*Consejo de Monumentos*, the institution that has legal responsibility for heritage objects) and carefully planning the stages and budget of the entire project according to Cultural Funds' guidelines, we sent off our proposal and waited for the results. Overall the process was quite straightforward and thankfully the permits and documents were not particularly hard to obtain, although as usual bureaucracies require a great deal of paper work and several business-days' worth of waiting time. Sadly, the project was not funded for the 2014 period. It was, however, a learning experience that will surely be influential in the next period's project planning.

7. CONCLUSIONS

This project proved to be much larger and more complex than initially expected. It was difficult to concentrate on improving the storage conditions for the textiles, without enlarging the project to include investigation of their origins. Although this is the intention for the future, the aim for the initial stages of the project was never to reveal the secrets of these textiles because the available tools are very limited and cannot be obtained in the short term nor without funding.

It is only a matter of time before improved storage and environmental controls for this collection become a reality. There is still time to look for and research additional alternative, readily available materials to avoid the costs of importing acid-free, conservation-grade materials that are so well known in the Northern Hemisphere. Not obtaining funding for this year has only motivated the team to improve the strategy as a whole. Overall, this has been a great experience and there is still much to learn, not only about the textile collection but the whole Chilean heritage sector.

When the project is funded, the findings will surely be transferrable to future projects and the textile conservation community, not only in Chile but South America as well, and hopefully will shed light on the issues at hand and give awareness to the institutions involved in order for them to provide funding for this kind of project in the future. This will hopefully provide a sense of realization that textiles are also an important part of our cultural heritage that offer historical evidence of earlier trade routes, construction techniques, and insight into the pre-Columbian cultures' technology and customs.

ACKNOWLEDGMENTS

We wish to acknowledge and thank the following people and institutions for their help in the development and promoting of this project: Mr. Pedro Andrade, archaeologist responsible for the archaeological collection held by the Anthropology department at University of Concepción; Ms. Francesca Mengozzi, archaeologist; Ms. Lauren K. Chang, Textile Specialty Group Program Chair at the AIC 42nd Annual Meeting held in San Francisco in May, 2014; the University of Glasgow and the Centre for Textile Conservation and Technical Art History; FAIC and the Samuel H. Kress Foundation.

REFERENCES

Archivo Central Andrés Bello. *Universidad de Chile*. Accessed July 30, 2013. http://archivobello.uchile.cl/category/productos-a-la-venta/.

Bullock, L. 2011. "Light as an Agent of Deterioration." In *The Manual of Housekeeping* edited by Adrian Tinniswood. Revised edition, 93–101. Aylesbury: National Trust.

Cronyn, J.M. 1995. *The Elements of Archaeological Conservation*. London: Routledge.

Fondos de Cultura. 2014. *Consejo Nacional de la Cultura y las Artes - Gobierno de Chile*. Accessed July 21, 2014. http://www.fondosdecultura.gob.cl/.

Kauffmann Doig, F. 1979. Los Textiles en el Museo Nacional de Antropología y Arqueología. In *Los Textiles Precolombinos y su Conservación*, edited by Juana Truel, 7–8. Santiago: Proyecto Regional de Patrimonio Cultural UNESCO/PNUD.

Paine, C., ed. 2011. *Standards in the Museum Care of Archaeological Collections 1992.* London: Museums & Galleries Commission.

Staniforth, S. 2011. "Relative Humidity As an Agent of Deterioration." In *The Manual of Housekeeping*. edited by Adrian Tinniswood. Revised edition, 103–113. Aylesbury: National Trust. 103–113.

FURTHER READING

Arroyo, C. 2011. Museo Arqueológico UdeC. *Panorama UdeC Facebook page*. www.facebook.com/media/set/?set=a.334776019928898.74456.319381108135056&type=1 (accessed 07/21/14).

Los tesoros arqueológicos que Antropología resguarda en el Aula 7. In *Panorama UdeC*, Universidad de Concepción. Accessed July 21, 2014. http://www2.udec.cl/panorama/p679/p12.htm.

Ogden, S., ed. 2004. *Caring for American Indian Objects: A Practical and Cultural Guide*. Minnesota: Minnesota Historical Society Press.

Vigo, T. L. 1980. "Protection of Textiles from Biodeterioration." In *Conservation and Restoration of Textiles International Conference, Como 1980*, edited by Francesco Pertegato, 18–26. Milano: Centro Italiano per lo Studio della Storia del Tesoro.

SOURCES OF MATERIALS

Papier Mâché Card (*Cartón Piedra, Cartón Europa*)
Papelera Dimar S.A.
Carretera General San Martín 7600
Quilicura, 8710023
Santiago, Región Metropolitana
Chile
Tel: +56-22-591-1100
www.dimar.cl/

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ASSESSING LED LIGHTS FOR TEXTILE COLORANTS

COURTNEY ANNE BOLIN AND MARY BALLARD

ABSTRACT—Museums are increasingly interested in installing energy-saving light sources, such as LED (light-emitting diode) lamps; however, LEDs are still a new technology with legitimate concerns about the effects of light spectra on artifacts, including textiles. Many models may not possess the same color-rendering properties that observers are accustomed to, and it is important to understand the effects that spectra can have on the perception of dyed textiles. This research explored the effects of different light spectra, including those of LEDs, on popular dyes with the goal of understanding the interaction of light with textiles. Eleven early synthetic dyes and two natural dyes were selected for exposure to 10 different LED spectra. This paper summarizes our findings to date: LED spectra with the same color temperature can render very different observable colors, especially with saturated colors. Saturated purples were found to be extremely hard to render accurately under LEDs. The experiment indicates that color temperature and illuminance level are no longer sufficient when specifying a light source for exhibit.

EVALUACIÓN DE LAS LUCES LED PARA LOS COLORANTES TEXTILES: RESUMEN—Cada vez más, los museos muestran su interés por instalar fuentes luminosas que ahorren energía, como lámparas LED (diodos emisores de luz). No obstante, la tecnología de las luces LED es nueva aún y despierta una preocupación legítima sobre los efectos de los espectros lumínicos en los objetos, incluyendo las telas. Muchos de los modelos tal vez no tienen la misma capacidad de representar los colores a la que los observadores están acostumbrados, y es importante entender los efectos que los diferentes espectros lumínicos pueden tener sobre la percepción de las telas teñidas. Esta investigación exploró los efectos de diferentes espectros lumínicos, incluyendo los de las luces LED, sobre las tinturas más populares con el objeto de entender la interacción de la luz con las telas. Se seleccionaron once tinturas sintéticas y dos tinturas naturales y se las expuso a 10 espectros de luces LED diferentes. Este documento resume los resultados hasta la fecha: que el espectro de las luces LED con la misma temperatura de color puede producir colores apreciables muy diferentes, especialmente con los colores saturados. Se encontró que los púrpuras saturados eran muy difíciles de apreciar con precisión bajo las luces LED. El experimento indica que la temperatura del color y el nivel de iluminación ya no son suficientes al especificar una fuente lumínica para la exhibición.

1. INTRODUCTION

Color and lighting of historic textiles are critical factors in visitor experience. Visitors want adequate light to perceive color well, while museums want to minimize light on artifacts to reduce actinic damage. Traditional artificial lighting sources used in museums are incandescent, including halogen, and occasionally fluorescent; however, LED lighting is quickly gaining popularity as an energy-saving option because manufacturers are now able to offer better quality assurance and color uniformity. The spectral power distribution (SPD) of LEDs can be very different from other artificial lighting sources and could significantly alter the appearance of artifacts. Although there are many studies involving the lighting of sculpture and paintings, textiles are often more susceptible to light damage and additional research is required to understand the role LEDs should have in lighting dyed textiles. Previous studies examining effects of modern light sources on historic textiles have been conducted and have proved that dyes fade differently under different spectra (Ishii et al. 2008; Commission

Internationale de L'Eclairage (CIE) 2004). In order for museums to use these options safely, a better understanding of light spectra and their effect on dye color perception and fading is required. To do this, light sensitive dyes should be observed and assessed under different LED technologies.

The Energy Independence and Security Act of 2007 introduced energy efficiency regulations for lighting that have effectively banned (after 2014) the production of incandescent lamps, excluding specialty bulbs (Energy Independence and Security Act of 2007). Incandescence in traditional lighting creates light in response to heat. With incandescent lighting becoming obsolete, the lighting industry is producing innovative lighting options using new and ever-changing technology, including LEDs. LEDs are manufactured to work by using semiconductors doped with phosphor materials. This creates an effect called electroluminescence, where light is emitted in response to an electrical current or strong electric field. The first patent for applicable LED technology was issued in 1966 (Biard and Pittman 1966) using gallium arsenide as the semiconductor. Over the last half century, semiconductors have become an important material used in many different electronics, and the market demand is driving research in the electronics and lighting industry. Although gallium arsenide remains a popular semiconductor, indium gallium nitride is more common in current cost effective LEDs on the market. Indium gallium nitride's emitted wavelength ranges from 390–440 nm depending on the material's band gap (controlled by the ratio of GaN/InN). As museums implement and install LEDs, it becomes increasingly important to understand how the spectra of these technologies affect the color rendering of historic dyed textiles.

The market for LEDs is expanding into industries where color rendering is critical. The Department of Energy (DOE) has funded the Solid-State Lighting GATEWAY Demonstrations to showcase high-performance LEDs in different applications, including museum gallery lighting (DOE 2013). GATEWAY museum demonstrations include projects with the Smithsonian American Art Museum, J. Paul Getty Museum, Jordan Schnitzer Museum of Art, and the Field Museum of Natural History. These reports focus on energy savings and feasibility of installing lamps in detail, and examine appearance of artifacts examined under LEDs; however, they did not study the effects of LEDs on fidelity in color perception of textiles. The international color organization, Commission Internationale de L'Eclairage (CIE) has released a draft of terms and definitions for lighting with inorganic semiconductors that will later be developed into a standard (CIE 2013) and a report that examines the suitability of existing lighting quality measures for interior LED lighting (Dikel et al. 2013). With increasing interest in LEDs' ability to render color, there is a need to explore and collect information about the effects of LEDs used in museums to light galleries with historic dyed textiles.

The elements that make up an LED's semiconductor material determine the color of light emitted in a manner similar to neon lighting, and there is a lot of variability between lamp models. The majority of LEDs use a semiconductor that emits a peak of blue-green light and a phosphor that luminesces a broader band of orange-yellow, which together create a white light (see fig. 1, graph E). The white light produced in this manner by LEDs is not a true white light, meaning a white light made up of nearly equal quantities of all colors of light in the visible spectrum. Although LED technology does have the capacity to create a full spectrum light source, doing so will not only increase the cost of producing the lamp but it will also sacrifice energy efficiency. Presently, LEDs are gaining interest exactly because they are a money saving option. To increase the market for LEDs, manufactures are trying to decrease the cost of lamps, which further limits the materials that are used, and the range and energy of colors emitted. Color rendering is not critical in many of their applications (e.g., automotive headlamps). Since LEDs are still a new technology and many models may not possess the same color rendering properties that observers are used to within the tradition of incandescent lamps, it is important to understand the effects that spectra can have on the perception of dyed textiles.

In this research three questions are examined. The first question is whether LED lighting will change color rendering uniformly by affecting all colors equally or change color rendering by groups of color. Uniformly changing the colors would affect the tonality but not their harmony; however, if different hues at different chroma are not equally affected, the color rendering of the textile may be skewed, depending on the particular colorway. The second question is whether the existing descriptors used to differentiate or grade LEDs are adequate for purposes of dyed textile display. The color rendering index (CRI) measures the ability of light sources to illuminate objects faithfully in comparison to an ideal or natural light source (usually incandescent). Another descriptor often used is Correlated Color Temperature (CCT) for the apparent color of a source warmer or cooler in color tone, meaning closer to incandescent light or to daylight, respectively. The third question is whether SPD as described by its manufacturer can be used to predict color rendering. Nanometer by nanometer across the 400–700-nm visible spectrum, the LEDs can be engineered to have specific levels of energy. The SPD of LEDs can vary from other artificial lighting sources and could significantly alter the appearance of artifacts.

2. MATERIALS AND EXPERIMENTAL METHOD

2.1 MATERIALS

Cotton and silk selected for dyeing were bleached desized cotton (style 400) and silk broadcloth (style 607) from Testfabrics, Inc. They possess similar fabric weight and construction to each other, which reduces variation in color readings (table 1).

Table 1: Fabrics Used in Study

Fiber	Testfabrics, Inc. Style #	Fabric Weight (g/m^2)	Weave Construction	Fiber Density (g/cm^3)
Cotton	400	100	Plain	1.55
Silk	607	105	Plain	1.30

Dyes selected for the study included 11 early synthetic dyes and 2 natural dyes. These dyes were selected for their known poor light fastness and range of colors (table 2).

Table 2: Dyes Used in Study

Dyestuff	C.I. Name	C.I. Number
Napthol Yellow	Acid Yellow 1	10316
Uranine A	Acid Yellow 73	45350
Auramine	Basic Yellow 2	41000
Chrysoidine	Basic Orange 2	11270
Crystal Violet	Basic Violet 3	42555
Diamond Green B	Basic Green 4	42000
Magenta	Basic Violet 14	42510
Rhodamine 6G	Basic Red 1	45160
Vesuvin BA	Basic Brown 1	21000
Victoria Blue B	Basic Blue 26	44045
Congo Red	Direct Red 28	22100
Safflower	Natural Red 26	75140
Turmeric	Natural Yellow 3	75300

2.2 SAMPLE PREPARATION

Cotton and silk fabrics were cut into samples that weighed approximately 20 g each and the weight, to four decimal places, was recorded. Each of the 11 synthetic dyes was dissolved into deionized water at 1% by weight (e.g., 1 g of dyestuff per 100 mL of deionized water). Each sample was separately dyed with the appropriate mordant and dwell time (Schweppe 1986) and/or auxiliaries (Schweppe 1987) using a 1:50 dye bath liquor ratio.

2.3 LIGHT EXPOSURE

Ten unique SPDs with different attributes were created using spectrally tunable lighting facility at the National Institute of Standards (NIST) with the assistance of Dr. Yoshi Ohno (fig. 1). The SPDs represented three different types of LED models: RGB, RGB-A, and broadband. The SPDs were mostly 3000°K and viewed at 100 lux.

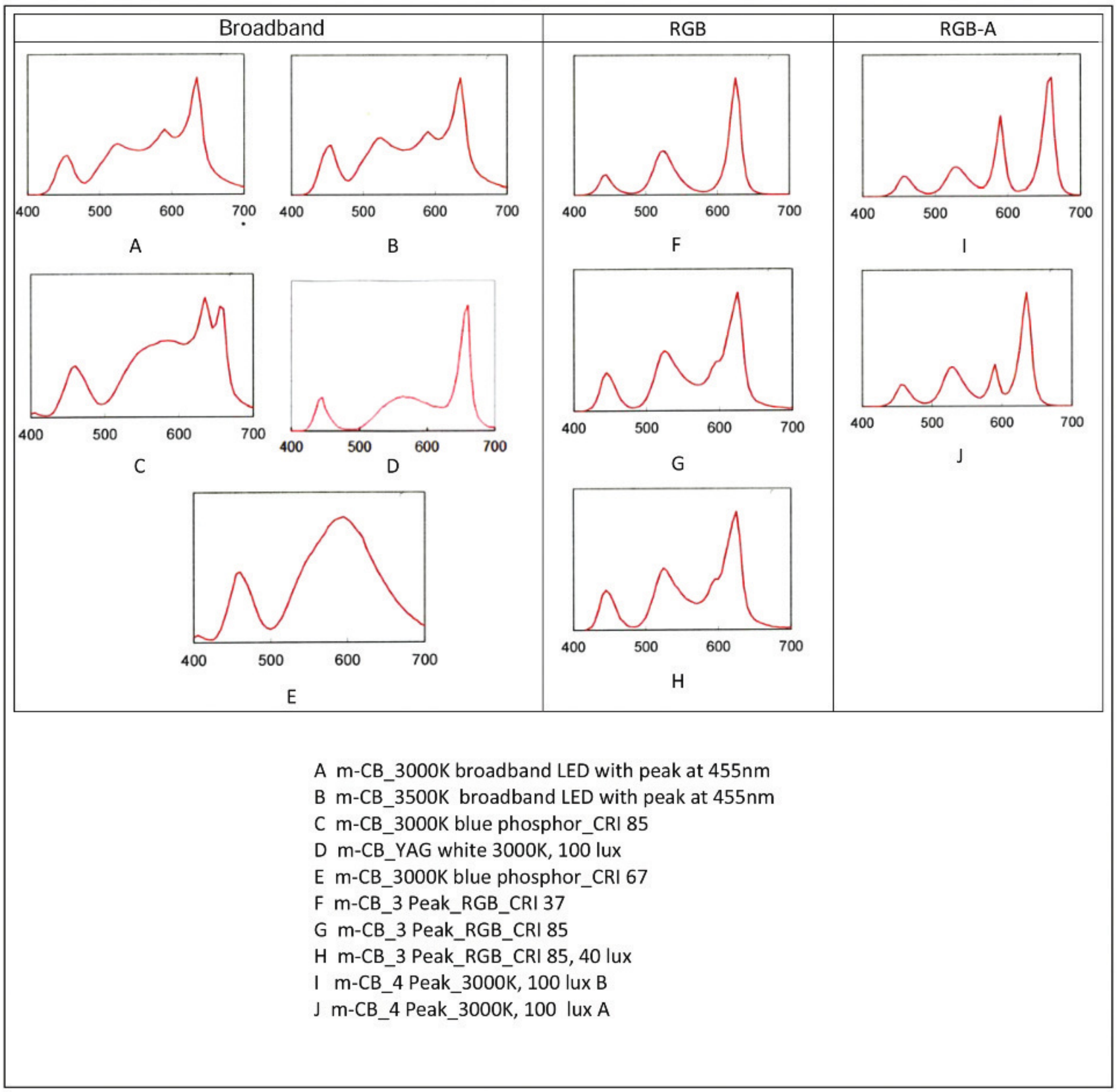

Figure 1: Spectral power distributions of LED spectra created at NIST. The visible spectrum is measured in nanometers (abscissa) and the energy (ordinate) present at each nanometer is relative.

2.4 EVALUATION METHODS

Each sample was measured for color-rendering changes under different spectra using the spectrally tunable lighting facility at NIST, where it is possible to switch rapidly between spectra. A digital simulator program with the spectral reflectance data for the fabric samples and the spectral emittance information for the LEDs was used for comparison and tracking color change using ΔE (See equation 1 for formula used). This simulator (Davis and Ohno 2011) is available for download free of charge from the NIST website.

$$\Delta E = \sqrt{(L_2^* - L_1^*)^2 + (a_2^* - a_1^*)^2 + (b_2^* - b_1^*)^2}$$

Equation 1: Formula used for Delta-E calculation

Finally a Canon PowerShot ELPH-150 12 megapixel point-and-shoot camera was used to photograph and record videos of the samples with the existing (changing) light sources. These photographs and videos give a general idea of the color change seen, but may not be completely accurate in portraying the change seen in person.

3. RESULTS AND DISCUSSION

In this research we used light with 10 unique SPDs to approximate the effect of different LED lights on color rendering of 11 dyes on two textiles. By comparing human perception, digital photography, and digital color prediction simulations, it was possible to gauge how useful the simulator program was in estimating the difference in color rendering. It was determined that the program's digital rendering was accurate for predicting the suitability of a source to be used with textiles for color rendering purposes. For example, the same crystal violet sample (reflectance data for this sample was collected with a Hunter MiniScan EZ and is shown in fig. 2) was examined under two LED lights with the same color temperature, but different SPDs (fig. 3). The first LED has a peak around 660 nm (red region) making the sample appear redder, while the second LED does not have any strong red peaks making the sample appear bluer. Purple is unique in reflecting high energy (blue) and low energy (red) visible light, and, therefore, is difficult to render accurately under

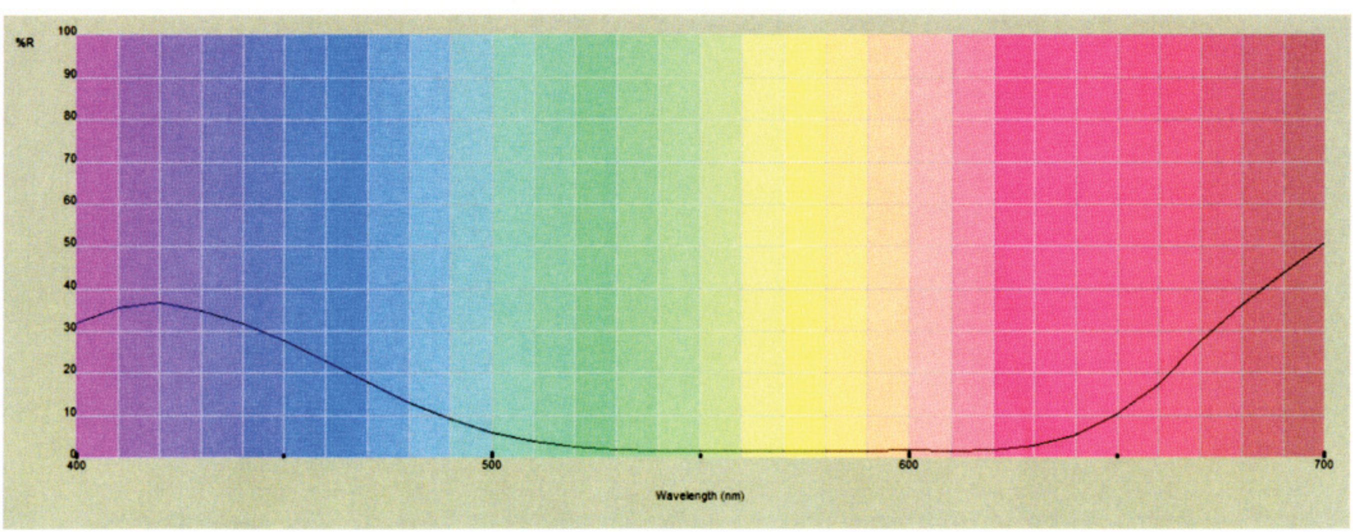

Figure 2: Reflectance data for Crystal Violet on silk

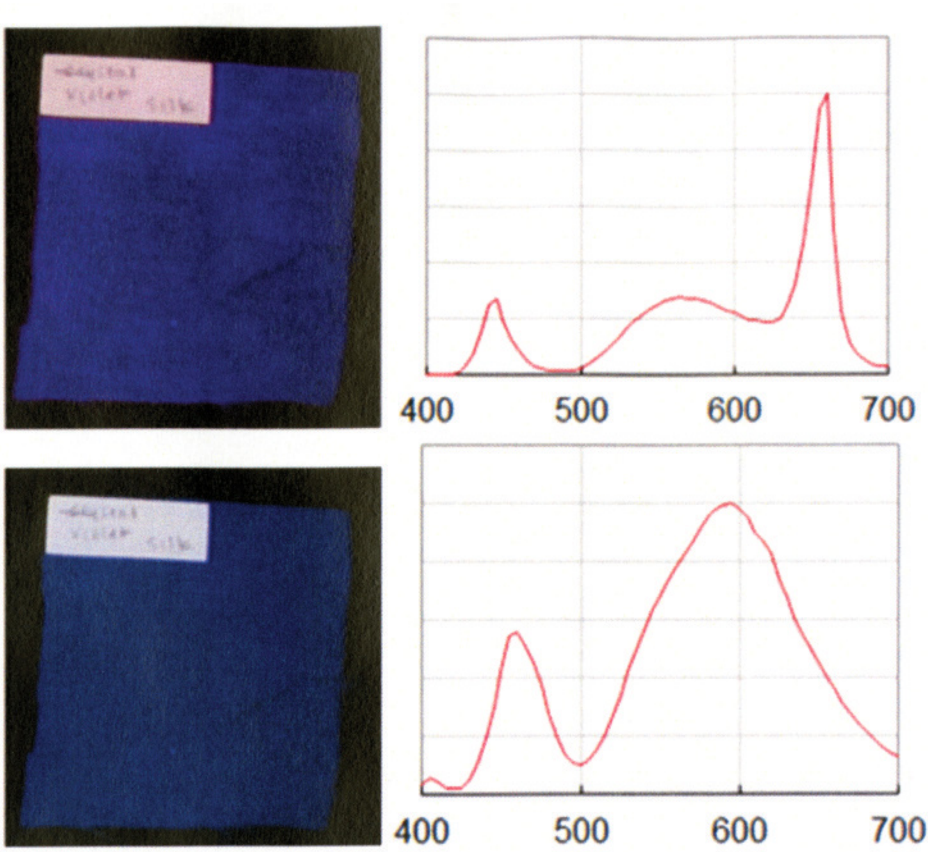

Figure 3: Crystal Violet on silk shown under two 3000-K LEDs

LEDs. Subsequent research has shown that multiple purple spectra including those of Tyrian (royal) purple (CI Natural Violet 1), Mauveine (Basic Dye, CI 50245) and Prussian blue (C.I. Pigment Blue 27), are all subject to color distortion (Bolin and Ballard 2014) under different light spectra.

During visual assessment, we also found that a lamp with a *low* CRI value, measuring the inability of its light source to illuminate objects faithfully in comparison to an ideal or natural light source (usually incandescent), did not always prove to be a poor choice. Deviation from incandescent properties could be beneficial to museums by increasing color saturation under low levels of light while still maintaining a neutral background. In Figure 4, a silk sample dyed with Congo Red is shown under two different LED spectra. Both spectra have same CCT and illuminance, but the SPD and CRI are different. The SPD of the low CRI LED (fig. 1, F) affects the range of the color gamut and creates a stronger red, a more saturated appearance of the Congo Red sample. Normally this would not be desirable—the color could become oversaturated. Yet, with faded objects the color would look more vibrant to viewers even at low illuminance levels (less than 50 lux). This could prove beneficial when it is desired to maximize the color seen with low levels of light.

After creating the spectra and exposing the dyed textiles, it was also determined that LEDs with specially formulated SPDs may offer many possibilities to museums. The lamps are very energy efficient and can be designed to offer options minimizing absorbed light and increasing the color saturation seen by observers. Because there are many available materials for LEDs, manufacturers can create unique spectra very unlike those of more traditional light sources; however, this will create issues in defining lamps and lighting. In the past, illuminance level (lux or foot-candles) and color temperature may have been used to communicate lighting with incandescent sources; other specifications will be necessary with LEDs.

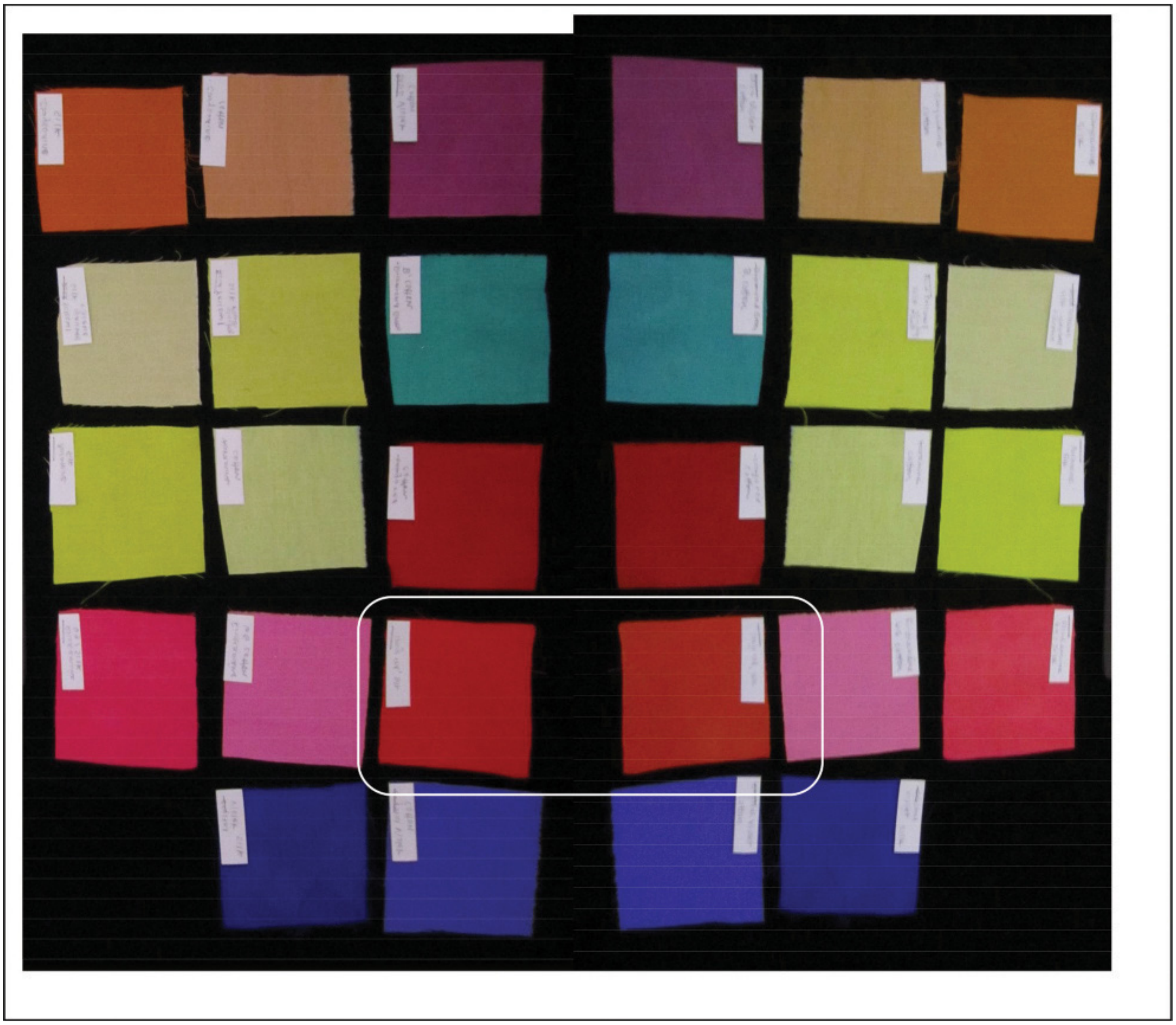

Figure 4: Congo Red on silk sample shown under two LEDs with different CRI values, (left) low CRI; (right) high CRI

4. CONCLUSIONS

LED lighting can affect the color appearance of dyed historic textiles and the color distortion can be hue specific. Overall, the present study indicates that the SPD is required to communicate an LED's color rendering characteristics and to predict a lamp's suitability for use on a case-to-case basis. The SPD, often provided by LED manufacturers, may be useful in predicting color-distortion issues and specifying lights for exhibits. The study also confirms that current metrics used to communicate lamp specifications (e.g., CRI, CCT, illuminance) are neither adequate nor informative when communicating precise specifications for LEDs to be used in exhibits of dyed historic textiles, especially those with bright chroma, multiple color ways, or interplays of hue. The CRI and the CCT were not suitable criteria for predicting this distortion and should not be used to specify lighting for their exhibits; SPD information is required.

Purple hues seem particularly vulnerable to distortion by indiscriminant lighting with LEDs. Although we used known dyes for this study, textile conservators and conservation scientists might be able to use the NIST program to predict the effect of an LED with a known SPD on any dye where reflectance spectra are available. The reflectance curves of dominant colors—with known or unknown dyes—of textile objects can be inserted into the NIST program to predict the color distortion. By fine-tuning the interaction of the LED's particular SPD with the reflectance data of the dominant or more important colors or tones, conservators, lighting designers and conservation scientists eventually may be able to enhance the colors, even purples and reds, of a historic textile with lower overall illuminance values (lux or foot-candles).

ACKNOWLEDGMENTS

During conduction of the study, we were fortunate to receive assistance from many lighting experts. We would especially like to thank Dr. Yoshi Ohno and Nick Lena for their help in understanding light and conducting our experiment. We also would like to acknowledge all of the groundwork conducted by Helmut Schweppe in historic dyes that we used when selecting our experiment's dyes and by Max Saltzman on color technology.

REFERENCES

Bolin, Courtney, Mary Ballard. 2014 "MCI #6601: The Effect of Light Source on Dye Fading." Unpublished transcript, Smithsonian Museum Conservation Institute, Washington, DC.

Commission Internationale de L'Eclairage (CIE). 2004. *Control of Damage to Museum Objects by Optical Radiation*. Technical Report No. CIE 157:2004. Vienna, Austria: Commission Internationale de L'Eclairage.

Commission Internationale de L'Eclairage (CIE). 2013. *Light Emitting Diodes (LEDs) and LED Assemblies-Terms and Definitions.* CIE Draft International Standard DIS 024/E:2013 Vienna, Austria: Commission Internationale de L'Eclairage.

Davis, Wendy, and Yoshi Ohno. 2011. *NIST CQS Version 9.0.* Gaithersburg, MA: NIST.

Department of Energy (DOE). 2013. *Solid-State Lighting GATEWAY Demonstration Results*. Accessed May 6, 2015. http://www1.eere.energy.gov/buildings/ssl/gatewaydemos_results.html.

Dikel, E., L. Dokuzer Öztürk, M. Knoop, N. Miller, E. Mochizuki, A. Némethné Vidovszky, J. Schanda, P. Thorns. 2013. "Review of Lighting Quality Measures for Interior Lighting with LED Lighting Systems." Technical Report No. CIE 205:2013. Vienna, Austria: Commission Internationale de L'Eclairage.

Ishii, Mie, Takayoshi Moriyama, Masahiro Toda, Kohtaro Kohmoto, and Masako Saito. 2008. "Color Degradation of Textiles with Natural Dyes and of Blue Scale Standards Exposed to White LED Lamps: Evaluation of White LED Lamps for Effectiveness as Museum Lighting." J*ournal of Light and Visible Environment* (370-378).

Biard, J.R., and Gary Pittman. 1966. Semiconductor radiant diode. US Patent 3,293,513 filed August 8, 1962, and issued December 20, 1966.

Schweppe, Helmut. 1987. *Practical Information for the Identification of Early Synthetic Dyes*; *Practical Hints on Dyeing with Early Synthetic Dyes* (Yellow Book). Washington, DC: Conservation Analytical Laboratory, Smithsonian Institution. Accessed May 6, 2015 http://www.si.edu/mci/downloads/articles/Schweppe1987Yellow.pdf.

Schweppe, Helmut. 1986. *Practical Hints on Dyeing with Natural dyes: Production of Comparative Dyeings for the Identification of Dyes on Historic Textile Materials.* Washington, DC: Conservation Analytical Laboratory, Smithsonian Institution. Accessed May 6, 2015. http://www.si.edu/mci/downloads/articles/Schweppe1986Green.pdf.

Energy Independence and Security Act of 2007. Public Law 110–140 110th Cong., 1st sess. (December 19, 2007). Accessed May 6, 2015. http://www.gpo.gov/fdsys/pkg/STATUTE-121/pdf/STATUTE-121-Pg1492.pdf

FURTHER REFERENCE

Ballard, Mary, ed. (Complied with the help of Andrea Bowes, Stephen Collins, Shannon Elliott, La Tasha Harris, Laura Hazlett, Ester Methe, Muhammadin Razak, and Pugi Yosep Subagiyo) 1991. *Important Early Synthetic Dyes: Chemistry, Constitution, Date, Properties.* http://www.si.edu/mci/downloads/reports/IESD-CCDP1991.pdf

Cardenas, Lina M., Renzo Shamey, and David Hinks. 2009."Key Variables in the Control of Color in the Textile Supply Chain." *International Journal of Clothing Science and Technology* 21 (5).

Hinks, D., S. Draper, Q. Che, M. Nakpathom, A. El-Shafei, and R. Conelly. 2000. "Effect of Lighting Variability on Color Difference." *AATCC Review 32 (6) 16-20*.

SOURCES OF MATERIALS

Dyes were obtained as commercial samples from a variety of companies in preparation for the Schweppe courses and kept sealed in dark storage (powders) or frozen bags (natural dyes). Dyes are often considered eye irritants and some early synthetic dyes are potential carcinogens. Please consult safety literature including data found on Important Early Synthetic Dyes on the MCI website.

Test Fabrics
415 Delaware Avenue
PO Box 26
West Pittston, PA 18643
Tel: 570-603-0432
Fax: 570-603-0433
www.testfabrics.com

Hunter Associates Laboratory, Inc.
11491 Sunset Hills Road
Reston, VA 20190
Tel: 703-471-6870
Fax: 703-471-4237
www.hunterlab.com

Sigma-Aldrich, Inc.
3050 Spruce Street
St. Louis, MO 63103
Tel: 1-800-521-8956
www.sigmaaldrich.com

Organic Dyestuffs Corporation ("Orco").
65 Valley Street
East Providence, RI 02914
Tel: 401-434-3300
Fax: 401-438-8136
http://organicdye-px.rtrk.com/

International Dyestuffs Corp.
PO Box 2169
Clifton, NJ 07015
Tel: 201-778-0122
(No longer in business)

Carolina Color and Chemical Corp.
PO Box 5642
Charlotte, NC 28225
Tel: 704-333-5101
(No longer in business)

Passaic Color and Chemical Co.
28-36 Paterson Street
Paterson, NJ 07501
Tel: 201-279-0400
(No longer in business)

Earth Guild
33 Haywood Street
Asheville, NC 28801
Tel: 828-255-7818
Fax: 828-255-8593
www.earthguild.com

Kremer Pigments
247 West 29th Street
New York, N.Y. 10001
212-219-2394
http://shop.kremerpigments.com/

Dyestuff	C.I. Name	C.I. Number	Manufacturer/Supplier
Napthol Yellow	Acid Yellow 1	10316	(past mfr: International Dyestuffs Corp.) Sigma-Aldrich, Inc.
Uranine A	Acid Yellow 73	45350	(past mfr: Carolina Color and Chemical Corp.) Kremer Pigments
Auramine	Basic Yellow 2	41000	Sigma-Aldrich, Inc. (past mfr: International Dyestuffs Corp.)
Chrysoidine	Basic Orange 2	11270	Sigma-Aldrich, Inc. (past mfr: Passaic Color and Chemical Co.)
Crystal Violet	Basic Violet 3	42555	Sigma-Aldrich, Inc.
Diamond Green B	Basic Green 4	42000	Sigma-Aldrich, Inc.
Magenta	Basic Violet 14	42510	Organic Dyestuffs Corporation and Sigma-Aldrich, Inc.
Rhodamine 6G	Basic Red 1	45160	Sigma-Aldrich, Inc.
Vesuvin BA	Basic Brown 1	21000	Sigma-Aldrich, Inc. (past mfr: Passaic Color and Chemical Co.)
Victoria Blue B	Basic Blue 26	44045	Sigma-Aldrich, Inc.
Congo Red	Direct Red 28	22100	Sigma-Aldrich, Inc.
Safflower	Natural Red 26	75140	Earth Guild
Turmeric	Natural Yellow 3	75300	Earth Guild, Kremer Pigments

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MARY BALLARD received her BA in art history from Wellesley College and her MA from the Institute of Fine Arts, New York University as well as her certificate in conservation. After an apprenticeship at the Jewish Museum in New York with Kathryn Scott and several years at the Detroit Institute of Art, she has been at the Smithsonian Museum Conservation Institute (formerly CAL) since 1984. Museum Conservation Institute, Smithsonian Institution, 4210 Silver Hill Road, Suitland, MD 20746. E-mail: ballardm@si.edu

IN CONSIDERATION OF THE *THANGKA*

DENISE MIGDAIL

ABSTRACT—By examining the history of storage, display, and conservation of *thangka*s over fifty years at the Asian Art Museum, San Francisco, it is possible to trace an evolution in conservation philosophies and the efficacy of preventive and sustainable care. With the 2003 move from Golden Gate Park to the museum's current home in San Francisco's Civic Center Plaza, the storage design shifted from vertical, free-hanging, paintings-style storage to horizontal, flat-tray storage with full support. Further changes followed and developments in storage systems, approaches to conservation treatments, and shifts in exhibition methods are examined, culminating in the creation of the museum's current modular magnetic mounting system, which streamlines departmental costs, reduces material waste, and successfully supports and displays much of the Asian Art Museum's *thangka* collection.

EN HONOR AL THANGKA: RESUMEN—Examinando la historia del almacenamiento, la exhibición y la conservación de los *thangka*s de los últimos cincuenta años en el Museo de Arte Asiático de San Francisco, se puede observar una evolución en las filosofías de conservación y la eficacia del cuidado preventivo y sustentable. Con la mudanza de 2003 de Golden Gate Park al museo actual ubicado en la Plaza del Centro Cívico de San Francisco, el diseño de almacenamiento pasó de ser vertical, colgante, similar al de las pinturas, a un diseño horizontal, en bandejas planas totalmente soportadas. A esto le siguieron otros cambios. Se examinaron los desarrollos de los sistemas de almacenamiento, los nuevos métodos de tratamientos de conservación y los cambios en los métodos de exhibición, culminando con la creación del actual sistema de montaje magnético modular con que cuenta el museo, el cual optimiza los costos departamentales, reduce el desperdicio de materiales y sostiene y exhibe con éxito la colección de *thangka*s del Museo de Arte Asiático.

1. INTRODUCTION

*Thangka*s have been part of the Asian Art Museum of San Francisco's collection since its early origins in 1966, at which time the collection was simply housed in a newly constructed wing of the M.H. de Young Memorial Museum in Golden Gate Park. Over the years, the collection has grown, museum philosophies have shifted, and conservation practices have evolved. Currently, the collection holds 154 *thangka*s and is housed in San Francisco's Civic Center former Main Library, with retrofitted design by the late Gae Aulenti. By examining the history of storage, display, and conservation, it is possible to trace an evolution in collections-care philosophies as well as in the efficacy of preventive and sustainable care.

The word *thangka*, according to Jeff Durham, the assistant curator of Himalayan Art at the Asian Art Museum, literally translates as "flat thingy" (Durham 2014). In reality, *thangka*s are composite objects that, when intact, include fabric borders, veils, upper and lower hanging rods, wood or metal end knobs, ribbons, hanging cords, as well as backing fabrics and inscriptions on their reverse (figs. 1, 2). These Buddhist images are rarely, if ever, flat. They can serve as aids for education or meditation (a tool much like a *mandala*); they can also function as offerings or as forms of thanksgiving or celebration (large, building-sized *thangka*s frequently

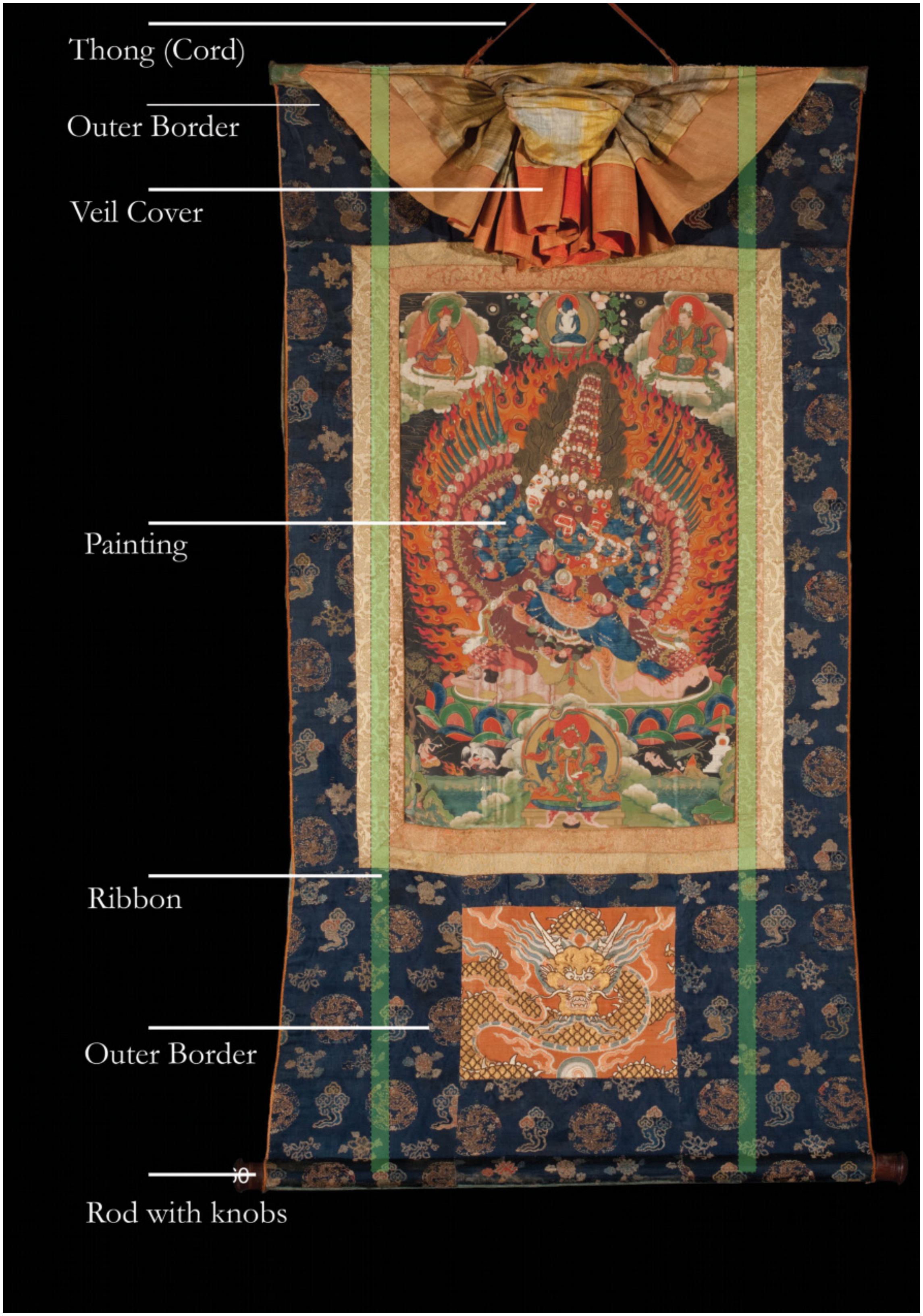

Figure 1: Labeled *thangka* (*The Buddhist deity Mahashri Heruka*) front, Asian Art Museum, San Francisco ©Asian Art Museum

Figure 2: Labeled *thangka* (*The Buddhist deity Mahashri Heruka*) back, Asian Art Museum, San Francisco
©Asian Art Museum

adorn Himalayan villages during festivals, for example). Although the central portions of *thangka*s are most often painted, the images can also be appliquéd, embroidered, woven, or a combination thereof. In other words, *thangka*s may range substantially in size, subject matter, and method of manufacture, but their overarching commonality is one of composite construction.

During the 1970s, when *thangka*s first started to be acquired by western collectors, they were prized for their central images and often removed from their fabric surrounds and accessory trappings. Over the last forty years, many museum professionals have advocated for a more holistic approach to the conservation of *thangka*s (Shaftel 1991). There has also been a push to educate and share preventative care approaches not only with western collectors, but with indigenous stakeholders as well (Brennan 2010). Symposia and outbreak sessions of ICCOM have focused on both the care and techniques of *thangka*s, and much of the literature can be found in a 2011 *Studies in Conservation* review paper by Sabine Cotte (Cotte 2011). The changes to treatment protocol, storage, and exhibition design at the Asian Art Museum echo many of these trends.

2. STORAGE DEVELOPMENTS

An early formative shift came with the relocation of the museum collections from Golden Gate Park to the newly designed facility in Civic Center. In preparation for the move, collection needs were reassessed and grants written. One in particular, which helped shape the new direction, was a National Endowment for the Humanities (NEH) grant for new storage units. Although *thangka*s were made to be rolled for storage, the paint layer is frequently lean (or low binder), and most western collections prefer not to risk damaging the painted image by constantly rolling and unrolling the pieces. The old storage system in Golden Gate Park allowed for hanging storage—an upgrade, perhaps, from rolled storage, but stressful for the objects nonetheless. The weight of these composite objects, especially if rods are still attached or if they have ornate lower end knobs, can be considerable, and it is typically the fragile silk border that bears this weight. Another downside to the hanging, paintings-style storage system was the movement of the sliding racks and the inherent risk of catching textile components within the framework. The NEH grant brought significant improvement with Delta Design closed cabinets containing flat trays (figs. 3, 4). The flat trays were so supportive and secure in their design that most of the *thangka* collection was moved within their storage cabinets, tied into position on their trays.

3. INSTALLATION STRATEGIES

Although one of the benefits of the Asian Art Museum is that much of the collection can be safely displayed behind glass, accessing the majority of these cases proved to be difficult. The Himalayan Gallery, for example, has a narrow (8-in. deep), floor to ceiling wall case that comprises seven glass panels, each measuring 8 × 3 ft. As it is only possible to move one pane of glass at any given time, the greatest case opening one can achieve is roughly 2 ft. Thus arose the first challenge of installing *thangka*s within their new gallery space: How does one protect the fragile painting or brittle silks from excessive movement while navigating the piece through a narrow opening?

To alleviate the stress of installation, fabric-covered boards were instituted. Although boards were occasionally used in the Golden Gate Park location, their use was more or less restricted to the most fragile of pieces. Installations in the new space confirmed the need for such boards for all *thangka*s: both for support

Figure 3: Images of old storage cabinets, Asian Art Museum, San Francisco ©Asian Art Museum

Figure 4: Images of new storage cabinets, Asian Art Museum, San Francisco ©Asian Art Museum

and aesthetic continuity. To minimize handling, each *thangka* would have its own hanging board—*thangka*s could then be stored flat, moved, and installed on their backing board.

Navy velveteen was chosen as the show fabric, as the color matched some of the outer border colors (blue is commonly the outer border color in *thangka*s) and the fabric was supportive via friction due to its soft nap. Over time, different materials were explored for the boards themselves. Tycore was very rigid, but it had a thick profile that took up extra space in storage. From registration's point of view, this was a huge deterrent, as support trays had to be moved further apart from each other, minimizing the overall number of trays in a cabinet. As a material, Tycore was also increasingly expensive to purchase. Coroplast was a less expensive alternative, but it was not nearly as rigid as Tycore, and it flexed when cut to size for the larger *thangka*s. Blue or gray board ended up being the most favored material because of its moderate rigidity, light weight, narrow profile, and ease of cutting to size. The edges of blue board are not nearly as sharp as those of coroplast and do not pose the risk of cutting the show fabric; however, the material was not as rigid as Tycore and would flex slightly with the larger sized pieces.

The *thangka*s were most often tied to their hanging boards: three ties at the top through the *thangka*'s hanging rod and backing board, and typically two ties at the bottom on either end of the lower rod. Buttons were frequently used on the reverse of the boards to distribute stress (the theory being that Coroplast edges could be sharp and gray board edges soft). Occasionally, additional stitching or pinning was necessary to provide full support to the pieces. Having all the *thangka*s on navy velveteen–covered boards offered a cohesive gallery look while fully supporting the pieces, but allowing them to appear to be free hanging (as they were made to be).

4. NEW DEVELOPMENTS

However, times change, the collection grows, and aesthetics shift. D-Lite board (aluminum-clad signboard), which provides superior stability while being lightweight and having an extremely thin profile, became the material of choice. The boards can be expensive, though; so, after several years of use, rather than having each *thangka* receive its own board, conservation considered standardizing mount sizes so that the boards could be interchangeable. The thought was to reduce the amount of overall material used over the course of a fiscal year. As new boards were being made, the opportunity to update the gallery look was seized upon and it was decided that the boards should match the case fabric. In an effort to make the standardized boards truly functional and receive the differently sized *thangka*s, a new hanging system was required: When tied to the boards, it is necessary to pierce the boards and create holes (with the position of the holes changing depending upon *thangka* size). Rare Earth magnets were being used for other purposes in the galleries, and their use was considered with the *thangka*s, as they could provide full support while avoiding the pitfall of holes in the support boards.

4.1 MAGNETIC MOUNTS

There are three components to a magnet system: the receiver (in the Asian Art Museum's case, the mount), the gap (which comprised the object and any show fabrics or covering), and the magnet itself (Spicer 2010). The mount board itself is straightforward in construction: D-Lite board is cut to size and D-rings are pop-riveted to the reverse to provide the hanging mechanism. Twenty-six gauge galvanized steel is secured to the D-Lite board with foil tape. To keep the overall weight down, the steel is often cut to 10-in. strips placed along the upper and lower portions of the mount. In this case, two-ply rag board would be cut to fill the void between steel strips to keep a flat profile. The downside to strips versus complete steel coverage is the limited magnetic area; the upside, as mentioned, is the reduced weight of the mount. The steel/board layer is covered in a layer of cotton flannel, and finally by the show fabric. To distribute the weight across the width of each *thangka*, magnets were embedded in rag board strips to create a hanging rod of sorts. This method built upon work the conservation department had developed for use with paper and textiles in other capacities within the museum, and the basics of our mounting system are available on AIC's *Objects Wiki* page: essentially, a layered bar is made up of two-ply ragboard and rare earth magnets (AIC, Objects Specialty Group 2011). Because of the weight of *thangka*s, with all of their component parts, stronger magnets (5/16 in. wide × 3 in. long × 1/8 in. thick, N40 grade, neodymium, magnetized through the width) were chosen rather than those used in the paintings gallery and mentioned on the *Wiki* page (fig. 5).

The systematized mount boards allow for a slim profile with minimal interference in viewing the *thangka*s: The boards, covered with the same fabric as the casework, drop back and the *thangka*s truly appear to be free hanging. All magnetic rods are labeled and stored on a spare backing board in conservation, and spare fabric-covered boards are stored in frame storage. The success of this mounting system has much to do with our current holdings: Many of the pieces in the Asian Art Museum's collection were conserved in the late 1970s and early 1980s and these treatments frequently entailed new shiny mounting materials complete with new fabric boarders, backings, and upper and lower hanging rods (frequently swapped out with acrylic). None of the rods removed for display with the current magnetic mounting system are original, and the sleeves that are opened to insert the rods are not original.

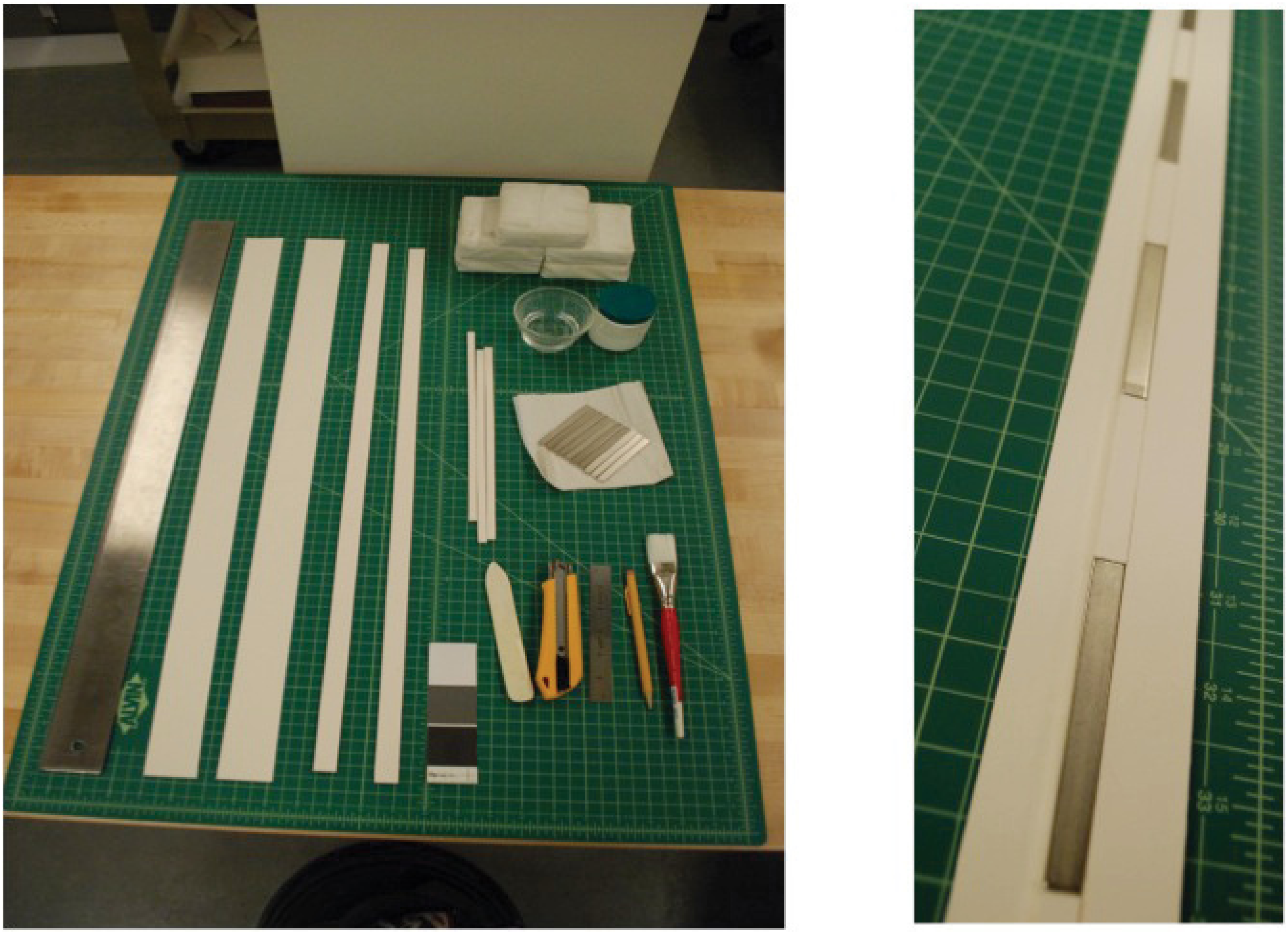

Figure 5: Magnetic strip setup with tools, Asian Art Museum, San Francisco ©Asian Art Museum

4.2 MAGNETIC MOUNT ACCESSORIES

The current system is constantly being tweaked to accommodate extra weight and to adapt it to work with original mounts. Magnetic support rods can be successfully hidden beneath veils, and painted or covered with fabric to camouflage their appearance and used on top of the *thangka* mount just beneath the original sleeve. Methods of adaptation also include bent Plexi clips with metal backings that can be temporarily bonded via a magnet to the backing board, and U-shaped metal hooks that serve in the same manner and can be toned to the color of the *thangka* with acrylic paint. Both types of brackets are used to help support the weight of lower rods and end knobs. Frequently, with the newer mounts, the hanging rods have been swapped out with hollow acrylic tubes. In this instance, a strong 6 in. × 5/16 in. × 1/8 in. magnet is placed within the hollow to help support the rod. Painted cast end knobs are also a staple in the museum, as many of the reconstructed mounts do not have their original lower hanging mechanisms—the facsimile knobs provide a finished look (figs. 6, 7). Despite all these adaptations, on occasion we still come across the *thangka* that is best served by being stitched or pinned to a board for overall support.

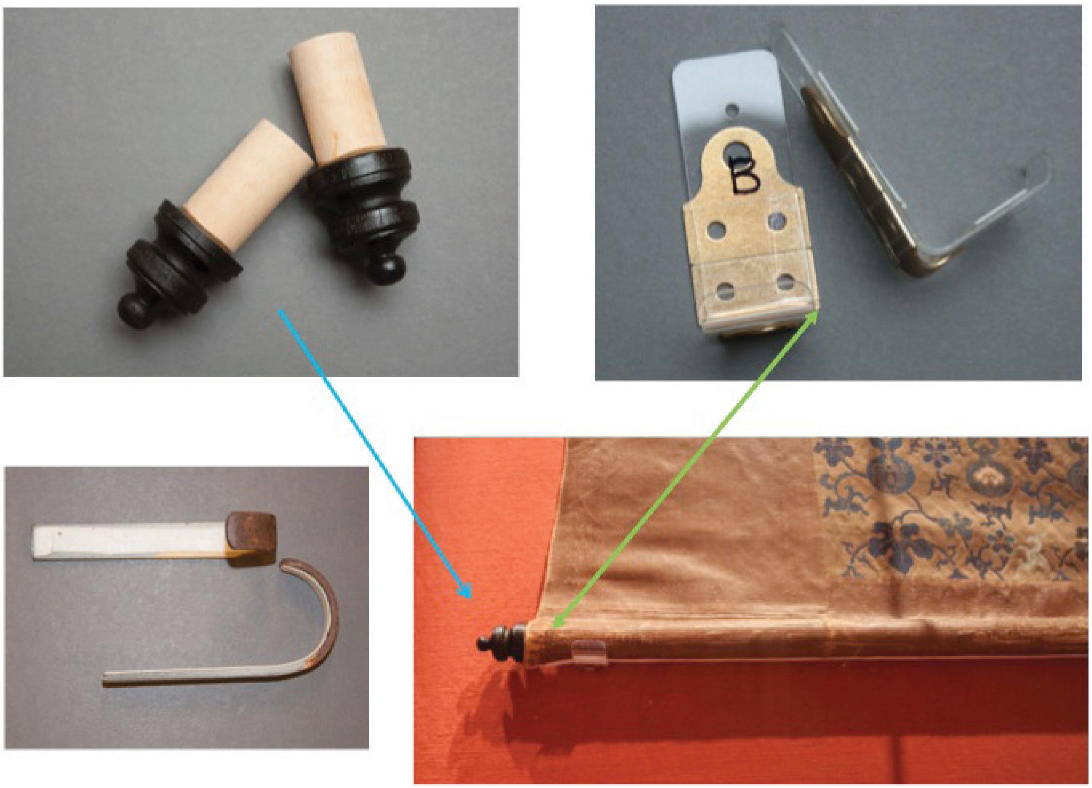

Figure 6: Magnetic mount accessories: hooks, clips, and knobs, Asian Art Museum, San Francisco ©Asian Art Museum

Figure 7: Gallery shot with magnetic mounts, Asian Art Museum, San Francisco ©Asian Art Museum

5. ALTERNATIVE MOUNTS

There are also times where the exhibition design dictates an entirely different mounting system. For a recent exhibition entitled "Enter the Mandala," the curator wanted to create the metaphysical, the actual mental entering of a mandala, on a physical plane. To assist in this vision, our designer created an exhibition in the round, complete with a mandala design and cardinal colors, printed on the floor (fig. 8). Four of the *thangka*s chosen were to be displayed double-sided so that the elaborate inscriptions on their reverse could be viewed. The pieces had been worked on in the past, and their current borders were reproduction with the possible exception of one where remnants of silk on the lower border are couched to a cotton fabric backing. At any rate, none of the pieces had finished backs and all turned-back edges were visible. Faux backings were cut to match the fishtail borders and were secured with stitching along all edges. The upper borders included stitched-in sleeves in which to insert hanging rods. The paintings, already heavily treated, had toned paper strips added to their outer edges as vertical support aids.

Figure 8: *Enter the Mandala* exhibition shot, Asian Art Museum, San Francisco ©Asian Art Museum

6. CHANGES TO CONSERVATION APPROACH

The preceding discussion mainly details the evolution of collections care with regard to storage and display at the Asian Art Museum, but the changes in philosophy have not stopped there. The overall approach to the care of *thangka*s has shifted and they are treated more as comprehensive wholes. Pieces are simply not removed when worn, but every effort is made to preserve the remaining component parts.

6.1 *THE GUARDIAN DHARMATALA AND THE GUARDIAN KINGS VIUPAKSHA AND VAISHRAVANA*, TIBET, 1800–1900, B62D39

For this Tibetan *thangka*, treated by Melissa Buschey (a New York University graduate intern) during her time at the Asian Art Museum, an effort was made to replace a missing knob based on the one remaining and to relax the distorted painting by humidification and adjustment of the poorly fitted fabric borders.

The knob was reproduced using Lego and clean clay as a support framework with which to make a room temperature vulcanized (RTV) rubber mold. Polyester resin was placed within the mold around a suspended cork insert to create the final hollow knob. The resin knob was painted with a combination of acrylic and metal spray paints to match the remaining knob (fig. 9). Following humidification, the painting was secured to its original fabric frame using the original holes in the painted portion of the *thangka* whenever possible and adjusting the tension whenever needed.

Figure 9: Reproduction knobs, Asian Art Museum, San Francisco ©Asian Art Museum

6.2 *THE TRANSMISSION OF THE TEACHINGS OF THE GELUGPA SECT*, CHINA, 1800–1900, B72D66

In the case of a Chinese *thangka* requested for loan, it was decided to proceed with the treatment requiring the least intervention: to support the worn borders in situ while fully attached. Fabric patches of appropriate color were inserted behind the areas of loss and the loose weft threads were couched in position using threads unraveled from Stabiltex. To minimize handling, the piece was packed tied to its backing/hanging board with a removable sheet of Photo-Tex tissue secured over the painted portion for protection during packing (fig. 10).

6.3 *THE BUDDHIST DEITY VAJRAPANI*, TIBET, 1600–1700, B60D51

As a final illustration of the shift in conservation philosophy as demonstrated by the Asian Art Museum, the treatment of *The Buddhist Deity Vajrapani thangka* embraces the current minimalist approach. Durham was delighted to discover this piece in the collection, as it had both a wonderful inscription on the reverse of the painting and another woven within its veil. The silk veil, however, was in very poor condition (fig. 11). As keeping the draping nature of the veil was determined to be the priority, it was decided to line the damaged lower section with polyester Stabiltex using stitching, rather than adhesive, as a means of stabilization. Care was taken to moderate stitch tension so as not to disrupt the weave structure. The treatment was a success, as the woven inscription remained visible after lining, and the object had enough strength and flexibility to be ruched and to continue to be used as intended (fig. 12).

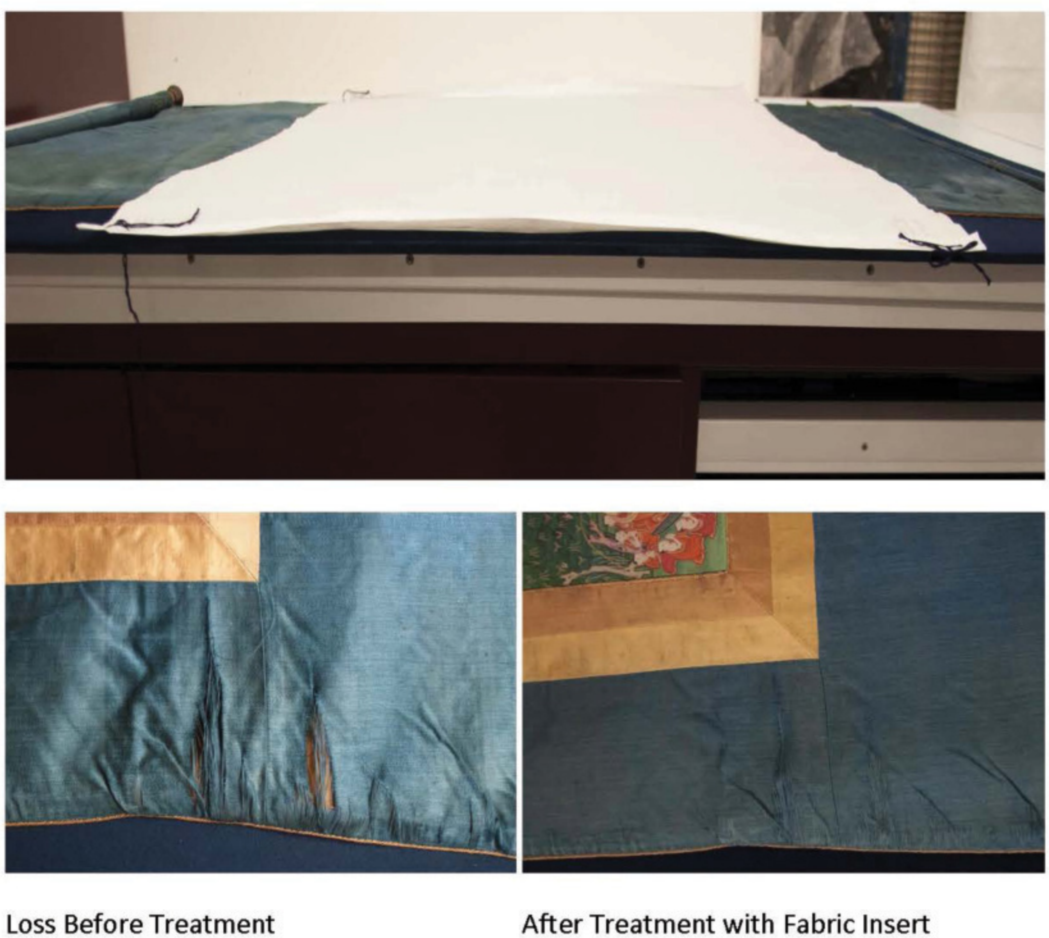

Figure 10: Fabric insert and Photo-tex Sheet, Asian Art Museum, San Francisco ©Asian Art Museum

Figure 11: *Thangka* veil before treatment, Asian Art Museum, San Francisco ©Asian Art Museum

Figure 12: *Thangka* veil after treatment, Asian Art Museum, San Francisco ©Asian Art Museum

7. CONCLUSIONS

Little work is completed successfully in a vacuum and the shifts in philosophies and embrace of new materials is largely the result of changes in the conservation community as a whole. Treatments will continue to be revisited and evolve in tandem with experience and access to new developments. The current goal of conservation within the Asian Art Museum is to maintain and display the collection with minimal interference to the original components and to support the remaining parts as completely as possible while reducing the overall material footprint.

ACKNOWLEDGMENTS

As this is a hugely collaborative effort, I would first like to thank my colleagues in the Asian Art Museum Conservation department both past and present. My special thanks to Melissa Buschey, Courtney Helion, and our image services department.

REFERENCES

Durham, J. 2014. Personal communication. Asian Art Museum, San Francisco, CA.

Brennan, J.M. 2010. “Teaching Preventive Conservation and Textile Treatments in Asia and Africa.” In *Textile Conservation Advances in Practice,* edited by Ewer, P. and F. Lennard, 277–283. Oxford: Butterworth-Heinemann.

Shaftel, A. 1991. “Conservation of Tibetan Thangkas.” *Journal of the American Institute for Conservation* 30 (2): 3–11.

Cotte S. 2011. “Conservation of Thangkas.” *Studies in Conservation* 56 (2): 81–93.

Spicer, G. 2010. “Defying Gravity with Magnetism.” *AIC News* 35 (6:1): 3–5.

AIC, Objects Specialty Group. 2011. “Magnet Mounts.” *Objects Specialty Group Conservation Wiki.* Holbrow, K, and Taira, K, contributors. Accessed August 11, 2014. http://www.conservation-wiki.com/wiki/Magnet_Mounts.

SOURCE OF MATERIALS

Aluminum Foil Tape
Uline
2950 Jurupa Street
Ontario, CA 91761
800-295-5510
www.uline.com

Blue/Gray Board
University Products
PO Box 101

Holyoke, MA 01041
800-628-1912
www.univeristyproducts.com

Corrugated Plastic and D-Lite Board
Product Signs Supplies
625 Emory Street
San Jose, CA 95110
Tel: 408-294-5823
www.productsignsupplies.com

Photo-Tex Tissue
Gaylord
PO Box 4901
Syracuse, NY 1322-4901
800-962-9580
www.gaylord.com

Pop Rivets
McMaster-Carr
562-692-5911
www.mcmaster.com

Rare Earth Magnets
K&J Magnets
18 Appletree Lane
Pipersville, PA 18947
888-746-7556
www.kjmagnetics.com

Rising Museum Board
DeltaHK Mat and Moulding
405 Victory Avenue, Suite L
South San Francscio, CA 94080
650-952-1634
www.deltahkinc.com

Storage Cabinets
Delta Designs Ltd.
PO Box 1733
Topeka, KS, 66601
800-656-7426
www.deltadesignsltd.com

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ANALYSIS OF ORGANIC DYES IN TEXTILES BY DIRECT ANALYSIS IN REAL TIME–TIME-OF-FLIGHT MASS SPECTROMETRY

CATHY SELVIUS DEROO AND RUTH ANN ARMITAGE

EXTENDED ABSTRACT—The analysis of an organic dyestuff on an historic textile is challenging because minute textile samples contain very low dye chromophore concentrations. Organic dye analysis is traditionally conducted using high-performance liquid chromatography (HPLC) often coupled to additional analytical tools, surface-enhanced Raman spectroscopy (SERS), and various mass spectrometric methods. The drawbacks of these methods are their requirements for either time-intensive dye extraction procedures or nanoparticle preparation protocols. Direct analysis in real time–time-of-flight mass spectrometry (DART-TOF-MS) is a novel method for organic chromophore analysis in natural fibers. Ambient ionization coupled to high-resolution time-of-flight mass spectrometry is both rapid and sensitive and is ideal for direct identification of small molecules of molecular mass less than 1000. Analysis of dyed fibers requires minimal or no prior preparation and is accomplished with fiber samples less than 0.5 cm long and weighing less than 1 mg. Initial studies consisted of analyses of dyestuffs in powder form, in solution, and in botanical source materials. Technique development involved the creation of dyed fiber reference materials. More than 40 dye chromophores have been identified by DART-TOF-MS, including anthraquinones, naphthoquinones, flavonoids, indigoids, carotenoids, tannins, and curcuminoids.

Organic dyes have also been successfully identified in situ in fibers from historic textiles. Preliminary analyses were conducted using fiber samples from a 19th century French treatise entitled, *Traité des Matiéres Colorantes du Blanchiment et de la Teinture du Coton*, on dye chemistry, various mordants, and dying protocols that conveniently included an appendix of dyed cotton fiber skeins. These initial studies are published in their entirety elsewhere (Selvius DeRoo and Armitage 2011; Geiger, Armitage, and Selvius DeRoo 2012). Additional studies consisting of fiber samples acquired from tapestries housed in the collections of the Detroit Institute of Arts have also been published elsewhere (Day, Selvius DeRoo, and Armitage 2013).

Most recently, DART-TOF-MS was used to verify the anecdotal account of the overdyeing Confederate hero Sam Davis's coat. The coat now resides in and belongs to the Tennessee State Museum. According to the museum, the coat was originally a sky blue Union cavalry greatcoat, which Davis's mother had overdyed to make it look more Confederate (i.e., more muddy gray). During the Civil War, Union forces considered anyone caught wearing Union uniform parts a spy, which Davis was. The Museum questioned the authenticity of the story and wondered if instead the coat was very dirty. Detroit Institute of Arts Textile Conservator Howard Sutcliffe working with the Tennessee State Museum provided samples of the coat fibers.

Reference materials were prepared from the husks of black walnut (*Juglans nigra*) and butternut (also called white walnut, *Juglans cinerea*), two materials known anecdotally as possible Confederate Civil War dyes. Mordants affected the color of the resulting fibers, which ranged from gray to brown. Indigo overdyeing of these reference samples resulted in colors ranging from blue to black. Indigo is readily identified in both positive and negative ion DART-TOF-MS, and was observed in all of the overdyed reference materials. Juglone (5-hydroxy-1,4-naphthoquinone) was identified by DART-TOF-MS in the wools dyed with the walnut husks, though at a very low relative abundance.

The findings from the analysis of the Sam Davis coat sample differed from those observed in the walnut-dyed test fibers. The sample consisted of a few fibers weighing approximately 0.3 mg. In the coat samples, two species

known to be walnut/butternut dye constituents were observed: naphthazarin and hydrojuglone. Juglone is the oxidized degradation product of the hydrojuglone glycoside botanical precursor; juglone differs from hydrojuglone in that the carbonyl groups of the latter are replaced with hydroxyls in the former. Indigotin was also detected in the coat fibers. Detecting both walnut dye constituents and indigo in the coat samples substantiates the account of Davis's mother overdying a Union greatcoat.

These studies demonstrate that DART-TOF-MS possesses the requisite sensitivity and the advantage of simplicity without the preparatory requirements of other techniques in the analysis of dyes in historic textiles. Furthermore, the technique is also capable of resolving multiple dyes in the same textile as was demonstrated in the analyses of the Sam Davis coat samples and the tapestry samples in the collections of the Detroit Institute of Arts.

ANÁLISIS DE TINTURAS ORGÁNICAS EN TELAS POR ANÁLISIS DIRECTO EN TIEMPO REAL-ESPECTROMETRÍA DE MASAS DE TIEMPO DE VUELO: RESUMEN—El análisis de una tintura orgánica de una tela histórica se encuentra con el problema de la detección de cromóforos en muy baja concentración en una muestra diminuta obtenida de un objeto de importancia cultural susceptible a la degradación. El Análisis Directo en Tiempo Real – Espectrometría de Masas de Tiempo de Vuelo es un método nuevo para el análisis de cromóforos orgánicos en fibras naturales y posee la sensibilidad necesaria y la ventaja de la simplicidad sin los requisitos preparatorios de las otras técnicas para el análisis de tinturas en telas históricas.

Los primeros estudios consistieron en el análisis de tinturas en polvo, diluidas y en materiales de fuentes botánicas. El desarrollo de la técnica incluyó la creación de materiales de referencia de fibra teñida. Hasta hoy, este método ha logrado identificar más de 40 cromóforos de tinturas: antraquinonas, naftoquinonas, flavonoides, indigoides, carotenoides, taninos y curcuminoides. Mediante la espectrometría de masas con análisis directo en tiempo real realizado in situ en fibras de telas históricas se han logrado detectar tinturas orgánicas, y esta técnica también puede resolver varias tinturas en la misma tela.

ACKNOWLEDGMENTS

We acknowledge Howard Sutcliffe, DIA textiles conservator, and Candace Adelson, senior curator of fashion and textiles at Tennessee State Museum, for obtaining and providing samples from the Sam Davis coat for analysis.

REFERENCES

Selvius DeRoo, C. and R. A. Armitage. 2011. "Direct Identification of Dyes in Textiles by Direct Analysis in Real Time–Time-of-Flight Mass Spectrometry." *Analytical Chemistry* 83 (18): 6924–6928.

Geiger, J., R. A. Armitage, and C. Selvius DeRoo. 2012. "Identification of Organic Dyes by Direct Analysis in Real Time-Time of Flight Mass Spectrometry." In *Collaborative Endeavors in the Chemical Analysis of Art and Cultural Heritage Materials*, edited by P. L. Lang and R. A. Armitage, 123–129. ACS Symposium Series 1103. Washington, DC: American Chemical Society.

Day, C. J., C. Selvius DeRoo, and R. A. Armitage. 2013. "Developing Direct Analysis in Real Time Time-of-Flight Mass Spectrometric Methods for Identification of Organic Dyes in Historic Wool Textiles." In *Archaeological Chemistry VIII*, edited by R. A. Armitage and J. H. Burton, 69–85. ACS Symposium Series 1147. Washington, DC: American Chemical Society.

AUTHOR BIOGRAPHIES

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PANEL DISCUSSION/DISCUSIÓN DEL PANEL
STRESSED ABOUT PESTS? A PANEL-LED DISCUSSION ON INTEGRATED PEST MANAGEMENT

RACHEL PERKINS ARENSTEIN, PATRICIA SILENCE, AND BERNICE MORRIS

ABSTRACT—Integrated Pest Management (IPM) is increasingly accepted by museums as a vital part of their conservation and collection care practices. IPM's comprehensive and proactive approach emphasizes prevention techniques to avoid the need for drastic remedial action. In this session, the panel members presented their experiences, and facilitated an audience-wide discussion about the challenges presented by pests to textile and other collections.

Patty Silence, conservator of Museum Exhibitions and Historic Interiors at the Colonial Williamsburg Foundation, discussed implementing IPM in a large institution with historic and contemporary structures. CWF's now runs a foundation-wide program, managed by a conservator and a full-time IPM technician. She shared how this holistic program has saved money and time, reduced pesticide use, and improved conditions for collections, from individual items such as textiles and furniture to entire buildings.

Bernice Morris shared her experiences as IPM coordinator at the Philadelphia Museum of Art. She discussed the development of a written IPM policy, the challenge of making the best use of monitoring data and the systems put in place at the PMA for preventing infestations in its costume and textile collection.

Rachael Arenstein, conservator at the Bible Lands Museum Jerusalem and partner in A.M. Art Conservation, spoke about challenges she has seen as a consultant working with small to mid-size museums in developing IPM programs, and the resources that the IPM Working Group has developed to meet those needs.

¿ESTRESADO POR LAS PLAGAS? UNA DISCUSIÓN DE PANEL SOBRE EL MANEJO INTEGRAL DE PLAGAS: RESUMEN—Cada vez más, los museos están aceptando el Manejo Integral de Plagas (MIP) como parte vital de sus prácticas de conservación y cuidado de las colecciones. El método integral y proactivo del MIP enfatiza las técnicas de prevención para evitar la necesidad de tomar medidas reparadoras drásticas. En esta sesión, los miembros del panel expusieron sus experiencias y facilitaron un debate entre todos los presentes sobre los problemas que presentan las plagas para las colecciones textiles y otras.

Patty Silence, Conservadora de las Exhibiciones e Interiores Históricos del Museo de la Fundación Colonial Williamsburg, habló sobre la implementación del MIP en una institución grande con estructuras históricas y contemporáneas. La Fundación ahora ofrece un programa dirigido por un conservador y un técnico de MIP full-time. Patty contó cómo este programa holístico les permitió ahorrar dinero y tiempo, redujo el uso de pesticidas y mejoró las condiciones para las colecciones, tanto para las piezas individuales, como telas y muebles, como para todo el edificio.

Bernice Morris compartió sus experiencias como Coordinadora de MIP en el Museo de Arte de Filadelfia. Habló sobre el desarrollo de una política de MIP, el desafío de aprovechar mejor el monitoreo de datos y los sistemas implementados en el museo para evitar infestaciones en su colección de trajes y telas.

Rachael Arenstein, conservadora del Museo Bible Lands de Jerusalén y socia de A.M. Art Conservation habló sobre los problemas que ha visto como consultora trabajando con museos pequeños y medianos en cuanto al desarrollo de programas de MIP, y los recursos desarrollados por el Equipo de Trabajo del MIP para cubrir esas necesidades.

All three presentations are available online at http:www.museumpests.net
http://museumpests.net/wp-content/uploads/2014/07/AIC-2014-Stressed-About-Pests-Arenstein-FINAL.pdf
http://museumpests.net/wp-content/uploads/2014/08/AIC-2014-Stressed-about-Pests-Silence-FINAL.pdf
http://museumpests.net/wp-content/uploads/2014/07/AIC-2014-Stressed-about-Pests-Morris-FINAL.pdf

AUTHOR BIOGRAPHIES

RACHAEL PERKINS ARENSTEIN is a professional associate member of the American Institute for Conservation. She is currently the conservator at the Bible Lands Museum Jerusalem but remains an active partner in A.M. Art Conservation, LLC, the private practice that she co-founded in 2009. Previously she worked at the Smithsonian National Museum of the American Indian, the Peabody Museum of Archaeology and Ethnology, the American Museum of Natural History, and the Metropolitan Museum of Art. Rachael is active in several professional organizations including positions as the e-editor for the AIC and the co-chair of the Integrated Pest Management Working Group.

BERNICE MORRIS is the associate conservator of Costume and Textiles and IPM Coordinator at the Philadelphia Museum of Art. Bernice holds an MA in textile conservation from the Textile Conservation Centre, University of Southampton, and a BA in history of art and Italian from the University of Birmingham, UK.

PATRICIA SILENCE is conservator of Museum Exhibitions and Historic Interiors at the Colonial Williamsburg Foundation, where she manages an extensive preventive conservation program. Patty manages the IPM program, working closely with a dedicated technician as well as specialists in architecture, landscape, safety, and conservation colleagues. She is an active participant in the Integrated Pest Management Working Group, which created and supports the http://www.museumpests.net website and the PestList listserv. Patty is a professional associate of AIC and co-founder of the Collections Care Network.

ADHESIVE SMACKDOWN: CONSOLIDATING A SYNTHETIC LEATHER WRESTLING COSTUME

ALISON CASTANEDA

ABSTRACT—Polyurethane (PUR) is one of the most commonly used materials for modern synthetic leather, and it is inherently flawed. Oxygen, light, and moisture all contribute to its decay within decades of production. The centerpiece of this poster is a garment sent by World Wrestling Entertainment (WWE) to the Textile Conservation Workshop. The synthetic leather was powdering and flaking badly with very limited amounts of the polyurethane "skin layer" remaining on the nylon knit substrate. Mock-ups were created using detached flakes and newly purchased nylon fabric to test the following adhesives for suitability: Gelatin, B72, Plextol B500, and Impranil DLV. Only B72 and Impranil DLV adhered the heavy flakes to an acceptable degree, and of the two, Impranil DLV left the nylon substrate more flexible. The costume was ultimately consolidated with a 24% solution of Impranil DLV in water and packed in a customized storage to be safely viewed and studied.

SMACKDOWN ADHESIVO: CONSOLIDACIÓN DE UN TRAJE DE LUCHA LIBRE DE CUERO SINTÉTICO: RESUMEN—El poliuretano (PUR) es uno de los materiales más usados para el cuero sintético moderno pero es inherentemente defectuoso. El oxígeno, la luz y la humedad contribuyen con su deterioro a las pocas décadas de su producción. La imagen central de este póster es un traje enviado por la World Wrestling Entertainment (WWE) al Taller de Conservación Textil. El cuero sintético se estaba descascarando y generando polvillo, y la capa de poliuretano que cubría el tejido de nylon prácticamente había desaparecido. Se crearon muestras con los trozos desprendidos y tela de nylon recién comprada para probar la eficacia de los siguientes adhesivos: Gelatina, B72, Plextol B500 e Impranil DLV. Solo el B72 y el Impranil DLV adhirieron los trozos de poliuretano de manera aceptable y de los dos, el Impranil DLV flexibilizó más el tejido de nylon. El traje fue reparado con una solución de Impranil DLV en agua al 24% y fue colocado en un lugar personalizado para ser observado y estudiado.

http://www.conservation-us.org/docs/default-source/annualmeeting/2014am_poster07_adhesive_smackdown_consolidating.pdf?sfvrsn=2

AUTHOR BIOGRAPHY

ALISON CASTANEDA holds a BA in history from Fordham University and an MA in fashion and textile studies from the Fashion Institute of Technology. She is an associate member of the American Institute of Conservation and has been a conservator at the Textile Conservation Workshop in South Salem, New York, since 2010. Before joining the workshop, she interned at the New York Historical Society and the Textile Conservation Laboratory at St. John the Divine. She specializes in historic costume and is currently earning a second degree in chemistry from the City College of New York. Address: 3 Main St, South Salem, NY. Email: alison.textileconservation@gmail.com.

EVALUATING AND CHOOSING SHEER OVERLAYS

CAMILLE MYERS BREEZE

ABSTRACT—Textile conservators have employed sheer overlays for stabilization and preventative conservation since the early days of our field. An overlay is a sheer material placed on an object's surface to protect the object and/or change its appearance. The benefit of a sheer overlay is that it can provide immediate stabilization, as well as preventative protection, and is easily reversible, except when applied using an adhesive. It is one of the first treatments that interns at Museum Textile Services learn. In an effort to create a standard protocol for evaluating and selecting sheer overlays, I created a Sheer Overlay Score Card based on the three main categories of sheer fabrics listed the *AIC Wiki*: nylon net, silk crepeline, and polyester sheer. The score card allows staff to weigh the relative pros and cons of each sheer material based on sets of variable and nonvariable factors. This interactive poster allows viewers to touch samples of many sheer overlay materials, vote for the material they most often use, tell us where they find these sometimes-evasive materials, and take away a copy of the Sheer Overlay Score Card. Results of my international survey on Sheer Overlays will be published in 2015.

EVALUACIÓN Y SELECCIÓN DE LAS CAPAS TRANSPARENTES:RESUMEN—Desde los comienzos, los conservadores textiles han utilizado capas transparentes con fines de estabilización y conservación preventiva. Una capa transparente es un material translúcido colocado sobre la superficie de un objeto para protegerlo y/o cambiar su aspecto. El beneficio de las capas transparentes es estabilizar y proteger preventivamente al objeto, y es fácilmente reversible, salvo que se aplique con pegamento. Por eso, es uno de los primeros tratamientos que aprenden los pasantes en los Servicios Textiles del Museo. Con el fin de crear un protocolo estándar para evaluar y seleccionar las capas transparentes, he creado una escala de puntuación de capas transparentes basada en las tres categorías principales de telas transparentes listadas en *AIC Wiki* (Instituto Americano de Conservación): malla de nylon, crepelina de seda y poliéster transparente. La escala de puntuación permite al personal sopesar los pros y contras relativos de cada material transparente en base a factores variables y no variables. En este póster interactivo, los observadores podrán tocar las muestras de diferentes materiales de capas transparentes, votar por el material que más utilizan, contarnos dónde encuentran estos materiales y llevarse una copia de la escala de puntuación de capas transparentes. Los resultados de mi encuesta internacional sobre Capas Transparentes se publicarán en 2015.

http://www.conservation-us.org/docs/default-source/annualmeeting/2014am_poster09_evaluating_choosing_sheer_overlays.pdf?sfvrsn=2

AUTHOR BIOGRAPHY

CAMILLE MYERS BREEZE is director and chief conservator of Museum Textile Services. Camille began her textile conservation career in 1989 at the Textile Conservation Workshop in South Salem, New York. After earning a BA in art history from Oberlin College, Camille received an MA in museum studies: Costume and Textiles Conservation from the State University of New York: Fashion Institute of Technology. She spent five years in the Textile Conservation Laboratory at the Cathedral of St. John the Divine in New York City before moving to the Textile Conservation Center at the American Textile History Museum, in Lowell, MA. Camille founded Museum Textile Services in 1999 as a full-service textile conservation studio serving museums, historical societies, and private collectors. She is the author of numerous articles, a book on American tapestry conservation techniques, and she has taught in the United States, the Dominican Republic, and Peru. Address: PO Box 5004, Andover, MA 01810. E-mail: museumtextiles@gmail.com

NEW APPROACHES IN COMPREHENSIVE MOLD REMEDIATION AND RECOVERY

ELISE YVONNE ROUSSEAU

ABSTRACT—This poster follows the comprehensive treatment of furniture, decorative arts, and painting collections to exemplify how conservators can identify active fungal, bacterial microorganism, and concomitant pest infestations. It includes specific protocols for remediation and recovery of contaminated collections and facilities.

What are bioaerosols, fungi, bacteria, mycotoxins, volatile organic compounds, and microbial microorganisms? Understanding the biological science of mycelium branching, germination, and spore blooming cycles is imperative to preventing reinfestation or cross contamination. Identifying the particular species strain is an important initial step. Accurate testing methods and sampling, such as ATP bioluminescence rapid hygiene swabbing and culturing for colony-forming unit counts, are discussed.

Methods for staging quarantine isolation workspaces that segregate dirty to clean treatment operations are described. The "New and Next Generation" appropriate baselines for dehumidifying, desiccating, dry thermal vacuum freezing, CO_2 anoxia oxygen deprivation encapsulation, dry-ice dusting, non-contaminant transfer HEPA-micro vacuuming, and antiseptic solutions for surface cleaning are established.

Mold, microorganisms, and pests must be addressed as contaminants with the potential of widespread damaging life cycles throughout collections. Preventative conservation planning costs little in comparison to disaster recovery and potential health hazards that would ensue from a fungal infestation passively allowed to proliferate.

NUEVOS MÉTODOS PARA LA REPARACIÓN Y RECUPERACIÓN INTEGRAL DE OBRAS CON MOHO: RESUMEN – Este póster muestra el tratamiento integral de colecciones de muebles, objetos de arte decorativos y pinturas para ejemplificar cómo los conservadores pueden detectar la presencia de hongos, microorganismos bacteriales e infestaciones de plagas concomitantes activas. Incluye protocolos específicos para la reparación y recuperación de colecciones e instalaciones contaminadas.

¿Qué son los bioaerosoles, los hongos, las bacterias, las micotoxinas, los compuestos orgánicos volátiles y los microorganismos microbiales? Es imperativo entender la ciencia biológica de la ramificación del micelio, la germinación y los ciclos de floración de las esporas para evitar la reinfestación o la contaminación cruzada. Un punto de partida importante es la identificación de la cepa de la especie en particular. Se discuten los métodos de prueba y muestreo, como el test rápido de hisopado higiénico y medición de ATP por bioluminiscencia, cultivos y muestras de aire para el recuento de unidades formadoras de colonias.

Se describen métodos para las cuarentenas por etapas y los espacios de trabajo aislados que separan las operaciones de tratamiento sucio y limpio. Se establecen las pautas apropiadas para la "Nueva y Próxima Generación" sobre la deshumidificación, deshidratación, congelación al vacío en seco, prueba de anoxia por privación de oxígeno y acumulación de CO_2, pulverización con hielo seco, aspirado de transferencia no contaminante con filtro hepa-micro, y soluciones antisépticas para la limpieza de superficies.

El moho, los microorganismos microbiales y las plagas deben ser tratados como contaminantes contagiosos con ciclos de vida potencialmente perjudiciales que se diseminan por todas las colecciones. Los planes de

conservación preventiva cuestan muy poco en comparación con lo que cuesta la recuperación de las obras y los potenciales riesgos para la salud generados por la proliferación de una infestación fúngica.

http://www.conservation-us.org/docs/default-source/annualmeeting/2014am_poster64_new_comprehensive_approaches_mold.jpg?sfvrsn=2

AUTHOR BIOGRAPHY

ELISE YVONNE ROUSSEAU is a conservator in San Francisco. She studied in Brussels, Belgium, at the Institute Royal de Patrimoine Artistique (IRPA-KIK) Cultural Heritage, acquiring further training in textiles at the Karlshrue Archdiocese Schule der Künste in Ettlingen, Germany. She has an MA in museum studies and 18.5 post-graduate credits from the Mount Sinai School of Medicine, Albany, New York, which she gained at the 6th Annual International Scientific Conference on Bioaerosols, Fungi, Bacteria, Mycotoxins in Indoor & Outdoor Environments and Human Health. In 1999 she established the atelier Art Conservation de Rigueur et Anoxia Abatement Solutions, a conservation practice in San Francisco specializing in textiles, historic objects, and decorative arts. They provide emergency and disaster remediation, conservation assessment, IPM, mold/microbial abatement, and recovery. These services complement the complete conservation services for the cleaning, repair, and presentation of a wide variety of artifacts and objects. Elise is currently serving her third elected term of office on the Costume Society of America's Western Region Boards of Directors and her second term with the Bay Area Art Conservation Guild. She was previously at the de Saisset Museum at Santa Clara University as guest curator of the Pre-Contact, Mission Santa Clara, and Early California Collections. Address: 577, 14th Avenue, No. 2 San Francisco, CA 94118 Email: elise@artconservationderigueur.com.

THE HUMMING BIRD 2: USING FOSSHAPE AS AN ALTERNATIVE BACKING FOR FIBER ART SCULPTURE

MARISSA STEVENSON, JASON DEPRIEST, SUZANNE HARGROVE

ABSTRACT—Fosshape is a malleable fabric commonly used in the costume and theater industry. It is a nonwoven fabric made of low-melting synthetic polyester fiber that can be manipulated into a permanent form when exposed to heat (200°F range). Fosshape conforms to an underlying surface to create a firm custom fit support that can be sewn in place. In 2009, the Textile Museum in Washington, DC, utilized Fosshape to construct invisible costume mounting structures (Amnéus and Miles 2012). At the Toledo Museum of Art, Fosshape was considered as a possible support for *The Hummingbird 2,* a three-dimensional hemp and sisal wall sculpture by Magdalena Abakanowicz. The artwork has an uneven weight distribution with wide-ranging undulating peaks and valleys. The weaving was tacked to an original wood frame mount, which did not provide adequate support. Fosshape was considered an ideal textile-friendly (or textile-compatible) material to provide needed auxiliary rigid support for both the sculpture and its existing wood frame.

EL COLIBRÝ 2: USO DEL FOSSHAPE COMO SOPORTE ALTERNATIVO PARA UNA ESCULTURA DE FIBRA: RESUMEN—El Fosshape es una tela maleable comúnmente utilizada en la industria del vestuario teatral. Es una tela no tejida hecha de fibra de poliéster sintética con punto de fusión bajo que, expuesta al calor (rango de 200°F), puede modelarse en cualquier forma. El Fosshape se adecua a la superficie subyacente para crear un armazón firme que puede coserse al traje. En 2009, el Museo Textil de Washington D.C. utilizó el Fosshape para armar estructuras invisibles para el montaje de trajes. En el Museo de Arte de Toledo, se consideró el uso del Fosshape como posible soporte para *El Colibrí 2,* una escultura de pared de cáñamo y sisal tridimensional hecha por Magdalena Abakanowicz. La obra de arte tiene una distribución de peso despareja, con grandes ondulaciones y valles. Originalmente, el tejido se fijó a un marco de madera que no le proporcionaba el sostén adecuado. Se consideró que el Fosshape podría ser un material compatible e ideal para proporcionar el soporte rígido auxiliar tanto para la escultura como para el marco de madera existente.
http://www.conservation-us.org/docs/default-source/annualmeeting/2014am_poster39_the_humming_birds.pdf?sfvrsn=2

REFERENCE

Amnéus, Cynthia and Marla Miles. 2012. "A Method for Invisibly Mounting Costume Using Fosshape". *Journal of the American Institute of for Conservation*. 51 (1): 3–14.

AUTHOR BIOGRAPHIES

MARISSA STEVENSON graduated from the University of Toledo with a BA in art history (2005) and has been a conservation intern at the Toledo Museum of Art since 2013. She has a broad range of experience in conservation of collections including books and book binding at the Bentley Historical Library at the University of Michigan with Master Bookbinder Jim Craven, conservation of books and western ephemera at the Buffalo Bill Center of the West under the direction of Beverly Perkins, and an extensive range of

conservation experience dealing with the museum environment, preventive maintenance, and treatment of artworks at the Toledo Museum of Art with Suzanne Hargrove. She will be applying to art conservation graduate programs for the Fall of 2016. Address: Toledo Museum of Art, 2445 Monroe St., Toledo, OH 43620. Email: mstevenson@toledomuseum.org.

JASON A. DEPRIEST has over 15 years' experience working with exhibit production. He holds an MFA in art history from the Savannah College of Art and Design (2003) and has worked as an art handler/mountmaker for the Toledo Museum of Art since 2008. Previously, he worked as a preparator for a history museum in Kansas City, MO, and spent several years working for commercial fine art galleries. Working hands-on with a diversity of objects in many different institutions, he has implemented a variety of installation techniques, often requiring custom-made mounts or support structures. The process of designing and fabricating a mount for an object—be it an ancient artifact or a contemporary piece—is what he considers the most interesting part of his job. Though the mount is intended to play a merely supportive role, he often jokes that, with the amount of time and craftsmanship that goes into making each one, the mount itself sometimes becomes so sculptural that it deserves to be displayed on its own. Address: Toledo Museum of Art, 2445 Monroe St., Toledo, OH 43620. Email: jdepriest@toledomuseum.org.

SUZANNE HARGROVE has been the head of conservation at the Toledo Museum of Art since 2003. Her focus of attention has been on collections care and conservation treatment with an emphasis environmental issues particularly related to going green and sustainability. Her interests include community outreach in the area of conservation and mentoring new generations of conservators. Formerly, she was the head of objects conservation at the Saint Louis Art Museum. She received her master's degree with certificate for advanced study in conservation from the State University College at Buffalo with a specialty in objects conservation. Address: Toledo Museum of Art, 2445 Monroe St., Toledo, OH 43620. Email: shargrove@toledomuseum.org.